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Psychological Construction: The Darwinian Approach to the Science of Emotion

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Abstract

Psychological construction constitutes a different paradigm for the scientific study of emotion when compared to the current paradigm that is inspired by faculty psychology. This new paradigm is more consistent with the post-Darwinian conceptual framework in biology that includes a focus on (a) population thinking (vs. typologies), (b) domain-general core systems (vs. physical essences), and (c) constructive analysis (vs. reductionism). Three psychological construction approaches (the OCC model, the iterative reprocessing model, and the conceptual act theory) are discussed with respect to these ideas.

Keywords
Darwin, emotion, evolution, psychological construction

According to the biologist Ernst Mayr (2004), radical changes in the conceptual framework of biology began in the 16th century, and were particularly revolutionary during the period of 1828 to 1859, culminating in the publication of Charles Darwin's *On the Origin of Species* (1859/1964). Before Darwin, animal species were assumed to be physical "types" whose members shared certain defining properties (essences) that distinguished them from all other types. Deviations within a type were due to error or accident. Scientific study meant reducing every phenomenon to mathematics of physical, mechanical laws. Darwin, and the biologists who further developed the conceptual framework for evolution in the following century, changed all of this. They replaced the essentialist, typological thinking with population-based thinking, where a species is a biopopulation, and individuals within a population are unique; individual variation within a species was meaningfully tied to variations in the environment. Variation within a species was the result not of species-specific processes, but instead from species-general mechanisms. And perhaps most importantly, they expanded the definition of science by offering nonreductionist, analytic approaches to understanding the natural world. Although this conceptual revolution took many years to accomplish, it was transformative: beforehand, biology was not considered a true science; afterwards, it was.

A definitive revolution in the conceptual framework of psychology has yet to occur. Instead, there has been a never-ending argument (dating back to Heraclitus and Plato) between two competing paradigms that have more than a passing resemblance to the "pre-Darwinian typology" and "post-Darwinian constructive" versions of biology. The science of emotion is a terrific example of this debate. In the pre-Darwinian view, the mind is structured as a typology, containing Platonic types such as anger, sadness, fear, etcetera. Emotions are presumed to be basic elements (i.e., they are thought to be biological and psychological primitives). Scientists search for the corresponding physical essences for these mental types in patterns of peripheral nervous system response, facial muscle movements, and the structure or function of the mammalian brain, and these are considered to be the "natural joints" that distinguish one emotion type from another. This approach, aptly termed the *natural kinds* approach (Barrett, 2006a), has its roots in the 17th-century mental philosophy of *faculty psychology* (e.g., see works by Wolff [1734] as discussed in Klein [1970], Gall (1835), and Spurzheim (1832); cf. Lindquist & Barrett, 2012).

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The alternative view, which has more in common with the post-Darwin conceptual framework in biology, is to consider each mental faculty not as a Platonic, physical type, but as a folk category that is populated with variable, physical instances optimized for a particular situation or context. Instances within a category do not share an essence, but instead arise from core systems that are domain-general (meaning the systems are not specific to the traditional domains of emotion, cognition, or perception). Instances across different categories do not differ in a physical essence, but are constructed from the same domain-general systems. Instead of redefining (or reducing) mental phenomena into these core systems, the goal is to analyze how mental states emerge from their interaction. In the history of psychology, scientists who conceive of mental events in such ways were crafting the foundations of a *psychological construction approach*, although they rarely identified it as such (Gendron & Barrett, 2009).

Until recently, psychological construction proposals were nascent, embedded in critiques of faculty psychology in general, or critiques of faculty psychology approaches to emotion. For example, starting as early as the 18th century, literature reviews or commentaries highlighted the fact that physical measurements of the body and behavior do not respect emotion as primitive, natural, or modular types, and in that context offered insights related to psychological construction with varying degrees of specificity (see Gendron & Barrett, 2009). The roots of psychological construction can also be found in the criticism of faculty psychology within the mental philosophy of the 17th century. In fact, criticisms of typologies stretch back to pre-Socratic times. Almost all of these proposals suggest what might be considered the unifying feature of psychological construction approaches: that emotions are not the basic building blocks of the mind, but instead are the mental states that emerge within the mind's system of more basic processes. In psychology, most psychological construction approaches propose that emotion instances are created when afferent information from the body or its central nervous system representation (i.e., the internal, physical state or its mental counterpart, affect) is made meaningful in relation to the external surroundings (for a discussion of different approaches, see Gross & Barrett, 2011).

In this special section of *Emotion Review*, we have the opportunity to read three examples from the current generation of psychological construction proposals. Unlike earlier psychological construction approaches, which mainly described the gist of psychological construction (e.g., see Gendron & Barrett, 2009), the articles in this special section (Clore & Ortony's [2013] discussion of their OCC model; Cunningham, Dunfield, & Stillman's [2013] discussion of their iterative reprocessing model; and Lindquist's [2013] discussion of the conceptual act theory) articulate a more detailed and nuanced approach to the psychological construction of emotion, and in certain cases provide specific computational hypotheses about the mechanisms that underlie the process of construction. As a result, it is now possible to identify several principles that characterize a psychological construction approach to the science of emotion, and that distinguish psychological construction models from their typological, pre-Darwinian alternatives. These principles together constitute a paradigm of experiments and interpretations that is a game changer for the scientific study of emotion. In this article, I summarize three of these principles, pointing to the similarities between the various approaches, and also at times their differences. Embedded in this discussion are points that touch on the major questions posed to authors in this *Emotion Review* special section on psychological construction.

The Principle of Variation

The faculty psychology approach to emotion is a textbook case of classical typological thinking, where mental states are organized as a limited number of categories. Each category is thought to be a physical (or morphological) type—what philosophers call "natural kinds" (Barrett, 2006a). The "natural joints" of each category are typically presumed to be neural activity in a dedicated brain region or network or some coordinated set of physiological responses, facial muscle movements, and voluntary behaviors like freezing, fleeing, and fighting. The presumed biological regularities for each category are considered to be its platonic form, issuing from the stimulus directly (as in the basic emotion approach; e.g., Ekman, 1972) or after the stimulus is evaluated (as in causal appraisal models; e.g., Ekman & Cordaro, 2011; Frijda, 1986; Lazarus, 1991; Roseman, 1991). The pattern for each emotion category is thought to either be obligatory (e.g., Ekman, 1992) or to occur probabilistically (e.g., Roseman, 2011). (Introducing probability is just a weaker version of the same argument because according to this view each emotion type should be recognizable by its characteristic pattern; i.e., the pattern should be diagnostic for the emotion.) A limited amount of variation in the observed pattern from the platonic form is acceptable, but significant deviation is treated as error, or as caused by processes that are outside the boundaries of the emotional response itself (such as display rules or regulatory mechanisms). With such assumptions, it makes sense to attempt a Linnaean-type classification of emotions. Experiments are designed according to this classification in an attempt to identify the physical basis of each type's platonic form by examining which features or properties are repeatable across instances of the same category, and which are maximally different across categories.

Ironically, the experiments inspired by the faculty/typological/natural kind approach to emotion have produced evidence of heterogeneity of instances within each emotion category as well as similarities across categories (Barrett, 2006a). This heterogeneity has been observed for the last century of emotion research, despite improving methods, increasing analytic sophistication, and technical advances in experimentation. Interestingly, the pre-Darwinian typological species concept failed in biology for largely similar reasons: meaningful morphological variation within a species is observed, and phenotypic similarity across species is evident, particularly when species inhabit the same ecological niche (Mayr, 2004). One of Darwin's greatest insights in *On the Origin of Species* (1859/1964) was that each species

does not have a platonic form—a species is a category of variable instances. The variation across unique individuals within the category is not only caused by stochastic processes like mutation—it is also meaningfully related to the environment via the process of natural selection. Instances vary because they have maximal utility in particular contexts.

Psychological construction relies on a similar kind of population thinking. Emotions are not physical (morphological) types, but are cognitive categories that contain a variety of unique instances. This idea is exemplified within the psychological construction articles within this special section of *Emotion Review*. For example, in Clore and Ortony's OCC model of emotion (2013; Ortony, Clore, & Collins, 1988), emotion categories are conceived of as cognitive types that reflect the structure of recurring situations that people find important and meaningful within our own cultural context. Emotions are "embodied, enacted, and experienced representations of situations" (2013, p. 337). They are situated affective states. Within each cognitive type, instances (emotional episodes) vary in their physical manifestations (heart rate can go up or down, there can be avoidance or approach, etc.) that reflect different avenues of coping with particular kinds of situations.

The conceptual act theory (Lindquist, 2013; see also Barrett, 2006b, 2012) further emphasizes that instances within an emotion category vary in their physical nature, because individual emotional episodes are tailored to the requirements of the immediate situation. Like the OCC model, the conceptual act theory also makes reference to the importance of the situation, but in a more mechanistic way that implicates conceptual knowledge: situation-specific, embodied conceptual knowledge is applied to initial affective predictions (Barrett & Bar, 2009) during the act of categorization (Barrett, 2006b), creating a "situated conceptualization" that is the emotional episode. The variation of situated conceptualizations is twofold: (a) the affective aspects of an episode can change after the initial affective prediction is modified by its conceptualization; (b) conceptual knowledge within a category is, itself, a population with unique instances. The conceptualization of affect does not happen in a step-like fashion, and is simultaneously occurring with affective change, but the hypothesis is that variation is occurring both within and between instances of the same emotion category. The emphasis on change within an episode over time is the key hypothesis in Cunningham et al.'s iterative reprocessing model (2013; Cunningham & Zelazo, 2007).

The variation observed within an emotion category is inherent to the way in which category knowledge is learned and applied during emotion construction. Initially, when encoding a category instance of emotion, say anger for example, we hypothesize that the brain captures the elements of the setting in which the anger occurs (i.e., other agents and objects), internal sensory (i.e., somatovisceral) cues from the body, as well as actions, instructions from others (in the form of rules), and words (e.g., the phonological form for "anger" or "angry"). Over time, these situated conceptualizations create a heterogeneous population of information that is available to represent new instances of the category "anger." Later, when the brain requires conceptual knowledge to construct an instance of emotion, it samples from the populations of situated conceptualizations, associated with relevant concepts, to create a novel situated conceptualization, which integrates current sensory input and retrieved conceptual knowledge. From this perspective, conceptual processing more closely resembles scene perception because the brain produces a conceptual state using multimodal information about entire situations. For example, in anger, when another driver cuts you off in traffic, you might shout as you slam on the breaks. When your child picks up a sharp knife, you might calmly take it from her or ask her to put it down. When you hear a news report about a bombing or a hurricane, you might turn up the radio. When a colleague criticizes you in front of a group, you might sit very still and perhaps even nod your head and smile. You may tease a friend who threatens your view of yourself, and so on. During these instances, your blood pressure might go up, or down, or stay the same—whatever will allow you to prepare for the situated action. Sometimes you will feel your heart beating in your chest, and other times you will not. Your hands might become clammy, or they might remain dry. Sometimes your eyes will widen, but other times your brow will furrow, or you may even smile.

Psychological construction's use of population thinking and emphasis on studying variation within an emotion category leads scientists to design experiments that explicitly encourage investigating the variability of emotional instances within a category (rather than explaining variation after the fact). In a recent neuroimaging study from our own lab, for example, we explicitly studied how the neural responses differed during two varieties of fearful experience (fearful instances of social threat and physical danger), as well as how the neural responses during fear and anger were similar when experienced in a similar context (e.g., social threat; Wilson-Mendenhall, Barrett, Simmons, & Barsalou, 2011). In fact, a growing number of articles are designed explicitly to capture heterogeneity within emotion categories, both within individuals and across cultures (e.g., see Ceulemans, Kuppens, & Van Mechelen, 2012; Hortensius, Schutter, & Harmon-Jones, 2012; Kuppens, Van Mechelen & Rijmen, 2008; Kuppens, Van Mechelen, Smits, De Boeck & Ceulemans, 2007; Nezlek & Kuppens, 2008; Stemmler, Aue, & Wacker, 2007). Some regularities in the psychophysiological correlates of emotion can be observed when considering their contextual variation (e.g., Kreibig, 2010), and variation is also observed when comparing patterns of physical correlates of emotion categories across different studies, even when exactly the same method and stimuli are used (e.g., compare patterns for different emotion in Kragel & LaBar, 2013, vs. Stephens, Christie, & Friedman, 2010).

Unlike the typology/faculty/natural kind approach to emotion which proposes that some number of categories are privileged as "primary" or "basic," the psychological construction approach emphasizes that the number and variety of emotion categories is considerably more variable, certainly across cultures, but perhaps even across individuals. For example, Clore and Ortony (2013) write emotions are "limited in number and variety only by the number and variety of the psychological

situations they represent" (p. 335). In psychological construction, the debate of how many true emotions there are, whether this or that (e.g., love or wonder) is an emotion, and what the necessary criteria for an emotion are, becomes inert (Ortony & Turner, 1990). It also allows us to ask the novel question of whether and how new emotion categories are formed.

Finally, the concept of variation also comes into play at the neuronal level, when mapping patterns of brain activity to a psychological instance of an emotion category (such as teasing a friend in anger). By incorporating the philosophical concept of supervenience (Barrett, 2011), the psychological construction hypothesis is that there are multiple brain states (or even a series of successive brain states) that could implement a specific instance of a mental category. This view is nicely exemplified in the iterative reprocessing model (Cunningham et al., 2013), with Cunningham and colleagues' proposal that many different patterns of neural activity (what they refer to as "microstates") can create a single mental state or emotional episode (what they refer to as a "macrostate"). This degree of representational flexibility (see also Edelman, 1987) presents certain computational challenges that faculty/typology/natural kind approaches to emotion do not face.

The Principle of Core Systems

The faculty/typology/natural kinds approach to emotions exemplifies an essentialism that has characterized Western views of the natural world since the time of Plato: one emotion type, one physical essence. The essence defines the type—it is the unchangeable underlying property or mechanism that determines a category's identity. Platonic essentialism dominated the conceptual framework in biology before Darwin. In the pre-Darwinian typological approach to species, the arithmetic mean value of the instances within a type was the type's essential features that are present in each and every instance of that type barring error (Mayr, 2004). In the post-Darwin era of population thinking, species have no essences—they are defined functionally, based on reproductive patterns. The arithmetic mean value of unique instances within a category is an abstraction that might never occur in real life. This observation very likely holds for emotion and helps to explain why decades of research have not found specific and replicable "natural joints" of emotion categories, despite the unending search for them (see Barrett, 2006a).

Since emotion concepts play a prominent role in most modern psychological construction approaches (including the three discussed in this special section), it is tempting to think about these concepts as essences, but this temptation should be resisted. For example, emotion categories appear to be goal-directed categories to guide action in certain situations (cf. Barrett, 2006b; see Barsalou, 2003; Barsalou & Ross, 1986), and as such, a category's most frequent instances will not necessarily form the ideal of the category or bear any physical resemblance to one another. The hypothesis is that emotion categories, like all abstract categories, do not have conceptual cores (Barrett, Wilson-Mendenhall, & Barsalou, in press; Wilson-Mendenhall et al., 2011). Instead, the ideal of the emotion category might be those instances that best achieve the goal (its action tendency; Frijda, 1986), relational theme (Lazarus, 1991), or prototypic situation (Clore & Ortony, 2013). This idea is similar to claiming that the prototype for each emotion category is like a script, a schema, or a stereotype (cf. Barrett, 2006b). Clore and Ortony (2013) point out that these prototypes can be misleading as a source of predictions about the nature of emotions, although they are useful for organizing, understanding, and interpreting personal stories (for a similar functional view, see Barrett, 2012).

Scientists as far back as William James have speculated that psychologists mistakenly assume that emotion categories are entities with physical essences as the result of our emotion vocabulary. James, for example, observed, "surely there is no definite affection of 'anger' in an 'entitative' sense" (1890, p. 206), and argued that emotion words are a trap, leading psychologists to search for the deep properties or essences. Many psychological construction approaches have reiterated this point, including all three articles in this special section of *Emotion Review* (see Barrett, 2009; Barrett, Lindquist, & Gendron, 2007). In fact, two recent studies have documented that people essentialize emotion categories (Lindquist, Gendron, Oosterwijk, & Barrett, in press). Moreover, there is evidence that words (particular nouns like "anger" or "fear") encourage essentialist thinking (for a review, see Barsalou, Wilson, & Hasenkamp, 2010). The fact that people essentialize emotion categories should not be surprising, given that essentializing is a basic phenomenon that develops early in human cognition and applies to many types of categories (Gelman, 2009), and may have its basis in the way that infants as young as 6 months old learn to use words as "essence placeholders" (e.g., Booth & Waxman, 2002; Dewar & Xu, 2009; Fulkerson & Waxman, 2007; Plunkett, Hu, & Cohen, 2008; Xu, Cote, & Baker, 2005). William James (1890) described the danger of referring to psychological categories with words when he wrote, "Whenever we have made a word… to denote a certain group of phenomena, we are prone to suppose a substantive entity existing beyond the phenomena, of which the word shall be the name" (p. 195).

Psychological construction accounts go further than unmasking essentialist biases in the science of emotion, however. They propose alternative theoretical accounts of how emotional episodes are realized, offering specific hypotheses about how each instance of any emotion category is constructed from the interactions of domain-general core systems (meaning that the systems are not specific to any emotion category, or even to the domain of emotion). These core systems are what I have previously referred to as "ingredients" of mental states (cf. Barrett, 2009). This is in contrast to the idea of a domain-specific system for each emotion type, or a general emotion-specific system such as in certain accounts of the limbic system. At the most general level of description, psychological construction approaches hypothesize that an instance of emotion is constructed when physical changes in the body (or their

corresponding affective feelings) are made psychologically meaningful as being related to, or caused by, a situation in the world. Physical changes are occurring all the time—blood pressure is going up and down, breathing rates speed and slow, voluntary muscles are contracting so that limbs are moving. Affective feelings of pleasure and displeasure, with some level of arousal, are ever present and always changing. Only sometimes are these changes perceived as being causally related to surrounding events, and when this happens, an emotion is constructed (e.g., Clore & Ortony, 2013). Said more formally, emotional episodes, no matter the category, are created with at least two domains of core systems: a system (or systems) for representing sensations related to the body (which is usually referred to as "affective"), and a system (or systems) for conceptually making sense of these sensations and/or feelings in relation to the situation. The iterative reprocessing model, for example, also incorporates a perceiver's goals, values, desires, and intentions as separate ingredients that can shape the processing of an emotional instance.

The conceptual act theory proposes that the brain's attentional matrix and language networks are additional domain-general core systems that are necessary for constructing emotions. Our hypothesis is that during every waking moment of life, mental states are constructed as interoceptive cues from the body and exteroceptive cues from the world are continually categorized and made meaningful with conceptual knowledge stored from past experience. The brain's attentional matrix (including endogenous attention which is linked to goals and values) manages the interactions between systems (Barrett, Tugade, & Engle, 2004). Because prior experience is organized as categories and concepts, and abstract categories, such as emotion categories, are grounded in emotion words, language processing is relevant to the construction of emotional episodes, even when emotion words are not explicitly required. In our view, an instance of emotion is constructed when affective changes are categorized as related to the situation using an instance of an emotion concept BECAUSE those affective changes are in the focus of attention (e.g., when the focus of attention is on events in the world, the mental event is experienced as a perception; Barrett, 2009). Categorization is not specifically directing the construction of emotional episodes—it is necessary for every mental state that is not pure sensation (and categorization is what people try to suspend with mindful meditation practices). If you are awake, you are categorizing. In other articles, ingredients also include basic behavioral adaptations like freezing, fleeing, and fighting, although there is no necessary one-to-one correspondence between a behavior and an emotion category (e.g., Barrett, 2012; LeDoux, 2012). When the brain predicts that one of these behavioral adaptations might be necessary, this produces affective changes even when the prediction is modified and the action is not realized (Barrett & Bar, 2009).

The three articles in this special section of *Emotion Review* exemplify subtle differences in how psychological construction deals with the question of core systems. What counts as a core system in different psychological construction models depends on whether a model is attempting to specify primitives at a psychological level of analysis (e.g., Barrett, 2006b; Clore & Ortony, 2013; Russell, 2003) or specify functional units at the neural level of analysis (e.g., Barrett & Satpute, 2013; Cunningham et al., 2013; Lindquist, 2013; Lindquist & Barrett, 2012). Furthermore, psychological construction approaches vary in their focus on processes versus products; some hypothesize specific core systems from which emotional episodes emerge (e.g., conceptual act theory) or processing frameworks for those systems (the iterative reprocessing model), whereas others focus more on describing the properties of the emotional episodes once they have emerged without making any claims about the computations that produced emergence (the OCC model). The fact that some approaches frame their construction hypotheses in neural terms is important, because emotions are not "merely mental" or "social" phenomena. Not all biological evidence for emotions is evidence for the faculty/typological/natural kind approach to emotion (i.e., biological "basicness").[1] The idea that biology equals basicness is a common misconception that is perpetuated in hundreds of published articles within the science of emotion.

Different construction models also vary in their hypotheses regarding how core systems contribute to physical variation within an emotion category. For example, in the conceptual act theory, because it is hypothesized that categorization prepares a person for action (i.e., conceptual knowledge that is used in constructing an instance of an emotion category is embodied and enactive; Barrett et al., in press), the person's physical state will vary as the predicted action varies. In the emotion literature, it is common to define emotions as coordinated packets of physiology, experience, and behavior, but in point of fact every waking moment of life is just such a coordinated package; there is no package that is "essentially" anger, or sadness, or even emotion. Furthermore, the core systems themselves are not faculties in the formal sense of the concept; we have developed formal hypotheses regarding how these "basic ingredients" of the mind (as we like to call them) are created as "functional motifs" within the networks that are intrinsic to the human brain (meaning that the neural assemblies that implement each core system can change across instances, in a way that is tied to the neural context; see Barrett, 2009; Barrett & Satpute, 2013; Lindquist & Barrett, 2012).

The iterative reprocessing model, with its focus on the temporal aspects of emotional episodes, hypothesizes that an instance of emotion is constructed as sensory information flows through a series of evaluative processes that are hierarchically organized from automatic to reflective. This approach is based on the presumption that the brain is hierarchically organized–an assumption that some have questioned (particularly those who do not subscribe to a stimulus–response metaphor of how the brain works; cf. Barrett, 2009). Relaxing the linear assumptions of a processing hierarchy, the iterative reprocessing model is a powerful framework for examining the temporal dynamics in the construction of an emotional episode, breaking down the distinction between changes that are considered to be more "reactivity" versus "regulation"; both are seen to result from

interactions of the same core systems (Barrett et al., in press). Furthermore, the idea that sensory input (or its corresponding affective feeling) is continuously reinterpreted in light of the goals, intentions, and values of the perceiver is a clear illustration of the psychological construction assumption that humans are the architects of their own experience, actively contributing something from the past, or the present, to every current emotional episode.

The three models also treat the power of emotion words somewhat differently. Whereas the OCC and iterative reprocessing models reiterate James's view that emotion words present a challenge for the science of emotion because they encourage essentialism, the conceptual act theory also discusses their potential role in the emotion construction process in relation to the formation and use of emotion concepts. A concept can be viewed as aggregated memories that accumulate for a category across experiences with its instances. Concepts form from experience because there are statistical regularities in the world that are captured and learned by the brain (via statistical learning). But how do people develop emotion concepts if each category is a population of instances with few statistical regularities? The conceptual act theory hypothesizes that the emotion words themselves introduce statistical regularities across the various instances of a concept, like anger, even though their physical instances are variable. Initially, young children are exposed to instances where caregivers and other adults use emotion words to label and communicate changes in physical sensations and actions (either the child's or their own), setting the stage for statistical learning of the emotion concept. So, when developing a concept of anger, for example, the child's brain encodes instances where the word "anger" or "angry" is used. The brain captures the elements of the setting in which the anger occurs (i.e., other agents and objects), internal sensory (i.e., somatovisceral) cues from his or her body, as well as actions from self and others, instructions from others (in the form of rules), and words (e.g., the phonological form for "anger" or "angry"). Over time, these situated conceptualizations create a heterogeneous population of information that is available to represent new instances of the category "anger" during future emotion construction. Recent evidence from the developmental literature is consistent with this account, showing that infants are constructive learners who use statistical learning; they start with perceptual primitives, but then quickly acquire new concepts and new inductive capabilities based on input (Xu & Kushnir, 2013).

Finally, the hypothesis of core systems allows psychological constructionists to ask the novel question of how different emotion categories might be similar to one another. All psychological constructionist models agree that emotional episodes have an affective core, sometimes characterized in terms of pleasantness or unpleasantness (called "valence"; Clore & Ortony, 2013; Cunningham et al., 2013), sometimes in terms of level of arousal (e.g., Duffy, 1957; Schachter & Singer, 1962), and sometimes in terms of both (e.g., Barrett, 2006b; Barrett & Bliss-Moreau, 2009; Lindquist, 2013; Russell, 2003). Valence (and arousal) are not usually conceived of as operations or systems per se, but as descriptive properties of affective feelings that are common to all emotion instances. In the psychological construction approaches that focus on valence as a common feature of emotions, for example the OCC model and the iterative reprocessing model, affective valence is a property of experience that is the result of evaluation processes, whereas the conceptual act theory (Barrett & Bliss-Moreau, 2009) and Jim Russell's view (Russell, 2003) conceive of evaluative processes as only one contributor to affective valence. And whereas some psychological constructionists hypothesize that valence is a property that is special or unique to the domain of emotion and distinguishes emotions from other classes of mental states (Clore & Ortony, 2013), other psychological construction approaches, including that of Wundt (1897), point out that every waking moment of life has some affective tone, so that emotions cannot be distinguished from cognitions and perceptions by any affective property (e.g., Barrett, 2009).

This ability of psychological construction approaches to articulate and test hypotheses about the affective similarities across emotion categories had led to one of the biggest misunderstandings about psychological construction—that different emotions can be sufficiently distinguished by their affective properties, or that instances of emotion can be reduced to (redefined as nothing but) affect. To my knowledge, no psychological construction approach has ever claimed this, although the approach is often mislabeled as "dimensional" (for a discussion, see Lindquist, Siegel, Quigley, & Barrett, 2013). However, most psychological construction approaches acknowledge, and some even emphasize, that instances of different emotion categories require more than just affective properties. Furthermore, some approaches, like the conceptual act theory and the iterative reprocessing model, propose that instances of different emotion categories share more than just affective properties.

The Principle of Emergentism and Holism

The assumption that the mind is populated with mental faculties or types has produced a research agenda that is shaped by the reductionist philosophy derived from physics (e.g., physicists built the Large Hadron Collider to smash atoms so that they could understand the fundamental elements of the universe). When applied to biology, this philosophy is exemplified in what the evolutionary biologist Richard Lewontin (2000) calls Descartes' machine metaphor: It should be possible to reduce the body and the brain to their smallest meaningful elements or parts, and then study how each part works, separately from all the others, like the bits and pieces of a machine. The assumption is that reduction will lead to a better and more complete understanding of any phenomenon. In evolutionary biology, Descartes' machine metaphor can be seen in the attempt to study the function of an individual gene, separately from other genes and from the epigenetic context. The machine metaphor can be easily observed in the faculty/typological/natural kind approach to emotion, where the field is still dominated by the search for specific neurons, swaths of brain tissue, or networks that are responsible for each emotion faculty or type. Notice, too, that a

certain type of theoretical reductionism is also possible here, because the same concepts (anger, sadness, fear, etc.) are used for the psychological phenomena and for the physical mechanisms that cause the phenomena. As a result, it is tempting to ontologically reduce emotions to their physical aspects. This temptation is often too strong to resist by those who want to emphasize how human and nonhuman animals are similar and derive from a common ancestor (but for a notable exception, see LeDoux, 2012).

Lewontin and other biologists have argued that a living organism is a system that cannot be understood by reduction. They have argued that natural selection functions at the level of the individual organism, and not at the level of the gene, meaning that it is not possible to develop an understanding of the living world one gene at a time. As a result, they have been highly critical of research programs in evolutionary biology that rely on the machine metaphor to study the function of individual genes separate from their epigenetic contexts (e.g., see Jablonka, Lamb, & Zeligowski, 2006).

Reductionism is impossible, they argue, because phenotypes are new properties that emerge at a different level of integration from the bits and pieces of DNA that make up the genotype (referred to as emergentism). The idea is that a composite whole has properties not evident in its individual parts. Emergentism is not metaphysical magic—it is widely in play throughout the natural world. The classic example of emergentism is water: Water molecules are more than the proverbial "sum of their parts" because when hydrogen and oxygen bond together to make a water molecule, they can produce novel properties that neither can achieve alone. Reductionism is also not advisable because the function of each part is conditional on the whole system in that instance (referred to as holism). Holism and emergentism are two sides of the same coin. If emergentism is the idea of studying properties of a whole system that no part alone can produce, then holism is the idea of studying the interacting parts in a complex system, but never studying one part alone, out of context (also called "contextualism," or "compositionalism"). Holistic thinking means that it is not possible to understand how one part of a system works without considering how it is influenced by the state of the whole system. The biologist Ernst Mayr, in particular, has credited Darwin with these insights, whereas others argue that these concepts were developed later, as the science of evolution proceeded. Regardless of who said what, biologists now argue for constructive analysis, where the goal is to find new information about the living world by studying the relations and interactions between components of a system.

As can be seen in the three articles in this special section of *Emotion Review*, psychological construction approaches to emotion emphasize constructive analysis over reductionism. The concept of emergentism, as a key hypothesis in psychological constructionist accounts, is not new—Wilhelm Wundt (1897) described emotions as "psychical compounds," Harry Harlow (Harlow & Stagner, 1932) described emotions as "unanalyzable wholes," and in the past, I have referred to "emotional gestalts" (Barrett, Mesquita, Ochsner, & Gross, 2007). All three articles in this special section discuss emotions as emergent phenomena. The OCC model describes emotion instances as emergent events, and in particular utilizes certain measurement approaches that treat emotions as the linear sum of component parts (e.g., Coan, 2010; but for a concern with this approach, see Barrett, 2011). The iterative reprocessing model stipulates instances of emotion as the dynamic emergent result of hierarchically organized brain systems that interact through time. In particular, Cunningham et al. (2013) use a dynamical systems framework as a heuristic for understanding emotion construction (see also Barrett, Ochsner, & Gross, 2007). The conceptual act theory proposes that emotion instances emerge from the interaction of core networks, producing a unified conscious field that cannot be localized to any one network in the brain.

Only the conceptual act model explicitly incorporates principles of holism into its psychological construction framework (e.g., Barrett, 2009; Barrett & Satpute, 2013). In particular, the concept of holism is deeply similar to the idea that the function of any unit within the nervous system (a neuron, a brain region or network) depends on its neural context (McIntosh, 2004). In psychological construction, interactions of core systems create the neural "ecosystem" from which mental states, like instances of emotion, emerge. As a consequence, an empirical strategy of constructive analysis, over reductionism, is to be preferred.

In all these psychological constructionist approaches, then, understanding how emotions are constructed does not require defining them out of existence. Instead, the nature of emotion will only be revealed when we understand the dynamics of how core systems interact and influence each other through time. This represents a serious analytic challenge for psychological constructionism at the moment, however, since most data analytic and modeling strategies are based on a reductionist statistical models. But theoretical need often spurs methodological development. For example, a recent article reported the development of a Network Cohesion Index that can be used to investigate the dynamics of interacting brain networks over time in relation to emotional experience and peripheral nervous system arousal. Subjects passively watched movies during brain scanning, and postscan, subjects watched the films again, during which they rated the intensity of their emotional experiences. The BOLD signal collected during movie watching was used to compute the associations between both the strength and variability in brain networks across a sliding time window of each movie (i.e., the networks' cohesion), and this significantly predicted the intensity of experience (Raz et al., 2012).

Because psychological constructionism attempts to explain emotions as making meaning of internal bodily sensations or their corresponding mental feeling (i.e., affect), some critics mistakenly refer to psychological construction as a "peripheralist" approach to emotion (e.g., Scherer, 2009). To my knowledge, however, no psychological constructionists (except, perhaps, William James) argued that emotions should be redefined as (i.e., ontologically reduced to) this bodily component. This observation is related to the previous point, that psychological construction approaches do not argue that emotions can be ontologically reduced to the affective properties of valence and arousal.

Lessons from Psychological Construction

The articles in this special section of *Emotion Review* illustrate how psychological construction offers methodological and theoretical opportunities for innovation within the scientific study of emotion. First, a psychological construction approach prescribes a different scientific paradigm for the design and interpretation of experiments. In designing experiments, the goal would be (a) to explicitly seek out and model variation *within* each emotion category (rather than attempting to aggregate across instances to find the essence of each category), and to consider multidimensional "stimulus situations" that incorporate context and situations as a key element of emotion experiments; (b) to examine both the similarities and the differences of instances *across* emotion categories; and (c) to engage in complex analysis of interacting systems over the time that an emotional episode unfolds.

In interpreting experiments, a psychological construction approach reminds us to resist the temptation to essentialize. This is important, because temptations are everywhere. For example, as an analytic approach, pattern classification techniques used in psychophysiological and brain imaging research attempt to find a multivariate pattern of variables that are repeatable across instances of a category, and can be used to classify new instances of that category. For example, Kragel and LaBar (2013) cultivated instances of emotion in the lab, and created multivariate patterns of peripheral nervous system activity and subjective report that they could use to distinguish different emotion categories. The temptation, of course, it is to interpret these patterns as the essence of each category. Yet diagnosis is not explanation. A pattern represents features that are repeatable and are diagnostic, but this does not mean that these features are sufficient for representing all that is meaningful and important about the instance. For example, it would be completely consistent with the principle of constructive analysis to hypothesize that an instance of an emotion category, such as anger, could be modeled as an *N*-dimensional pattern of physiological response, or a brain state (or a series of brain states) constituted by interactions between widely distributed networks; some portions of this pattern will be repeatable across instances of the category, but these portions would, in and of themselves, would be insufficient for understanding any given instance—that is, there may be some aspects to the interactions in a given instance that are unique and important to understanding and to explaining that instance. Moreover, such as approach is consistent with a psychological construction assumption that all semantic categories, even those that are highly abstract and man-made (without an essence), have characteristic patterns of activation within the human brain (e.g., Naselaris, Preng, Kay, Oliver, & Gallant, 2009).

It is not an overstatement to state that progress in the science of emotion depends on whether scientists can resist the urge to essentialize. The historical record in emotion science bears witness to this claim. For example, in the late 1800s, James and Wundt and other early psychologists warned against essentializing emotion, yet decades of studies then attempted to find the specific, distinctive physical basis of each emotion category. Evidence for emotion categories as physical types did not materialize, however, and in the 1930s and 1940s, nascent psychological construction ideas were offered in their place (for a review, see Gendron & Barrett, 2009). Yet in the 1970s onward, armed with improved methodology, old ideas (particularly from Floyd Allport and William McDougall) were resuscitated by Silvan Tomkins (1962, 1963) and the field again returned to the search for emotion essences in the peripheral nervous system. With the advent of brain imaging, this search then extended to the human brain. Individual studies were able to distinguish instances of one emotion category from another in a given study, but the measurements that distinguished emotions in one study did not replicate across others, even when only the most typical instances of the categories were examined. Half a century later, the science of emotion found itself exactly where it was before, with authors, including myself, offering reviews of the literature showing that the evidence does not support a faculty/typological/natural kinds view, and offering psychological construction accounts in their place. Now, with the advent of more sophisticated multidimensional analytic approaches, articles are beginning to appear claiming that they have discovered the *N*-dimensional pattern that distinguishes one emotion category from another in a single study. If the past is any predictor of the present, then in another couple of decades we will discover that those patterns do not replicate each other across studies, and we will be no further ahead in understanding the nature of emotion than we are today. (In fact, it might not even take a couple of decades; for example, the findings from a pattern classification study by Kragel & LaBar (2013) do not replicate the findings from Stephens et al. (2010), even though both studies use the same stimuli and induction methods.) Explicitly considering a psychological construction approach as an alternative hypothesis, or even better, conducting experiments that are explicitly designed to test psychological construction ideas, is a remedy to repeating mistakes of the past.

Second, the articles in this special section of *Emotion Review* demonstrate the value of applying population thinking not only within the workings of an individual model or theory, but also to the science of emotion as a whole. In the emotion literature, there has been a tendency to create types or classes of theories and models (basic, appraisal, psychological construction, social construction), assuming that those within a class share more with each other than any given theory or model shares with others in a different class (see Gross & Barrett, 2011). Yet we can see from this special section that this is not the case. The similarities between the OCC model, which is traditionally classified as an "appraisal" theory, and the conceptual act theory, which is a psychological construction approach, outweigh their differences. Until now, the OCC model has focused mainly on describing the whole (emphasizing emergentism), whereas the conceptual act theory has concentrated on understanding how interacting systems produce the emergent emotional instances (emphasizing holism); but really the two approaches are more productively considered as two sides of the same emotional coin. In fact, when appraisals are conceived of as characterizations of "how the situation is experienced" during an emotion, rather than as causal

mechanisms of emotions, then there is the opportunity for building more powerful, integrated approaches to understanding the nature of emotion (cf. Barrett, Mesquita et al., 2007). Still, the causal appraisal approach highlights an important theme shared by the psychological construction approach—the importance of meaning-making in creating an emotional episode. In psychological construction approaches, there are mechanisms (typically, but mistakenly, referred to as "cognitive") that are elemental and necessary to constructing an emotional episode, but they are domain-general processes such as memory and categorization rather than specific mechanisms called appraisals. Memory and categorization can be called "appraisal processes" in that they are the systems that, in effect, create appraisals (as the experience of situated affect), even though they are not processes that specifically and exclusively "perform" appraisals (i.e., evaluations).

A similar point can be made about the links to social construction and basic emotion approaches. Social construction highlights the importance of the situation (the way that people interact and attempt to regulate each other) as creating opportunities for constructing instances of certain emotion categories over other categories (and even certain instances within a category over others in that category). Because their focus of inquiry extends outside the inner workings of the body and the brain, and explicitly incorporates the situation into their conceptual structure for explaining emotion, psychological constructionist approaches can seamlessly be integrated with social construction proposing that the structure of interpersonal interactions encourages the cultivation of culturally endorsed emotion approaches (e.g., Boiger & Mesquita, 2012). Similarly, basic emotion approaches highlight that there are species-general aspects to emotional episodes that we share with other mammals. By considering a behavioral adaptation (e.g., freezing, fleeing, fighting) as an ingredient of emotion, but not as an emotion itself, combined with population thinking, it is possible to find common ground between basic emotion and psychological construction views (cf. Barrett, 2012).

It is ironic that basic emotion approaches, as an example of the typological/faculty/natural kinds approach to emotion, claim Darwin as its inspiration (e.g., Shariff & Tracy, 2011). The approach is, in fact, more reminiscent of the kind of preformation theory that is decidedly pre-Darwinian (e.g., human infants are born with emotions encoded into their brains, and thus come prepared to experience and recognize a set of biologically basic emotion types). There is more to say about this than space permits, but perhaps is it sufficient to say here that Darwin's treatment of emotion in *The Expression of Emotions in Man and Animals*, written in 1872 (1872/2005), is actually a bit of a theoretical throwback when compared with his conceptual innovations in *On the Origin of Species*, written in 1859 (1859/1964). This includes, for example, a reliance on Lamarkian evolution in the former, rather than the principle of natural selection, which, admittedly, was Darwin's greatest conceptual achievement.

Finally, the iterative reprocessing model and conceptual act theory both highlight that psychological construction is not only a powerful theoretical framework for understanding emotional life, but represents a paradigm change for understanding how the brain creates the mind. The idea of domain-general core systems constitutes a formal hypothesis about the functional architecture of the human brain. One overarching goal in neuroscience research is to understand the physical responses of neurons (e.g., electrical, magnetic, blood flow, or chemical measures- related neurons firing) in mental (i.e., psychological) terms. At its inception, brain-imaging research started with psychological "faculties" such as emotions (e.g., anger, disgust, fear, etc.), social cognitions and perceptions (the self, person perception, etc.), as well as nonsocial cognitions (e.g., memory, attention, etc.) and perceptions (visual images, auditory sounds), and searched for their correspondence in topographically distinct swaths of brain tissue (often on the assumption that each constitutes its own mental ability as a specific process). This faculty psychology tradition carved up human brain imaging research into at least three sister disciplines—affective, social, and cognitive neuroscience. Increasingly, this paradigm in the human neurosciences has been criticized, in large part because the brain imaging research it inspired reveals it to be misguided. Emotions, social cognitions, and nonsocial cognitions (and perceptions, which for this article we include in the category "cognition") are better thought of as mental events (prompted by specific experimental tasks, or arising as naturally occurring states) that are constructed from interactions within and between these networks that compute domain-general functions. From this perspective, then, the distinction between social, affect, and cognitive neuroscience is artificial. There is no "affective" brain, "social" brain, or "cognitive" brain. Each human has one brain whose functional properties can be understood differently for different time scales and levels of organization. Psychological construction provides a single systems neuroscience framework that spans psychological domains (Barrett & Satpute, 2013). In such a framework, the brain contains a set of intrinsic networks that can be understood as performing domain-general operations; these operations serve as the functional architecture for how mental events and behaviors are constructed.

Note

1 To claim biological evidence for the faculty/typological/natural kind approach to emotion, it would be necessary to show that changes in a biological measurement were consistent, specific, and inheritable. For example, with brain imaging, it would be necessary to show that increased BOLD activations within a swath of brain tissue (a location or a network) were (a) consistent during all instances of the category barring error, (b) specifical during that category and only that category, (c) anatomically defined, and therefore inheritable, and perhaps (d) homologous in nonhuman mammals.

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