Bodily Contributions to Emotion: Schachter's Legacy for a Psychological Constructionist View on Emotion

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Abstract

Although early emotion theorists posited that bodily changes contribute to emotion, the primary view in affective science over the last century has been that emotions produce bodily changes. Recent findings from physiology, neuroscience, and neuropsychology support the early intuition that body representations can help constitute emotion. These findings are consistent with the modern psychological constructionist hypothesis that emotions emerge when representations of bodily changes are conceptualized as an instance of emotion. We begin by introducing the psychological constructionist approach to emotion. With Schachter as inspiration, we next examine how embodied representations contribute to affective states, and ultimately emotion, with inflammation as a key example. We close by looking forward to future research on how body representations contribute to human experience.

Keywords

body states, core affect, embodiment, emotion experience, homeostasis, psychological construction

Early theorists posited that body states contribute to emotion experience (e.g., James, 1890). However, the prevailing view in affective science over the last century was that representations of bodily changes are outcomes rather than constituents of emotions. In this view, an emotion, once triggered—either by dedicated neural circuitry (Cannon, 1921, 1927; Ekman & Cordaro, 2011; Panksepp, 1998; Vytal & Hamman, 2010) or a cognitive system (Arnold, 1960; Lazarus, 1966; Roseman, 2011), produces changes in facial and peripheral musculature, as well as patterned changes in the cardiac, respiratory, and neurochemical systems. However, growing evidence suggests that representations of bodily changes may also help *constitute* emotion, by generating the affective states that contribute to emotion experience in the first place (for discussions, see Barrett & Lindquist, 2008; Craig, 2009; Critchley & Nagai, 2012; Damasio, 2001; Laird & Lacasse, 2014; Lindquist, 2013; Oosterwijk et al., 2012).

The idea that representations of body states can constitute, not just result from, emotions is consistent with a psychological constructionist approach to emotion. We begin our article by introducing the psychological constructionist approach to emotion and outlining predictions for the role of body representations in emotion. We argue that Stanley Schachter's research played an important, yet frequently

unrecognized, role in the legacy of this theory. In particular, Schachter's focus on the constitutive role of body representations in emotion was especially important to the psychological constructionist theory. Building on Schachter's legacy, we next review growing evidence that representations of the body's ongoing state help generate and create variation in emotion experience. To illustrate this, we close by examining how putatively "nonemotional" bodily changes such as inflammation can shape our everyday emotional lives.

A Psychological Constructionist View: Body Representations Help Constitute Emotion

The idea that body representations help constitute emotion is consistent with modern *psychological constructionist* views (e.g., Barrett, 2006; Barrett & Russell, 2015; Cunningham, Dunfield, & Stillman, 2013; Lindquist, 2013; Storbeck & Clore, 2008). According to psychological constructionism, an emotion is a highly situated subjective state that emerges from the combination of more basic constitutive parts (for discussions of this approach's causal and measurement models, see Barrett, 2006, 2011).[1] Many constructionist views agree that representations of the body's state serve as one such constitutive part in emotion

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(e.g., Barrett & Russell, 2015; Cunningham et al., 2013; Lindquist, 2013; Storbeck & Clore, 2008). According to our particular constructionist view, the Conceptual Act Theory (CAT; cf. Barrett, 2006; Barrett, Wilson-Mendenhall, & Barsalou, 2015; Lindquist, 2013), emotions emerge from causal indicators such as representations of the body's internal state and exteroceptive representations from the current context, as well as attention and conceptual knowledge about emotion categories acquired via prior experiences (for fuller discussion of emotions as emergent variables, see Barrett, 2006, 2011; Clore & Ortony, 2008; Coan, 2010; Coan & Gonzalez, 2015; see Figure 1). These elements combine in a given context when representations of bodily changes and exteroceptive sensations are automatically categorized as an instance of an emotion category (e.g., anger vs. fear) using conceptual knowledge about emotions (Barrett, 2015; Lindquist, 2013). Our own approach calls the process by which body representations and exteroceptive sensations are made meaningful *situated conceptualization* (cf. Barrett & Russell, 2015; Barrett et al., 2015; Lindquist, 2013). Emotions are thus at once bodily, conceptual, and highly situated phenomena (cf. Lindquist & Barrett, 2008; Wilson-Mendenhall, Barrett, Simmons, & Barsalou, 2011). These findings are consistent with the idea that the brain is a predictive organ: it uses both a priori conceptual knowledge to interpret current sensations and also ongoing afferent representations from the body to update those interpretations in context (see Barrett & Simmons, 2015; Chanes & Barrett, in press).

Body Representations Contribute to Emotions Via Core Affect

All psychological constructionist views agree that *core affect* (sometimes "affect") is a basic, constitutive component of emotions that can be experienced as having some degree of valence and arousal (Barrett, 2006; Clore & Ortony, 2008; Cunningham et al., 2013; Russell, 2003; Russell & Barrett, 1999). Some constructionist views further hypothesize that core affect is derived from representations of changes in the organism's viscera and allostatic state (Barrett & Bliss-Moreau, 2009; Lindquist, 2013; Russell, 2003; Storbeck & Clore, 2008).[2] The CAT particularly focuses on how body representations help constitute core affect, and ultimately emotions. Core affect is thought to serve as a homeostatic barometer by bringing disparate representations of bodily information (from the autonomic, proprioceptive, kinesthetic, somatovisceral, and neurochemical systems) together to generate evaluative representations of hedonic valence and arousal (Barrett, 2006; Lindquist, 2013; Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012; Russell, 2003).

Critically, insofar as embodied information suffuses and informs every aspect of conscious experience (Barrett & Simmons, 2015; Seth, 2015; Seth, Suzuki, & Critchley, 2012), core affect provides a constantly updating "snapshot" of the body's internal conditions. Core affect may move to the forefront of awareness when there is a noticeable shift (e.g., increases in feelings of arousal, feelings of pleasantness, etc.) or when attention is directed towards our internal state (e.g., when someone asks "how are you?"). The "ambiguous arousal"

proposed by Schachter and Singer (1962) is a historical predecessor of the modern-day conception of "core affect."

Core affect is represented by the central nervous system when afferent information from the peripheral nervous system is projected to limbic and paralimbic structures (Craig, 2009; Nauta, 1971). We hypothesize that core affect is sometimes the product of relatively direct representations of body states—for instance, a feeling of arousal associated with perceptions of increased heart rate. However, core affect perhaps more often includes representations of relatively distal, less overt bodily causes that are more ambiguous and less easily or immediately perceived, such as inflammation or low blood sugar, but which still contribute to a gestalt representation (e.g., high arousal, unpleasantness, or both).

Schachter's Psychological Constructionist Legacy

In our view, Schachter's model of emotion (Schachter & Singer, 1962) is a classic example of a psychological constructionist account. However, Schachter's approach was historically aligned with appraisal theories of emotion because the model discussed the role of "meaning making" in emotion. Until recently, it was assumed that any model that invoked "meaning making" in the generation of emotion was necessarily an appraisal model, although this is incorrect (for history, see Gendron & Barrett, 2009). Both appraisal and psychological constructionist approaches focus on meaning making in emotion (see Lindquist, 2013, for a distinction between types of appraisal views). However, what ultimately divides appraisal from psychological constructionist views is that the latter focuses on the role of other fundamental components such as core affect in the generation of emotions. According to constructionist views, core affect is transformed into an emotion experience during situated conceptualization when it is linked to the context and made meaningful as a specific emotion using conceptual knowledge about emotion categories (see Kirkland & Cunningham, 2011; Lindquist, MacCormack, & Shablack, 2015; Wilson-Mendenhall et al., 2011). We believe that Schachter's emphasis on the interactive role between ambiguous physiological arousal from the viscera and the situated conceptualization of that arousal as an emotion during social affiliation thus aligns his approach with modern psychological constructionist accounts.

Schachter's legacy for the psychological constructionist approach stems not only from his focus on the interaction of arousal and meaning making, but also from his particular focus on the bodily representation of arousal. For instance, in his classic study with Singer, he induced arousal via injections of epinephrine (i.e., adrenaline), a neurochemical that affects heart rate, respiration, the vasculature, and muscle contraction (Cryer, 1993). Participants' felt arousal in Schachter and Singer's experiment is therefore derived from representations of bodily changes. Even Schachter's lesser known research had a (at least implicit) focus on the role of body representations in other mental states. For instance, he investigated how body sensations were conceptualized as pain (Nisbett & Schachter, 1966), how
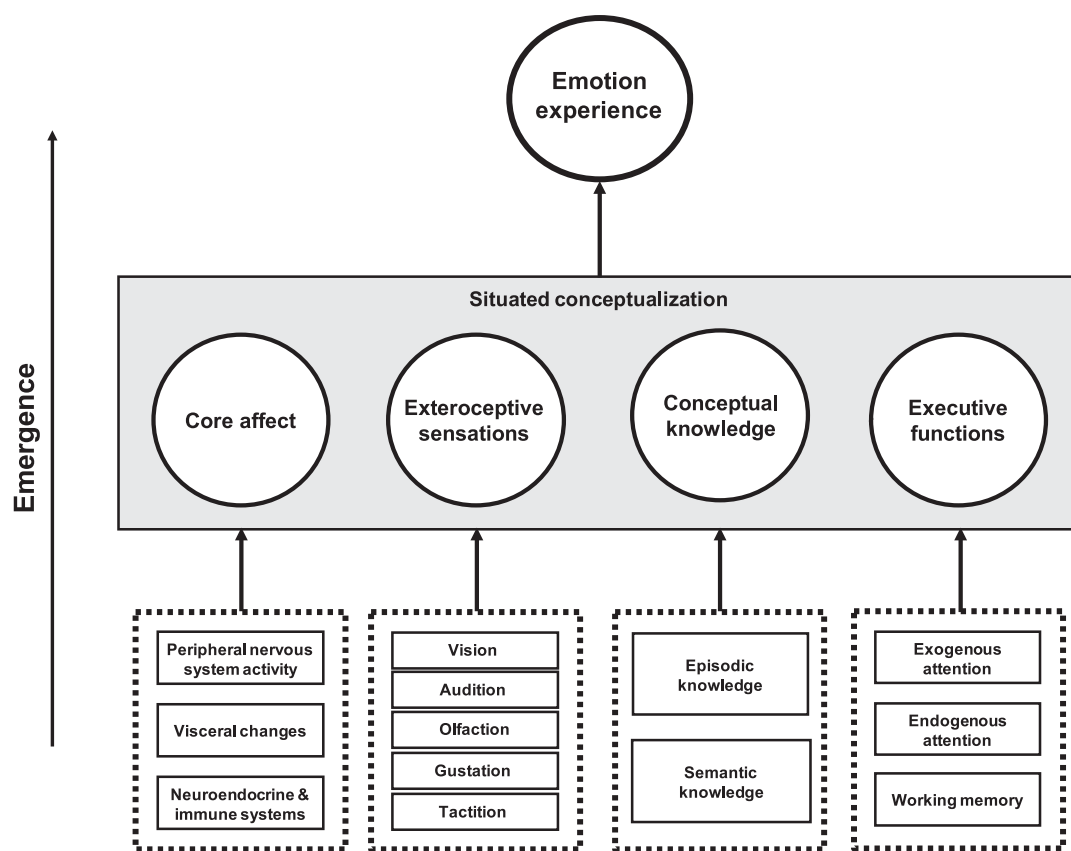
Figure 1. An emergent model of emotion as theorized by the Conceptual Act Theory. Measurable phenomena such as peripheral nervous system activity, visual sensations, episodic knowledge, exogenous attention, etcetera, contribute to the more basic psychological components of emotion such as core affect, exteroceptive sensation, conceptual knowledge, and executive function. These components combine in a given context to create an emergent emotion experience. The Conceptual Act Theory proposes that these components combine through the process of *situated conceptualization*.

representations of unpleasant core affect (i.e., stress) contributed to experiences of hunger (Schachter, 1978, 1982), and how individuals differentially sensed and made meaning of sensations such as hunger (Schachter, 1968, 1971, 1974; Schachter & Rodin, 1974). The idea that representations of bodily changes could also be conceptualized as other mental states depending on the context and a person's available conceptual knowledge is consistent with our own psychological constructionist predictions (see Barrett, 2009; Lindquist, 2013; Oosterwijk et al., 2012). For example, core affect derived from body representations could be conceptualized as an emotion (e.g., "anxiety"), as a drive state (e.g., "hunger"), as a somatic complaint (e.g., "an upset stomach"), or as an attitude (e.g., "intense dislike" of something), depending on the situated conceptualization that is made.

Although the specific hypotheses of Schachter and Singer's (1962) model were not all supported by early evidence (see Reisenzein, 1983, for review), new evidence substantiates the more general psychological constructionist hypothesis that a person experiences an emotion when core affect is made meaningful during situated conceptualization. In particular, accumulating evidence suggests that both peripheral nervous system feedback from the body and central representations of that bodily feedback in the brain are made meaningful as emotion

experiences (see Critchley & Harrison, 2013; Harrison, Gray, Gianaros, & Critchley, 2010, for reviews).

Body Representations Contribute to Emotion

Although early emotion theorists hypothesized that the body was important for emotion (Duffy, 1957; James, 1884; Sully, 1892), only now with improved methodologies in psychophysiology and neuroscience have researchers been able to test the embodied mechanisms underlying emotion. For example, meta-analyses of neuroimaging studies reveal that a host of brain regions responsible for representing body sensations are active during emotion experience (Kober et al., 2008; Lindquist et al., 2012). One such region is the insula. Neuroanatomical findings suggest that the posterior and mid-insula receive projections from spinal cord lamina representing sensations from the peripheral nervous system and then project this information forward to the anterior insula, a region crucial for integrating specific body representations into a more holistic sense of the body's condition (see Barrett & Simmons, 2015; Craig, 2009, 2011; Critchley, 2004, 2009).

Insula activation, and in particular, anterior insula activation, has been linked to greater *interoceptive sensitivity*—that is, the

ability to detect inner bodily changes, such as identifying one's heartbeats accurately (Critchley, Wiens, Rotshtein, Ohman, & Dolan, 2004; Pollatos, Schandry, Auer, & Kaufmann, 2007). Insula activity has also been linked to the experience of other body sensations, such as orgasm (Ortigue, Grafton, & Bianchi-Demicheli, 2007), the sensations caused by gastric distention (Vandenbergh et al., 2005; Wang et al., 2008), and pain (Ostrowsky et al., 2002), as well as the perception of other body states such as hunger (Del Parigi et al., 2002), breathlessness (Banzett et al., 2000), and craving (Gray & Critchley, 2007). The insula may thus be the hub via which peripheral feedback on the body's current state is translated into core affective representations (Craig, 2009). For instance, individuals with greater interoceptive sensitivity demonstrate greater activity within the insula during emotion experience (Critchley et al., 2004; Gray et al., 2012; Zaki, Davis, & Ochsner, 2012). Similarly, individuals who describe their experiences more in terms of body-based affective terms (e.g., "cry") versus reflective cognitive terms (e.g., "think") show greater activity within the mid- and anterior insula and primary (SI) and secondary (SII) somatosensory cortex during emotion experience (Saxbe, Yang, Borofsky, & Immordino-Yang, 2013).

The insula, along with brain regions that are directly involved in visceromotor control (e.g., basal ganglia nuclei, periacqueductal gray), project to the orbitofrontal cortex (OFC). Growing evidence suggests that the OFC also contributes to affective experiences (Barrett & Bar, 2009; Bechara, Damasio, & Damasio, 2000; Cunningham et al., 2013; Kringelbach & Rolls, 2004; Lindquist, Satpute, Wager, Weber, & Barrett, 2015; Nauta, 1971; Roy, Shohamy, & Wager, 2012; Schnider, Treyer, & Buck, 2005); aspects of OFC may help compute the evaluative meaning of body states (Barrett & Simmons, 2015; Cunningham et al., 2013; Lindquist, Satpute, et al., 2015).

There are many correlational and experimental studies suggesting that shifts in peripheral physiology alter emotion experience. For example, experimentally manipulating perceived feedback from the body (such as providing false cardiac feedback) can shape how arousing individuals experience their emotions to be (Gray et al., 2012; Gray, Harrison, Wiens, & Critchley, 2007; Valins, 1966; see Critchley & Garfinkel, 2015, for a review). In correlational studies, individual differences in interoceptive sensitivity are associated with greater reports of high arousal emotions in daily life (e.g., greater anger and excitement vs. sadness and contentment; Barrett, Quigley, Bliss-Moreau, & Aronson, 2004). Greater interoceptive sensitivity is also associated with more intense peripheral physiological, self-reported, and neural reactions to emotionally evocative images (Herbert, Pollatos, Flor, Enck, & Schandry, 2010; Herbert, Pollatos, & Schandry, 2007). For instance, an index of affective intensity called the P300 event-related potential is greater in individuals with greater interoceptive sensitivity (Herbert et al., 2007).

Even intraindividual differences in emotion experience and perceptions appear to be influenced by body representations. For example, participants experience electric shocks as less aversive when they are delivered prior to ventricular contraction compared to other points within the cardiac cycle (Gray, Minati,

Paoletti, & Critchley, 2009). This presumably occurs because shocks cannot produce a change in blood pressure when blood has not yet entered the vasculature; thus, the lack of afferent feedback from the baroreceptors during shock causes emotion experiences to be less intense. The opposite effect is observed when fearful faces are presented supraliminally during the ventricular contraction of the heart—in these cases, fearful faces are more likely to be subjectively seen by participants and more likely to prompt amygdala activity as compared to when they are presented prior to ventricular contraction (Garfinkel et al., 2014). By contrast, activation of the parasympathetic nervous system reduces the affective potency of perceived fearful faces. On experimental trials when the parasympathetic nervous system is activated via pressure to the carotid baroreceptors in the neck, participants view fearful faces as less aversive and show less insula, amygdala, and hippocampus activity (Makovac et al., 2015). Activation of the parasympathetic nervous system presumably induces experiences of calm and inhibits activation of highly arousing feelings produced by the sympathetic nervous system.

Conditions in which internal body representations are impaired or attenuated more specifically point to the body's role in emotion experience. Pure autonomic failure (PAF) is a neurodegenerative disease linked to autonomic denervation, resulting in decreased transmission of afferent information from the peripheral nervous system to the brain (Critchley, Mathias, & Dolan, 2002). PAF is also associated with decreased peripheral physiological activity, such as decreases in skin conductance (Magnifico, Misra, Murray, & Mathias, 1998), heart rate (Mathias & Bannister, 1999), and catecholamine levels (e.g., epinephrine, norepinephrine, and dopamine; Meredith et al., 1991). Critically, with reductions in sympathetic changes and autonomic feedback, individuals with PAF report experiencing less stress when performing a difficult math task in front of peers than do patient controls (Critchley, Mathias, & Dolan, 2001). These same individuals also demonstrate decreased insula activity and possess less awareness about the aversive nature of stimuli during classical conditioning (Critchley et al., 2002). With significantly reduced afferent information from the body, individuals seem less able to acquire the representation that stimuli are aversive.

Even healthy aging causes some peripheral attenuation (Levenson, Carstensen, Friesen, & Ekman, 1991; Neiss, Leighland, Carlson, & Janowsky, 2009; Tsai, Levenson, & Carstensen, 2000) and is thought to produce emotion experiences that are less linked to representations of the body's current state and more associated with external, situational cues (cf. Mendes, 2010). These findings may in part account for the age-related changes observed in emotion such as older individuals' increased facility for emotion regulation (Gross et al., 1997; Urry & Gross, 2010). It is perhaps relatively easier to regulate one's emotions when you don't experience intense bodily changes.

The fact that the elderly and patients with PAF still retain some emotional abilities even in the presence of changes in body representation is itself ultimately consistent with our psychological constructionist account. Body representations are not

the only constitutive element in emotion; thus, maintained emotional abilities may stem from the maintenance of other elements. First, in the cases of PAF and aging, both proprioception and some somatovisceral representations appear to remain intact, even as autonomic representations decline (Critchley et al., 2002; Mendes, 2010). Second, and most critically, patients with PAF and individuals undergoing healthy aging still possess the conceptual knowledge about emotion experiences that they have amassed over their lifetimes. Even in the absence of robust online representations of bodily changes, centrally represented conceptual knowledge about the internal and external cues associated with emotions could potentially be used to compensate for peripheral declines, so that individuals still retain somewhat normal emotion experiences. Consistent with this hypothesis, patients with PAF are still able to engage in normative emotion recognition, motivational decision-making, theory of mind, and social cognition (Heims, Critchley, Dolan, Mathias, & Cipolotti, 2004). Similarly, although recent evidence suggests that patients with high spinal cord injuries may experience changes in the intensity or specificity of emotions following their injuries (Nicotra, Critchely, Mathias, & Dolan, 2006; Pistoia et al., 2015), patients retain accurate conceptual knowledge about emotions after their injuries (Deady, North, Allan, Smith, & O'Carroll, 2010).

Unlike neo-Jamesian interpretations of the body's role in emotion (for discussion, see Reisenzein & Stephan, 2014), we are not arguing that body representations are alone sufficient for emotion. Current body representations may not even be strictly necessary after a person has acquired years of conceptual knowledge that can be simulated by the brain during emotion experience (after all, spinal cord injury patients can simulate the experience of limb pain and pleasure in the absence of real sensations; Sjogren & Egberg, 1983). Of course, the purest test of the body's constitutive role in emotion would be to observe individuals who had never experienced the representation of bodily changes from birth, but finding such cases are difficult, if not impossible in humans.

Whereas much research has examined the peripheral physiological and visceral contributions to emotion, far less research has focused on how other bodily systems contribute to emotion experience. We turn to this research now. A unique prediction of the psychological constructionist view is that myriad allostatic bodily processes—that is, those that help achieve homeostasis such as immune responses that induce inflammation, hormonal fluctuations, and "drives" such as hunger and fatigue—feed into core affective representations that then may become conceptualized in context as instances of discrete emotions. If conceptualized as an instance of emotion, these bodily changes could contribute to emotions in ways that the field has little considered, breaking down the traditional distinction between "motivational states" versus "emotions," and even "the immune system" versus "the affective system." As a case in point, we explore preliminary evidence suggesting that inflammation is one source of bodily change that can shift individuals' core affective states, and then hypothesize how such inflammation-induced shifts in core affect might be experienced as specific discrete emotions.

Inflammation Contributes to Core Affect and Emotion

Although the "immune system" and the "affective system" have been traditionally viewed as distinct, growing evidence suggests that inflammatory responses related to immune function also cause shifts in core affect, and that some of the same neurochemicals involved in immune responses can generate affective changes. Herein, we discuss the inflammatory response in particular, and its relation to and potential impact on emotion.

Neurochemical Mechanisms of Inflammation

Inflammation is an immune response to harmful stimuli that occurs across a wide range of disorders (see Iwata, Ota, & Duman, 2013) as well as in response to tissue trauma, chemotherapy, surgery, and social stressors (Brydon, Edwards, Mohamed-Ali, & Steptoe, 2004; Cole et al., 2012; Cole et al., 2007; O'Conner, Schultze-Florey, Irwin, Arevalo, & Cole, 2014). Both local and systemic inflammation involve proinflammatory cytokines, which are associated with a variety of physiological changes and somatic sensations; we thus suggest that proinflammatory cytokines may serve as one mechanism by which inflammation feeds into core affect, and ultimately, emotion.

Inflammatory Contributions to Core Affect

Research increasingly demonstrates that the presence of proinflammatory cytokines correlates with and induces the experience of heightened and persistent unpleasant core affect. Regular administration of cytokines in humans is correlated with increased reports of general unpleasantness (Raison et al., 2010; Reichenberg et al., 2001; Schiepers, Wichers, & Maes, 2005) and injections of bacteria that promote an inflammatory response in the immune system increase negative mood (Brydon, Harrison, Walker, Steptoe, & Critchley, 2008; Strike, Wardle, & Steptoe, 2004; Wright, Strike, Brydon, & Steptoe, 2005). Induced inflammation can also produce high arousal states (e.g., irritability, insomnia, hyperactivity) that can be experienced as either positive or negative affect (Constant et al., 2005). In contrast, acetaminophen, a drug that may dampen central nervous system inflammation, reduces the self-reported intensity of positive and negative states (Durso, Lutrell, & Way, 2015).

Inflammation's impact on core affect is further suggested by neuroimaging studies that examine central nervous system activity in the presence of proinflammatory cytokines (for full review, see Dantzer, O'Connor, Freund, Johnson, & Kelley, 2008). For instance, typhoid- (vs. placebo-) injected participants experience increased activation in the neural regions supporting the generation and representation of core affect including the brainstem, thalamus, amygdala, anterior cingulate, and the anterior insula (Harrison et al., 2009a, 2009b). Critically, changes in core body temperature or self-reported somatic symptoms were not experienced, suggesting that shifts in negative core affect do not merely result from feelings of sickness.

Inflammatory Contributions to Discrete Emotion

The key hypothesis that we put forward, inspired by psychological constructionism and ultimately Schachter's work, is that when an inflammatory response leads to core affective changes, it is then possible for those inflammatory-induced representations to become conceptualized as a discrete emotion. The dynamics of when and how these core affective shifts are made meaningful as specific emotions likely depends as much on the context and a person's available conceptual knowledge as the core affective shifts themselves (e.g., unpleasantness might be experienced as fatigue in one context, but sadness in another).

In the case of chronic inflammation, individuals likely experience persistent shifts in core affect that track the production cycles of proinflammatory cytokines (such as in depression, which has been linked with chronic, systemic inflammation; Dowlati et al., 2010; Howren, Lamkin, & Suls, 2009). Shifts in proinflammatory cytokines might be conceptualized as specific emotions (e.g., sadness) when the context makes knowledge about sadness more accessible (e.g., in the face of a failed job performance), but not when sadness is relatively less accessible (e.g., when watching an enjoyable movie with a friend). Chronic inflammation might lead to the chronic accessibility of negative emotion concepts which could perpetuate the cycle of negative affectivity in some cases of chronic inflammation, thus increasing the likelihood of depression (especially in combination with adverse life events). By contrast, acute inflammation might cause only a temporary fluctuation in core affect, which may make individuals access situation-specific emotion concepts in that instance and then experience only a relatively short-lived experience of emotion. Either acute or chronic shifts in core affect may interact with the context and conceptual knowledge, essentially "turning up the dial" on core affect and subsequent emotion experiences that might have been likely to occur in that context anyway. For instance, experiencing a loss while experiencing an acute shift in core affect due to the flu might increase the intensity of sadness experienced.

No research to date has explicitly assessed how making meaning of one's core affective state, as induced by inflammation, can result in the experience of different discrete emotions. However, some evidence is suggestive. For instance, in the United States, people who have greater chronic inflammation are also chronically more likely to express anger; in Japan, the inverse is the case (Kitayama et al., 2015). One interpretation is that individuals who have greater inflammation (perhaps due to lifestyle) are more likely to conceptualize their feelings of inflammation as anger in U.S. contexts than in Japanese contexts. Since the U.S. concept of anger emphasizes anger as an emotion that should be expressed when feeling strong unpleasant, high arousal affect, U.S. participants may be more likely to conceptualize their inflammation-related unpleasantness and high arousal as feelings of anger. By contrast, the Japanese concept of anger condemns expressions of anger (Boiger, Mesquita, Uchida, & Barrett, 2013) and the Japanese make interpersonal adjustments to reduce the likelihood of experiencing anger during conflict (Trommsdorff & Kornadt, 2003). Thus, in Japan,

greater inflammation may be less readily associated with highly unpleasant, activated feelings; feelings associated with inflammation may in turn be less likely to become conceptualized as an instance of anger.

In other contexts, individuals experiencing negativity and tension due to inflammation might be more likely to conceptualize their state as an instance of anxiety (see Moons & Shields, 2015). For instance, individuals given inflammation-inducing endotoxin versus placebo show heightened amygdala response to threatening, but not nonthreatening, faces and images (Inagaki, Muscatell, Irwin, Cole, & Eisenberger, 2012). Amygdala activity is associated with uncertainty (Whalen, 2007) and individuals with anxiety disorders have heightened amygdala activity (Etkin & Wager, 2007). As in previous studies, inflammation was constructed as an experience of anxiety when participants were faced with threatening faces and scenes, above and beyond any feelings of sickness that participants reported (Inagaki et al., 2012).

The findings reviewed herein are preliminary, and the studies themselves were not designed to answer questions about how individuals are conceptualizing inflammation-related core affect as instances of discrete emotion across different contexts. However, these findings provide promising evidence in line with a psychological constructionist approach that body representations can "feed into" core affect and discrete emotion experiences. Thinking of immune responses as only one of several bodily sources that contribute to shifts in core affect may ultimately be the most parsimonious way for framing the immune system's relation to the affective system.

Conclusion

The evidence on inflammation we reviewed suggests that representations of body states, including more basic allostatic processes not typically associated with emotion, feed into core affect and can become conceptualized as emotions. We can thank Schachter for inspiring a psychological constructionist approach that emphasizes the body's constitutive role in emotion. Extending the body's role in emotion to include inter- and intraindividual variation in allostatic processes could, if further explored, deepen our understanding of why emotion experiences vary so much within and between individuals, and will further clarify what we know about the link between emotions, health, and wellbeing.

We highlighted research suggesting that inflammatory responses drive affective changes that might, in conjunction with a person's conceptual knowledge, be conceptualized as specific discrete emotions. These findings, if further tested, will clarify how putatively "nonemotional" body states (e.g., immune responses, hunger, fatigue) could shape emotion, and more specifically, how longstanding changes in representations of body-based information due to illness, trauma, or even normative development (e.g., puberty, aging) impact individuals' core affective states and how they conceptualize core affect as experiences of discrete emotions. For example, patients with inflammation-inducing disorders may be at greater risk for

developing emotion-related psychopathologies (e.g., depression, anxiety, more labile anger) that may feed back to negatively shape physical health outcomes.

Although we did not review evidence beyond inflammation, we suggest that other allostatic body states will also contribute to shifts in emotion experience. For instance, hungry individuals appear more likely to experience anger. It is typically assumed that hunger depletes individuals' regulatory resources (cf. Bushman, DeWall, Pond, & Hanus, 2014), but it is also possible that hunger helps create anger when individuals conceptualize the unpleasant, high arousal changes induced by hunger as an instance of anger if given a frustrating situation. Similarly, fatigue could be conceptualized as instances of loneliness, depression, or sadness. Future research should investigate these questions and assess how allostatic bodily changes shape a person's core affect and ultimately emotion. Such work would clarify how bodily changes help constitute and create variation in emotion experience. Thanks in part to Schachter's legacy, the field of affective science is further exploring these questions about how the body constitutes emotions and the mind more generally.

Declaration of Conflicting Interests

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

Notes

1   Unlike views that assume that emotions are effect indicators (see discussions in Barrett, 2006; Coan, 2010), psychological constructionist views operationalize "emotion" and "emotion experience" as identical, not separate, constructs.

2   Other views are less explicit about whether core affect derives from body representations (Clore & Ortony, 2013; Cunningham et al., 2013) and focus more on its role as an evaluative state.

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