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Is there consistency and specificity of autonomic changes during emotional episodes? Guidance from the Conceptual Act Theory and psychophysiology

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ABSTRACT

The consistency and specificity of autonomic nervous system (ANS) responses during emotional episodes remains a topic of debate with relevance for emotional concordance. We present a recent model of how mental states are constructed, the Conceptual Act Theory (CAT), and then review findings from existing meta-analyses and a qualitative review along with studies using pattern classification of multivariate ANS patterns to determine if there is across-study evidence for consistency and specificity of ANS responses during emotional episodes. We conclude that there is thus far minimal evidence for ANS response consistency and specificity across studies. We then review the current understanding of the functional and anatomical features of ANS including its efferent and afferent connections with the central nervous system, which suggests the need to reformulate how we conceptualize ANS response consistency and specificity. We conclude by showing how this reformulation is consistent with the CAT, and how the model suggests when we would and would not expect to see consistency and specificity in ANS responses, and concordance more generally, during emotional episodes.

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> "Were we to go through the whole list of emotions which have been named by men, and study their organic manifestations, we should but ring the changes on the elements which these three typical cases involve. . . . We should, moreover, find that our descriptions had no absolute truth; that they only applied to the average man; that every one of us, almost, has some personal idiosyncrasy of expression, laughing or sobbing differently from his neighbor, or reddening or growing pale where others do not." (James, 1890, pp. 447–448)

> "The fact is that there are changeable expressions of grief. . . and the shrunken, cold, and pale condition which Lange describes so well is more characteristic of a severe settled sorrow than of an acute mental pain. Properly we have two distinct emotions here, both prompted by the same object, it is true, but affecting different persons, or the same person at different times, and feeling (italics in the original) quite differently whilst they last, as anyone's consciousness will testify. (James, 1890, p. 444)

> "Surely there is no definite affection of 'anger' in an 'entitative' sense" (James, 1894/1994, p. 206)

Even before William James made popular the idea that peripheral physiological changes were a crucial feature of emotional states, scholars and poets had often remarked that feelings were inextricably entwined with bodily states. These ideas have been a part of the Western cultural or folk psychology since the time of Plato (for a more recent history, see Gendron & Barrett, 2009) and provide a compelling narrative that has stymied repeated attempts to develop a non-entitative model of emotion. What has been relatively ignored by the folk psychological view, but highlighted by the quotes from William James above, is the importance of *individual* and *situational* differences even in the physiological manifestations of emotional and affective experiences. All modern emotion theoretical views posit a role for variation in bodily responses during emotions, but the nature of that variability remains debated. At one end of the continuum, adaptationist ("basic" emotion) theories and some appraisal theories propose that instances of the same emotion category either share a pattern of bodily changes

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in common (so variability is error) or there is systematic variation around a modal bodily response (Ekman & Cordaro, 2011; Panksepp, 1998; Roseman, 2011; Tracy & Randles, 2011). At the other end of the continuum, psychological construction theories propose that each emotion category is populated with a set of variable instances, where the variation is meaningfully tied to the situation (Barrett et al., in press; Barrett & Bliss-Moreau, 2009). Views of emotional concordance across physiological, cognitive and behavioral emotional response patterns vary across these theoretical frameworks (Gendron & Barrett, 2009; Gross & Barrett, 2011). Although responses in multiple physiological measurement channels might be coordinated within an instance (e.g., a heart rate increase coupled with a systolic blood pressure increase), we consider here whether this coordinated physiological response pattern is consistent across instances within the same emotion category, and whether it is specific to that category. A similar comparative review of the literature could instead consider concordance among physiological, cognitive and behavioral emotional response patterns. We have focused here, however, on studies assessing concordance between physiological response patterns and the subjective labels used to define emotion categories. Specifically, we will consider the strength of the evidentiary base for concluding (or not) that there is sufficient consistency and specificity of autonomic changes during specific emotional episodes. Here we will take as strong evidence of consistency when induction of a specific emotion category instance results in a directionally consistent change in an outcome measure such as blood pressure, or in a pattern of measures, across multiple studies. We will take as strong evidence of specificity when a given emotion induction results in a consistent outcome that is also distinct from that evoked by another discrete emotion (i.e., both consistent and unique). Considering both space limitations and the goals of this Special Issue, we will focus on the consistency and specificity of autonomic nervous system (ANS) responses during emotional and affective states, and then discuss how ANS consistency and specificity relates to emotional response concordance more generally.

We begin by providing a brief outline (with section headings) of a recent theoretical approach, the Conceptual Act Theory (CAT), that takes variation and individual differences in ANS responses as phenomena to be explained by an emotion theory (*Conceptual Act Theory: When should we expect consistency and specificity?*). Using this new framework, we propose it might be possible to see consistency and specificity under certain circumstances, not because the physiological change is driven by a basic biological program as suggested by some basic emotion theories, but as a result of situated or embodied concepts that will be particularly likely to be activated in specific contexts or situations. This theory, guided by current understanding of both central and peripheral neuroscience, provides a theoretical framework for proposing hypotheses about when we would expect to see greater consistency and specificity of ANS responses in emotional episodes, and when we should see less. We then briefly review prior cross-study assessments (three meta-analyses and a qualitative review) of the ANS correlates of emotion (*Review of prior cross-study assessments of ANS consistency and specificity).* We next review studies that have used a multivariate modeling approach to look for consistent and/or specific physiological response patterning for different emotion or affective states (*Multivariate assessments of ANS consistency and specificity*). We then provide an overview of some psychophysiological principles that must be considered in future studies designed to assess consistent and specific ANS effects of emotion inductions (*ANS and CNS system features: Impact on consistency and specificity*). In the closing section (*Conceptual Act Theory: Hypotheses on Individual variation, contextual variation and temporal variation*), we return to the CAT, and suggest how it can be applied to understanding emotional response concordance in the context of individual, contextual and temporal variations in emotion responses.

1. The Conceptual Act Theory (CAT): When should we expect ANS consistency and specificity?

Psychological construction approaches to emotion explicitly account for and predict the variability in autonomic nervous system (ANS) responses during instances of the same emotion category (rather than explaining them as error or as systematic variation around a modal pattern). Psychological construction relies on the kind of population thinking that is popular in scientific accounts of the biological world where categories (such as species) have fuzzy boundaries. Emotions are not physical (morphological) types, but are cognitive categories that contain a variety of unique instances. The Conceptual Act Theory (CAT; Barrett, 2006, 2011a,b, 2013; Barrett & Satpute, 2013; Barrett, Wilson-Mendenhall, & Barsalou, in press; Lindquist & Barrett, 2012) is an example of this approach, where mental states like emotions are constructed moment to moment using basic processes (or ingredients) that integrate and make sense of sensory information from the world and from the body using stored representations from the past. In this model, instances within an emotion category vary in their physiological nature, because individual emotional episodes are tailored to the requirements of the immediate situation. Changes in peripheral physiological state (including the ANS, but also endocrine, immune, metabolic, proprioceptive, kinesthetic and other peripheral changes, which we will collectively refer to as the somatovisceral state), are combined with sensory information transduced via exteroceptive sense organs and with stored conceptual representations (organized as category knowledge) to instantiate a current mental state, thereby producing a "situated conceptualization" (Barsalou, 2005, 2009). This situated conceptualization is a prediction of how a person should prepare to act during a given emotion in a given context. The hypothesis is that situation-specific, embodied conceptual knowledge is applied to initial affective predictions (Barrett & Bar, 2009) during the act of categorization (Barrett, 2006). These affective predictions both impact a person's expectations of what is to come, and also can shift the person's somatovisceral state such that subsequent afferent traffic from the periphery is changed. Because of the brain's heterarchical arrangement, afferent feedback from the periphery quickly leads to new predictions, and further updating of the situated conceptualization. Situated conceptualizing is instantaneous, ongoing, obligatory, and automatic, meaning that a person will rarely have a sense of agency, effort or control in constructing an emotion. It rarely happens because of a deliberate, conscious goal to figure something out. It is via the process of conceptualizing or the conceptual act, that physiological changes acquire functions (i.e., meaning) that they do not have on their own (i.e., without conceptualization). Thus physiological changes play a role in the conceptual act; they are like a biasing function, with particular physiological changes more likely to be conceptualized as one emotion or another depending on both the nature of the physiological change and the specific situated conceptualization used. The situated conceptualization is the process by which concordance across physiological, cognitive and behavioral action occurs in a given instance, although the pattern is not necessarily the same for each instance of a single emotion category. Thus, a pattern of concordant emotional responses will occur when a particular situated conceptualization is generated, and a similar pattern will be generated when a very similar situated conceptualization is generated in the future, although a given emotion category can be represented as a variety of different situated conceptualizations, depending on the demands of the situation.