PERSPECTIVES ON PSYCHOLOGICAL SCIENCE

Are Emotions Natural Kinds?

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ABSTRACT—***Laypeople and scientists alike believe that they know anger, or sadness, or fear, when they see it. These emotions and a few others are presumed to have specific causal mechanisms in the brain and properties that are observable (on the face, in the voice, in the body, or in experience)—that is, they are assumed to be natural kinds. If a given emotion is a natural kind and can be identified objectively, then it is possible to make discoveries about that emotion. Indeed, the scientific study of emotion is founded on this assumption. In this article, I review the accumulating empirical evidence that is inconsistent with the view that there are kinds of emotion with boundaries that are carved in nature. I then consider what moving beyond a natural-kind view might mean for the scientific understanding of emotion.***

> At the most global level, I think it is reasonable to view basic emotions as arising from coherent brain operating systems that . . . orchestrate and coordinate a large number of output systems in response to specific inputs. (Panksepp, 1994, pp. 23–24)

> Until demonstrated otherwise, it is assumed that these systems constitute the core processes for the “natural kinds” of emotion. (Panksepp, 2000, p. 143)

> The error of arbitrary aggregation is deeply embedded in much of adaptive explanation, especially in our attempts to give evolutionary explanations of human social behaviors. (Lewontin, 2000, p. 78)

What is an emotion? This question has been debated through the ages, dating back to Plato and Aristotle, and is as old as psychological science itself. Questions about emotion are central to psychology and are pervasive in scientific models of the mind and behavior. Emotions are seen as the causes, mediators, or effects of other psychological processes such as attention, memory, and perception. Emotions are implicated in a range of psychological disorders and are seen as central, if not essential, to interpersonal functioning. Questions about the fundamental nature of emotion, then, strike to the heart of what psychology is all about.

Recent years have seen a virtual explosion of research activity on emotion-related topics. Psychologists, neuroscientists, philosophers, computer scientists, sociologists, economists, and anthropologists all study something called “emotion.” New journals and societies dedicated to emotion research have emerged, private and public funding agencies are beginning to support the study of emotional activity in all its forms, and the number of research papers and books dealing with emotion-related topics is steadily increasing across disciplinary lines. Given all the scholarly activity, and the general importance of emotion in the science of the mind, it is surprising that knowledge about emotion has accumulated more slowly than knowledge about other comparable concepts, like memory or attention. The consensus seems to be that the lack of progress in a scientific understanding of emotion results from unresolved disagreements over the fundamental question of how an emotion is to be defined. Indeed, there continues to be much discussion of this question (for examples, see Ekman & Davidson, 1994, and Solomon, 2003b).

In this article, I suggest that progress in the scientific understanding of emotion is not, as one might assume, hampered by disagreements. Instead, I argue that progress is limited by the wide acceptance of assumptions that are not warranted by the available empirical evidence. These assumptions can be summarized by one core idea: Certain emotions (at least those referred to in Western cultures by the words “anger,” “sadness,” “fear,” “disgust,” and “happiness”) are given to us by nature.[1] That is, they are natural kinds, or phenomena that exist independent of our perception of them. Each emotion is thought to produce coordinated changes in sensory, perceptual, motor, and physiological functions that, when measured, provide evidence of that emotion’s existence. The natural-kind view of emotion has been productive in defining the boundaries for the scientific study of emotion and continues to guide scientific discourse: It underlies the major questions, the experimental designs, and the

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[1] Emotion words that appear in quotation marks refer to linguistic forms (the words themselves), whereas emotion words in italics refer to emotion categories. For example, “anger” indicates the word, whereas *anger* indicates the associated category.

interpretation of empirical findings that characterize emotion research as a domain of scientific inquiry. In the pages that follow, however, I suggest that the natural-kind view of emotion may be the result of an error of arbitrary aggregation (Gould, 1977; Lewontin, 2000, p. 78). That is, our perceptual processes lead us to aggregate emotional processing into categories that do not necessarily reveal the causal structure of the emotional processing. I suggest that, as a result, the natural-kind view has outlived its scientific value and now presents a major obstacle to understanding what emotions are and how they work.

I begin by briefly reviewing how philosophers of science characterize the concept of a natural kind. Next, I outline in more detail the core assumptions that characterize a natural-kind view of emotion. I then examine these assumptions by presenting a focused review that is specifically designed to highlight accumulating evidence that is inconsistent with the idea that emotions have definable boundaries in the brain or body. Finally, I consider what moving beyond a natural-kind view might mean for the scientific understanding of emotion.

WHAT IS A NATURAL KIND?

To examine the assumptions that embody a natural-kind view of emotion, it is important to understand what it means to call something a natural kind. In everyday terms, a natural kind is a collection or category of things that are all the same as one another, but different from some other set of things. These things may (or may not) look the same on the surface, but they are equivalent in some deep, natural way. In the most straightforward philosophical sense, a natural kind is a nonarbitrary grouping of instances that occur in the world. This grouping, or category, is given by nature and is discovered, not created, by the human mind. In a natural-kind category, instances cluster together in a meaningful way because they have something real in common. There are two main ways of characterizing what is real, or meaningful, about natural-kind categories.

A Cluster of Observable Properties

A category constitutes a natural kind if every instance of the kind looks the same and shares a collection of features or properties that co-occur. These correlated features can be observed and measured. As I discuss in more detail later, *anger*, *sadness*, and *fear*, as well as several other emotion categories, are thought to be natural kinds of emotion that have a distinctive pattern of correlated outputs (facial movements, autonomic activity, instrumental behavior, and so on). That is, each emotion is presumed to have a distinctive cluster of properties. Any two emotions (e.g., *anger* and *fear*) may have some overlap in one output or another (e.g., increased heart rate), but the patterns of outputs are presumed to be distinctive. For example, for *anger* to be a natural kind, all instances of *anger* should have a characteristic facial display, cardiovascular pattern, and voluntary action that are coordinated in time and correlated in intensity. The pattern taken on by this core set of correlated properties is different from the pattern that characterizes another category (say, *fear*). Instances of *anger* must be sufficiently similar to one another in their profile of correlated properties, but sufficiently different from instances of *fear*, so that people can clearly distinguish between the two, thereby "cutting nature at its joints."

The property cluster that characterizes a natural kind is sometimes said to be *homeostatic*, in the sense that the properties work to maintain and reinforce one another (Boyd, 1991). The property cluster must be *projectable*, meaning that it must be reliably observed for every instance of the category (Goodman, 1954). As a result, it should be possible to predict what is, and what is not, an instance of a kind, which allows scientists to make inductive discoveries about natural-kind categories. In philosophical terms, correlated properties can be thought of as specifying the *extensions* of each natural-kind category—the instances that the category refers to. In a sense, these correlated properties are necessary and defining features of the category.

It has been argued that concepts (as mental representations of categories) have no necessary or defining features, and as a consequence it is not possible to define a natural kind by the similarity of its instances (Kripke, 1972; Putnam, 1975). In this view, members of a category share a family resemblance on a characteristic set of features, and therefore concepts for categories, whether they refer to natural kinds (e.g., birds) or not (e.g., marriages or superheroes), are best defined by probabilistic sets of features (Rosch & Mervis, 1975; Wittgenstein, 1953). That a concept has no necessary and sufficient features is not grounds for assuming that the category itself (made up of its members or extensions) has no such features, however (Kripke, 1972; Putnam, 1975). Nonetheless, some researchers have argued that natural kinds cannot be characterized in terms of similarity, and instead propose that there is something deeper and more basic to a natural kind—some underlying causal structure or mechanism that makes a set of instances the kind that they are (and not some other kind).

A Causal Mechanism

Although many modern philosophical treatments define a natural-kind category by analogy (instances of a category have similar observable properties), an older philosophical tradition defines a natural kind by homology (instances of a category have a common derivation). Aristotle assumed that each kind has an essence—some underlying cause that defines it and makes the kind what it is (distinguishing it from other kinds). From an essentialist point of view, an essence is the mechanism that guarantees the identity of the natural kind and serves as the principal defining element for instances of that kind, regardless of what those instances actually look like (Kripke, 1972; Putnam, 1975). So, emotional episodes that look different on the surface—a driver speeds up and yells or shakes a fist, someone sits quietly seething in the boardroom, and a child on the playground makes a scowling face and stomps or throws a toy—are all instances of *anger* because they presumably issue from the same underlying cause.

There continues to be debate within the philosophy of science over the need for essences to explain the existence of natural kinds (e.g., Boyd, 1991; Dupré, 1981; Mellor, 1977), but the idea of causal mechanisms still figures in some discussions. For example, Griffiths (1997) argued that "affect programs" (i.e., hypothetical mechanisms that guide cardiovascular and facial responses and direct their co-occurrence; Ekman, 1977; Tomkins, 1962) are *causal homeostatic mechanisms* that produce kinds of *basic emotion*. Emotions are called basic when they are assumed to be universally present in humans, homologous in animals, selected for over the course of evolution, and biologically primitive, thereby constituting the fundamental elements of emotional life (cf. Ortony & Turner, 1990). Although Griffiths (1997, 2004) suggested that the category "emotion" is too broad to constitute a natural kind (also see Russell & Barrett, 1999), he assumed, as do many emotion researchers, that particular types of emotion are given by nature and can be identified for scientific study.[2]

Causal mechanisms (whether of the essentialist or homeostatic sort) specify the way in which instances of any natural kind are determined. In philosophical terms, they often dictate the *intension* of a category. For example, if every instance of *anger* is caused by a specific neural circuit, or by an "anger program," then every instance of *anger* is homologous with every other instance because they all derive from a common cause. Anything that derives from the mechanism for *anger* is considered an instance of *anger*, even if it does not include all the prescribed parts (e.g., a facial movement, a physiological reaction, a subjective feeling).

KINDS OF EMOTION

The term "natural kind" is a philosophical label for what many people already assume about emotion. Many of the most influential scientific treatments of emotion are founded on the view that certain emotion categories (such as *anger*, *sadness*, *fear*, *disgust*, and *happiness*) carve nature at its joints. It is assumed that each kind of emotion can be identified by a more or less unique signature response (within the body) that is triggered or evoked by a distinct causal mechanism (within the brain). As a result, it should be possible to recognize distinct emotions in other people, identify them in oneself, and measure them in the face, physiology, and behavior.

Projectable Property Clusters

The idea that each kind of emotion produces a distinct set of responses (a characteristic property cluster) can be found in early scientific theorizing about emotion. Darwin's (1859/1965) *The Expression of the Emotions in Man and Animals* is infused with commonsense ideas about how specific mental states seek expression in and therefore cause specific sets of behaviors. Despite criticism from James (1884, 1890/1950, 1894/1994), early scientific models retained the assumption that emotions are entities that trigger a complex suite of responses in an obligatory way, propelling a person to act in characteristic ways (e.g., Cannon, 1929; MacLean, 1949; Papez, 1937; Tomkins, 1962).

Several influential modern models have preserved the assumption that there are different kinds of emotion, each causing a distinct pattern of physiological and behavioral response. In the starkest form of such models, each kind of emotion is biologically basic, a separate, inherited, complex reflex that is hardwired at birth. Many models assume that each emotion kind is characterized by a distinctive syndrome of hormonal, muscular, and autonomic responses that are coordinated in time and correlated in intensity (e.g., Buck, 1999; Cosmides & Tooby, 2000; Ekman, 1973, 1992, 1999; Izard, 1977, 1993; Johnson-Laird & Oatley, 1992; LeDoux, 1996; Levenson, 2003a, 2003b; Panksepp, 1998, 2000; Plutchik, 1980; for several recent examples, see Ekman, Campos, Davidson, & de Waal, 2003). More recent discussions of basic emotions include a broad acknowledgment that epigenetic influences (such as context and learning history) may play a role in emotional responding (e.g., Ekman, 1992; Keltner & Haidt, 2001; Panksepp, 1998), and that the face, voice, and body are not tightly linked in a highly invariant manner. Yet it is not uncommon for emotion researchers to make reference to specific kinds of emotions that are represented as a set of diagnostic responses to particular kinds of antecedents.

It is not only the basic-emotion approaches that rely on the assumption of projectable property clusters. The idea of privileged kinds of emotion defined by a set of specific and bounded responses can also be observed in some appraisal models of discrete emotions. Unlike the basic-emotion approach, however, the appraisal approach does not assume that particular emotions are biologically basic in the sense that objects or situations trigger prescribed emotional responses in an unmediated or reflexive way. Instead, appraisal models posit that cognitive processes mediate emotion elicitation, and some models attempt to account for the same kinds of emotional responses as the basic-emotion approaches.

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[2] The idea that *anger*, *sadness*, *fear*, and other select emotion categories are natural kinds is somewhat distinct from the idea that the category emotion is a natural kind and therefore unlike other psychological phenomena (say, cognition or attention). For discussion of the natural-kind status of the category emotion, see Charland (2002) and Griffiths (1997, 2004).

The primary assumption that unites all appraisal accounts is that a person's interpretation of a stimulus situation evokes an emotion. Frijda (1988) has called this the *law of situated meaning*. "Input some event with its particular meaning; out comes an emotion of a particular kind" (Frijda, 1988, p. 349). There is a good deal of variation in how appraisal models implement the law of situated meaning (for reviews, see Ellsworth & Scherer, 2003, and Roseman & Smith, 2001). One important source of variation is that some models (e.g., Lazarus, 1991; Roseman, 1984, 1991; Scherer, 1984) include an assumption that specific categories of emotion have projectable property clusters that are available within the individual and that are lawfully triggered by particular meanings.[3] These natural-kind appraisal models do not assume that emotions are reflexively triggered by the environment. Like all appraisal models, they posit that an emotion-evoking stimulus is decoupled from any subsequent emotional response, so that the intervening cognitive interpretation of the stimulus produces flexibility in emotional responding. The hallmark of natural-kind appraisal models is that they characterize emotions as definable patterns of outputs that preexist within the individual (e.g., Roseman, 2001) or that arise from interrelated systems that influence and constrain one another to produce something like a homeostatic property cluster (e.g., Scherer, 1984, 2005).

According to natural-kind appraisal models, once the meaning of a situation or object is computed (by whatever cognitive processes are at play) and a particular profile of appraisals is invoked, the result will be an automated set of emotional changes that correspond to the profile of appraisals in that instant. Categories of emotion like *anger*, *sadness*, and *fear* are considered "modal" emotions because their appraisal profiles recur with some frequency (Scherer, 1994). As a result, *anger*, *sadness*, and *fear* can still be characterized by some set of facial behaviors, physiological responses, and subjective experience. Natural-kind appraisal models allow for some heterogeneity in responses for modal emotions by assuming, as do basic-emotion approaches, that fixed response patterns can be overridden by conscious control or less conscious forms of emotion regulation (Frijda, 1988; Scherer, 2005).

Despite the difference in their surface features, then, both basic-emotion models and some appraisal models of emotion endorse the view that there are distinct expressive and physiological changes for some emotions, and that emotions organize into behavioral and physiological patterns for dealing with emotion-evoking events (for opinions on this matter, see Ekman & Davidson, 1994). So, for example, when a stimulus triggers an instance of *anger*, either directly or via a set of cognitive appraisals, people produce a suite of facial movements, vocal changes, patterned physiological reactions, and voluntary actions that are specifically characteristic of *anger*. People might also experience a feeling of anger, which they may or may not be able to report.

Causal Mechanisms

Natural-kind models of emotion not only assume that there are distinct profiles of responses to characterize each kind of emotion, but also assume that these responses are caused by distinct emotion mechanisms. The causal mechanism for *anger* is presumed responsible for the coordinated package or correlated set of features that constitute an anger response. The anger mechanism also serves to identify an instance as *anger* when some factor (e.g., a regulation strategy) intervenes between emotion elicitation and expression and disrupts the signature profile of response. That is, the anger mechanism defines an instance of emotion as *anger*, no matter what the observable response actually looks like. By positing some sort of causal mechanism for each emotion that harnesses the face, the voice, and the body, researchers are, in effect, presuming that each natural kind of emotion has an essence or some sort of "causal homeostatic mechanism" (Griffiths, 1997) that initiates a set of correlated responses that maintain and reinforce one another.

This emphasis on causal mechanism can be seen in the earliest scientific models of emotion. Darwin (1859/1965) gave distinct mental states causal status. This idea is echoed in some modern treatments, in which mental signals (Johnson-Laird & Oatley, 1992) or feelings (e.g., Johnson-Laird & Oatley, 1989) are the primary mechanisms that define kinds of emotion. Some early models also located causal mechanisms in particular areas of the brain, such as the thalamus (Cannon, 1929) or the so-called limbic system (MacLean, 1949; Papez, 1937). Modern neuroscience models of emotion have expanded on this view, such that different emotions are presumed to be caused by distinct neural circuits that involve the amygdala, orbitofrontal cortex, the insula, and various brainstem areas (e.g., Buck, 1999; Damasio, 1999; Dolan, 2002; Ekman, 1992; Izard, 1993; LeDoux, 1996; Panksepp, 1994, 1998, 2000). Still other emotion models have proposed that emotions are caused by hypothetical psychological mechanisms, such as affect programs (Ekman, 1973, 1977, 1999; Izard, 1977; Tomkins, 1962), cognitive modules (Cosmides & Tooby, 2000), or motivations (e.g., Frank, 1988; Izard & Ackerman, 2000; Plutchik, 1980) that are presumed to have neural counterparts.

Natural-kind appraisal models also assume that there are causal mechanisms producing distinct kinds of emotions. The same models that assume projectable property clusters for discrete emotions also assume that appraisals are the literal cognitive mechanisms that compute meaning of a situation, which in turn determines the quality and intensity of the ensuing emotional response (e.g., Lazarus, 1991; Roseman, 1984, 1991;

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[3] The appraisal models that do not assume projectable property clusters instead assume that situational meaning, however it is computed, produces a variable combination or pattern of outputs. Such a combination constitutes an emotional state, and may or may not correspond to a known category of emotion.

Scherer, 1984).[4] This is perhaps the clearest way in which some appraisal models of emotion can be said to hold a natural-kind view—an emotional response that includes increased blood pressure and one that does not are both instances of *anger* if they derive from the same situational meaning (computed by a set of appraisals).

It must be said that all appraisal models, at least in principle, allow for enormous variety in emotional responding and do not, by necessity, require emotions to be bounded categories. Yet most appraisal models organize emotional responding into the familiar set of discrete categories discussed by basic-emotion approaches and offer profiles of the necessary and sufficient appraisals to characterize each category (e.g., Frijda, 1986; Lazarus, 1991; Ortony, Clore, & Collins, 1988; Roseman, 1984, 1991; Scherer, 1984; Smith & Ellsworth, 1985).

A Scientific Paradigm for the Study of Emotion

Despite the differences in their surface features, many of the most prominent models share a common set of beliefs about the nature of emotion: Emotions are categories with firm boundaries that can be observed in nature (meaning in the brain or body) and are therefore recognized, not constructed, by the human mind. As a natural kind of emotion, *anger*, for example, is assumed to be a package of behavioral and physiological changes that are produced by some causal mechanism (in the brain or the mind, again depending on the level of analysis) that is released under certain conditions. Researchers assume that they will know an instance of *anger* when they see it in the face, voice, or body of another person, or feel it in themselves.

Without question, the natural-kind paradigm has played a crucial role in developing the scientific study of emotion. If *anger* is a natural kind, then the projectable properties of *anger* (the specific pattern of facial movements, cardiovascular pattern, and voluntary action, or the specific patterns of cognitive appraisals) should be the criteria for identifying when an instance of anger has occurred. If there is some core set of properties that makes a response *anger* and not some other kind of emotion, then every instance of *anger* can be categorized with some degree of accuracy. And if instances of *anger* can be identified, then they can be studied to produce general observations or claims about the emotion *anger*.

Furthermore, because changes in the face, the voice, and the body are presumed to have a common emotional cause (be it a neural circuit or a set of appraisals), any single response (e.g., facial movements alone) can be taken as evidence that a particular kind of emotion has occurred. Therefore, the assumption is that scientists need measure only one response, because it can serve as a proxy for all the others. As a result, scientists feel free to state that their findings are about, for example, *anger* even if they measured only a peripheral nervous system response, facial movements, or a subjective feeling state. If one behavior (say, a voluntary action) is present but another (say, facial expression) is not, then it is assumed that the tendency was there, but that some other mechanism (e.g., a display rule) interfered with its expression.

Not only has the natural-kind view shaped the scientific study of emotion by defining what emotions are, but it also has produced a clear research agenda for contemporary study of emotion in humans and nonhuman mammals. For much of the past century, the natural-kind view set researchers on a quest for the observable, coordinated outputs in the face, voice, and body that would prove the existence of emotion kinds. The face, voice, and body are thought to contain specific information about emotion that can be detected and decoded by other people (including scientists) with some degree of accuracy. For example, facial movements that people perceive as coordinated expressions are thought to broadcast information about the internal emotional state of the sender (e.g., Ekman, 1972, 1980). Peripheral nervous system responses are thought to have sufficient specificity to indicate the emotional state of participants (for recent reviews, see Keltner & Ekman, 2000; Levenson, 2003a, 2003b). More recently, with the advent of neuroscientific investigations, emotion scientists have also begun to search for the brain markers of emotion kinds (e.g., Murphy, Nimmo-Smith, & Lawrence, 2003; Phan, Wager, Taylor, & Liberzon, 2002).

The natural-kind view not only has shaped the kinds of scientific questions asked about emotion, but has also dictated how the evidentiary record should be interpreted. For example, if coordinated responses are the rule, then every instance of *anger* is supposed to produce a recognizable pattern of facial movements, vocal changes, peripheral nervous system activations, and voluntary behaviors. Instances in which responses do not coordinate are anomalies that require additional explanation.

EVALUATING THE NATURAL-KIND VIEW OF EMOTION

> I cannot give any scientist of any age better advice than this: the intensity of the conviction that a hypothesis is true has no bearing on whether it is true or not. The importance of the strength of our conviction is only to provide a proportionally strong incentive to find out if the hypothesis will stand up to critical examination. (Medawar, 1979, p. 39)

By defining emotion as a topic worthy of study in its own right, and organizing scientific inquiry for several decades, the natural-kind view of emotion has produced a virtual explosion of empirical findings about emotional responding. These findings can now be used to evaluate the two basic assumptions that make up the natural-kind view of emotion. Each assumption can be

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[4] In other models, appraisals are not causal mechanisms, but rather represent dimensions of meaning that are associated with particular emotions. In these models, the appraisals describe the set of rules for which emotions are felt when, but are not, in themselves, the causal processes that determine how meaning is arrived at (e.g., Ortony, Clore, & Collins, 1988).

translated into a testable hypothesis that can be examined in light of the available empirical evidence.

A comprehensive review of the entire evidentiary record of emotion research is well beyond the scope of this article for both practical and logical reasons. Several recent reviews of evidence in support of basic-emotion models (e.g., Ekman, 1992; Ekman et al., 2003; Keltner & Ekman, 2000; Keltner, Ekman, Gonzaga, & Beer, 2003; Panksepp, 1998) and appraisal models (e.g., Scherer, Schorr, & Johnstone, 2001) already exist. My goal in this article is to provide a complementary review that highlights and summarizes evidence that is potentially disconfirming of a natural-kind view. In doing so, my review builds on recent articles that review evidence against the basic-emotion approach (e.g., Ortony & Turner, 1990; Russell, 1994; Russell, Bachorowski, & Fernández-Dols, 2003; Turner & Ortony, 1992). A focus on disconfirming evidence is not only practical, but also logically preferable (Popper, 1959) because it will allow the interested reader to evaluate whether the evidence is weak enough to be dismissed or sufficiently strong to call the natural-kind view into question. In this section, then, I briefly review the accumulating evidence that is available to disconfirm the hypotheses that projectable clusters of properties and specific causal mechanisms define certain kinds of emotion.

Are Emotion Categories Revealed in Correlated Response Patterns?

The Hypothesis

If certain categories of emotion are natural kinds, characterized by projectable property clusters, then it should be possible to characterize each kind of emotion in terms of a suite of distinctive, observable responses that are coordinated in time and correlated in intensity. That is, it should be possible to empirically verify that *anger*, *sadness*, *fear*, and so on have distinctive sets of correlated properties. Dolan (2002) nicely summarized this hypothesis in his recent *Science* article:

> Emotions are embodied and manifest in uniquely recognizable, and stereotyped, behavioral patterns of facial expression, comportment, and autonomic arousal. (p. 1191)

According to this hypothesis, for example, when *anger* erupts, blood pressure will rise, a scowl will form on the face, and there will be an urge to hit or yell. These responses can be measured, should show some sort of coherence or association, and will therefore give evidence that an instance of *anger* has occurred.

This idea that emotions are correlated sets of measurable responses is very consistent with how scientists think about measurement in psychology. One way to establish the presence of an abstract construct like *anger*, *fear*, or *sadness* is to demonstrate that each has measurable effects that are highly correlated. From a purely psychometric standpoint, psychologists assume that if measures are highly correlated, then they must derive from a common cause (in this case, the emotion). If measures are weakly correlated, then psychologists typically conclude that the measures have separable causes and do not give evidence of the construct in question. As a result, the extent of correlation between measurable responses provides a psychometric test of whether or not a construct exists. In this case, such correlations provide a way of testing whether or not kinds of emotion exist as definable categories.

The Evidence

More than 30 years ago, emotion researchers began to report that strong correlations among measurable responses failed to materialize as expected (e.g., Lacey, 1967; Lang, 1968). Although no single study of emotion has simultaneously measured facial movements, vocal signals, changes in peripheral physiology, voluntary action, and subjective experience, many studies have measured at least two or three of these responses (usually some combination of subjective experience, behavior, and autonomic activity). These studies have reported a range of associations, from modest correlations to no relationship to negative correlations among experiential, behavioral, and physiological measures of emotion (Edelmann & Baker, 2002; Fernández-Dols, Sanchez, Carrera, & Ruiz-Belda, 1997; Fridlund, 1991; Gross, John, & Richards, 2000; Jacobs, Manstead, & Fischer, 2001; Lang, 1988; Mauss, Wilhelm, & Gross, 2004; Rachman, 1978; Reisenzein, 2000). The strongest links tend to be between self-reports of emotion experience and measures of facial behaviors (e.g., for reviews, see Fridlund, Ekman, & Oster, 1987; Ruch, 1995), although the correlations are typically small to moderate in size, and there is some question about their consistency across studies (Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000).

Several studies have reported moderate to strong correspondences between the face and the subjective experience, however. For example, Bonanno and Keltner (2004) reported moderate to strong correspondences between facial behaviors and ratings of experience for anger and sadness, with effect sizes ranging from .34 to .52. Mauss, Levenson, McCarter, Wilhelm, and Gross (2005) reported strong correspondences between facial behaviors and ratings of experience for amusement and sadness, with effect sizes of .73 and .74. Such studies often fail to rule out the possibility that the observed differences are due to other psychological properties, such as arousal (e.g., Bonanno & Keltner, 2004) or valence (e.g., Mauss et al., 2005).

Furthermore, even the strongest correspondences within emotion categories are weaker than those observed for broad affective dimensions. For example, facial behaviors, reports of experience, and peripheral nervous system activity show strong correspondences for the affective properties of valence and intensity (effect sizes range from .76 to .90; Lang, Greenwald, Bradley, & Hamm, 1993). Taken together, enough evidence has accumulated for some theorists to conclude that lack of response coherence within each category of emotion is empirically the rule rather than the exception (Bradley & Lang, 2000; Russell, 2003; Shweder, 1993, 1994).

Despite this evidence, however, the science of emotion proceeds as if facial behaviors, autonomic activity, and the like configure into signature response clusters that distinguish particular kinds of emotion from one another. The frequent failure to observe such clustering is explained in several different ways. One argument suggests that social factors, like display rules (Ekman, 1972, 1973; Matsumoto, Kasri, & Kooken, 1999) or other regulation processes, might mask or inhibit prepotent responses that would otherwise materialize. A second argument suggests that scientists routinely fail to observe correspondences because response systems differ in temporal dynamics, sensitivity, and reliability of measurement (cf. Bradley & Lang, 2000). A third argument is that laboratory studies of emotion do not employ emotion-eliciting stimuli that are strong enough to produce prototypical emotion episodes, in which responses would be correlated with one another (cf. Tassinary & Cacioppo, 1992). Although any of these explanations may be correct, an equally plausible explanation is that scientists have failed to observe stable and reliable response clusters because they are not really there. Projectable property clusters may not exist because emotions may not be natural kinds.

In fact, it is not necessary to rely on natural-kind assumptions to understand how the face, the voice, the body, and subjective experience configure in an emotional response. One possibility is that there is idiographic distinctiveness, such that the pattern for *anger* differs from the pattern for *sadness* within an individual, and the patterns for *anger* and *sadness* are not stable across people. Although some evidence is suggestive of such idiographic patterning (Fridlund, Schwartz, & Fowler, 1984; Lacey, Bateman, & van Lehn, 1953; Picard, Vyzas, & Healey, 2001; Wallbott & Scherer, 1991), no research to date has specifically evaluated this possibility.

Another possibility is that each individual reacts to a range of stimuli with the same modal response, but that modal responses vary across individuals. For example, some people may react to all emotional events primarily with facial movements, whereas others may show primarily autonomic effects (for a discussion, see Tourangeau & Ellsworth, 1979). An individual may consistently be a blood pressure reactor regardless of the type of negative affect experienced (Marwitz & Stemmler, 1998). Recent research has also shown individual differences in the complexity of cardiac responses across a variety of different laboratory stressors (Friedman, 2003). These sorts of findings clearly suggest that a more idiographic approach to understanding emotion would prove beneficial. Such an approach is certainly consistent with some of the ideas originally put forth by James (1890/1950; 1894/1994).

A third possibility is that the face, the voice, the body, and experience are separable components of an emotional response and that each is controlled or caused by a distinct, parallel system that responds to particular features of the stimulus situation (McNaughton, 1989; Öhman, 1999; Ortony & Turner, 1990; Russell, 2003; Stemmler, 2003). A componential model of emotional responding would provide for substantial flexibility in how the parts of an emotional response configure, allowing individuals to tailor their response to the demands of the situation. In this view, an emotion would be an emergent phenomenon, something that results from distinct but interacting response systems (Barrett, 1998b) and that could be modeling via the principles of constraint satisfaction (see Barrett, Ochsner, & Gross, in press).[5]

Is There Evidence of Causal Mechanisms?

The Hypothesis

The failure to find correlated features does not, in and of itself, disconfirm the natural-kind view of emotion. Strictly speaking, if a natural kind is defined by homology (common derivation), rather than by analogy (similar observable properties), then instances of that kind need not share the same set of observable features. If it is assumed that all episodes of an emotion category result from the same underlying cause, then any one instance of that category need not look exactly the same as any other. This means, of course, that a causal mechanism for the category exists and can be discovered somehow through scientific means. The second hypothesis that can be derived from the natural-kind view of emotion, then, is that different emotion kinds have distinct causal mechanisms (in the form of either essences or causal homeostatic mechanisms).

Causal mechanisms are difficult to observe directly in science. In emotion research, measures of emotional behavior are often used to infer the existence of underlying emotion mechanisms. People scowl when they are angry. They cry when they are sad. Scowling and crying are taken to be observable evidence that the causal mechanisms for *anger* and *sadness* have been triggered. Inferring unobservable causes from observable measures not only is common in emotion research, but also is standard practice in all areas of psychology and in other scientific disciplines, such as physics and biology (Hacking, 1983; Maxwell, 1964; McMullin, 1978; Toulmin, 1961). One major assumption in this endeavor, at least in psychology, is that the structure of observed responses will mirror the structure of the underlying mechanisms that caused them. If emotions are distinct kinds that correspond to real distinctions in nature (i.e., distinctions in the brain and body), then examining the

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[5] In measurement terms, emotions would be modeled as causal indicators, such that a construct (in this case, the emotion) is a linear combination of its causes (Bollen & Lennox, 1991). According to the effect-indicator model that is typical of classical measurement theory, an abstract construct produces changes within a set of measurable effects, so a strong correlation between the supposed parts of an emotional response would be required. In contrast, a causal-indicator model has the advantage that measurements of the face, voice, and body (i.e., indicators) can have any relation to one another (positive, negative, or no correlation). As a result, it is possible to model each category of emotion as a heterogeneous class of events, and to observe, rather than assume, what they have in common.

observable outputs for each emotion should give evidence of these distinctions. That is, nature's joints, at least with respect to emotional phenomena, should be exposed by the structure of the data. Questions about the structure of emotion responses (such as the structure of self-report or the structure of facial behaviors) are really questions about whether *anger*, *sadness*, *fear*, and so on are the natural kinds that constitute the building blocks of emotional life, and are therefore the most appropriate categories to support scientific induction.

One version of the causal-mechanism hypothesis, then, is all observable events, such as voluntary action or action tendencies, facial muscle movements, vocalizations, subjective experiences, and peripheral nervous system responses, encode specific information that derives from the causal mechanism that produced them. It is presumed that other people—be they perceivers in a social interaction or psychologists in a laboratory—can easily decode this emotional information.

With the advent of neuroimaging techniques, such as functional magnetic resonance imaging (fMRI) and positron emission tomography (PET), a second version of the causal-mechanism hypothesis has emerged—that there may be a specifiable and separate neural circuit or brain marker that corresponds to each emotion category (in particular, *anger*, *sadness*, *fear*, *disgust*, and *happiness*). Researchers have begun to search in earnest for these causal emotion mechanisms in the human brain.

The Evidence

Subjective Experience. In the natural-kind view, the subjective experience of emotion is the simple veridical sensory detection of the causal mechanism (Barrett, 2006). Each emotion mechanism is thought to produce a distinctive internal feeling (Damasio, 1999; Panksepp, 1994), so that emotions like *anger*, *sadness*, *fear*, *disgust*, and *happiness* are universal categories of direct experience (Johnson-Laird & Oatley, 1989). From the emoter's perspective, the conscious experience of emotion (the feeling) is taken as clear evidence that the causal mechanism—the "emotion"—was triggered. Feeling angry is evidence that the *anger* mechanism has fired.

If the subjective experience of emotion is indeed the sensation that results from a discrete causal entity (the essence or causal homeostatic mechanism of an emotion), then experienced emotions, when measured, should produce a structure that mirrors the structure of the mechanisms—we should see *categories of experience* that are distinct and separate from one another. Reports of experienced emotion, when assessed with a self-report scale and projected into geometric space (with a procedure like factor analysis) should exhibit simple structure with one factor each for *anger*, *sadness*, *fear*, and so on (for a discussion of simple structure, see Thurstone, 1935). That is, measures of emotion experience should produce evidence of discrete, discriminable categories. Such findings would indicate that reports of any given emotion (e.g., *anger*) are *homogeneous*, measuring a singular and unified content area (e.g., feelings of anger) and not anything else (e.g., feelings of sadness). Simple structure would also suggest that experiences of emotion are *experientially primitive*, meaning that reports of anger, sadness, fear, and so on cannot be broken down into component parts or reduced to anything else psychological.

Despite early factor analytic evidence that self-reports indeed produced discrete groupings of subjective experience (e.g., Borgatta, 1961; Izard, 1972; Nowlis, 1965), there is little consistent evidence for the sort of categorical organization in self-reports that would be predicted by the natural-kind view of emotion. For example, reports of negative emotion experience tend to correlate so highly that measures of *sadness*, *fear*, and other categories of negative emotions often fail to capture any unique variance (e.g., Feldman, 1993; Watson & Clark, 1984; Watson & Tellegen, 1985). Even scales that are explicitly built to measure discrete emotions tend to show high correlations between like-valenced states (e.g., Boyle, 1986; Watson & Clark, 1994; Zuckerman & Lubin, 1985), leading many researchers to measure instead broad dimensions of positive and negative activation (e.g., Waston, Clark, & Tellegen, 1988), or pleasure-displeasure (valence) and feelings of activation or arousal (e.g., Barrett & Russell, 1998; Mayer & Gaschke, 1988; Russell, Weiss, & Mendelsohn, 1989).

Not only are reports of discrete negative emotions systematically related to one another in a way that contradicts a categorical model, but these relationships can be summarized by more elemental affective properties, suggesting that the experience of each emotion is neither homogeneous nor experientially primitive. The main evidence that experiences of emotion can be broken down into more elemental bits is that when projected into geometric space, self-reports conform more or less to a circumplex structure (Feldman, 1995b; Remington, Fabrigar, & Visser, 2000; Russell, 1980; for a review, see Russell & Barrett, 1999). A circumplex structure emerges only when the objects in a correlation matrix (in this case, reports of emotion experience) are heterogeneous and psychologically reducible to a more basic set of properties (Guttman, 1957).

A circumplex configuration for self-reports of emotion experience indicates that a simple linear ordering is not sufficient to depict the similarities and differences among those reports. For example, interpersonal behavior has two properties that are well modeled by a circumplex: nurturance and dominance (Wiggins & Trobst, 1997). Any interpersonal behavior is a combination of both properties. If you order behaviors along one of these dimensions, you lose information about the other. The relationships among the behaviors can be depicted only in their proximity to one another around the perimeter of the circle, and must be described along two dimensions simultaneously. And so it is with self-reports of emotion experience. As the minimal arc distance between two emotion reports increases, the degree of similarity declines (i.e., the correlation becomes smaller), suggesting that the reports are qualitatively different. When emotion reports are separated by an arc distance of 90° (e.g., "happy" and "surprised"), they are completely independent. When the arc distance increases to 180° (e.g., "happy" and "sad"), the reports represent opposite emotion experiences. Past 180°, the reports become increasingly similar again until the original starting point is reached. These relationships among reports might be due to simultaneous changes in two properties, or three, or even four—the point is that there is more than one property, meaning that each report can be broken down into more elemental features.

Circumplex-like structures routinely appear in self-reports of emotion taken from a group of individuals who are asked to report on their experience at one point in time (i.e., a nomothetic analysis; Carroll, Yik, Russell, & Barrett, 1999; Feldman, 1995b; Russell, 1980; Yik, Russell, & Barrett, 1999; for reviews, see Barrett & Russell, 1998; Russell & Barrett, 1999), and also appear when the structure of self-reported emotion is examined separately for individuals (i.e., idiographically; Barrett, 1998a, 2004; Feldman, 1995a).[6] This constitutes strong evidence that reports of experience are multidimensional—that is, a report of *anger* or *sadness* or *fear* can be broken down into more fundamental psychological properties.

There is considerable debate over just what the fundamental properties of emotion experience are—that is, which dimensions should be used to anchor the self-report circumplex (for recent summaries of the debates, see Cacioppo, Gardner, & Berntson, 1999; Carver, 2001; Russell & Barrett, 1999; Watson, Wiese, Vaidya, & Tellegen, 1999). One popular model holds that emotional feelings can be simultaneously decomposed into pleasant or unpleasant feelings (a valenced property) and into highly activating or deactivating feelings (an arousal property; Barrett & Russell, 1998, 1999; Russell, 1980; Russell & Barrett, 1999). A second popular model holds that valence and arousal are not independent properties of affect, but that combinations of the two are more psychologically and biologically basic (Cacioppo et al., 1999; Watson et al., 1999). Additional psychological properties may be fundamental to emotional responding and therefore relevant for anchoring the affective circumplex. Some candidates are a dominance property (Russell & Mehrabian, 1977), an interpersonal or relational property (e.g., Mesquita, 2001; Mesquita & Markus, 2004), and a desirability property (e.g., Barrett, 1996; Tsai, Knutson, & Fung, 2005). And evidence from appraisal-as-components models suggests that there may be several more properties that are psychologically elemental to emotional feeling (e.g., Smith & Ellsworth, 1985).

The number and description of fundamental psychological properties that are needed to parse the affective domain is a distinct and separate question, however, from the issue of whether or not reports of emotion conform to a categorical structure and are therefore consistent with the view of emotions as natural kinds. The important observation here is that self-reported emotion experiences do not conform to simple structure with one factor each for *anger*, *sadness*, *fear*, and so on, but rather can be broken down into more fundamental, descriptive properties and are therefore not homogeneous or experientially primitive. As a result, there is little support in self-report data for the hypothesis that emotions are natural kinds.

An obvious concern with the use of self-report data to test the natural-kind status of emotion is that such reports may reveal more about emotion language than about emotions or the experience derived from them. Some researchers have suggested that feelings bear a one-to-one correspondence with the emotional states that caused them, but verbal reports of those experiences primarily reflect the artificial influence of language (i.e., the words used in the rating process; e.g., Frijda, Markam, Sato, & Wiers, 1995; Ortony et al., 1988). As a result, observing something other than discrete categories in reports of experienced emotion (i.e., deviations from the expected simple structure) would reflect the imperfection of self-reports, and therefore would not constitute evidence against the natural-kind view of emotions. The structure of how words are used to represent feelings, it is argued, tells us very little about the structure of feelings or their underlying causes.

There are three reasons to suspect that self-reports of emotion experience reveal something about the experience of emotion, and possibly about the natural-kind view as well. First, self-reports are not merely a function of emotion language (Barrett, 2004). A person's understanding of emotion words does not strongly dictate the way that he or she uses those words to verbally represent experience. In three studies, individual differences in the cognitive structure of emotion language were observed, but these individual differences were weakly to moderately related to how emotion words were then used when reporting on actual emotion experiences (meta-analytic summaries yielded $r = .13, p < .0001$, for valence and $r = .32, p < .0001$, for arousal).

Second, self-reports of experience contain some valid information about actual feeling states. For example, individuals who emphasize the valenced content of their experience (whether they feel pleasant or unpleasant) when reporting on their feelings are more prepared to evaluate than are those individuals who emphasize valenced content to a lesser degree. Presumably, enhanced evaluative processing would lead people to experience valenced affective states more intensely, causing them to be more valence focused in their reports. Evidence consistent with this view comes from studies documenting that individuals who are highly valence focused also show greater perceptual sensitivity to negative information (Barrett & Niedenthal, 2004) and are quicker to evaluate (Conner, Barrett, & Bliss-Moreau, 2005) compared with individuals who focus less on feelings of pleasure and displeasure. Similarly,

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[6] Although a circumplex structure is defined by formal, mathematical criteria (Browne, 1992; Fabrigar, Visser, & Browne, 1997), the structure need not be, and rarely is, perfectly circular with equally spaced elements.

individuals who emphasize activation or deactivation when reporting how they feel presumably do so because they experience high and low arousal states more intensely than do individuals who are less arousal focused, and, indeed, individuals with a high arousal focus are more interoceptively sensitive than are those who focus less on that property of experience (Barrett, Quigley, Bliss-Moreau, & Aronson, 2004). Taken together, these findings suggest that self-reports, despite their difficulties, do contain valid information about the properties of experience, but that these reports reveal affective properties, rather than categories of emotion.

Finally, some researchers might object to the use of self-report data to test the natural-kind view of emotion because they assume that the experience of emotion is epiphenomenal to emotion proper (e.g., Dolan, 2002; LeDoux, 1996, 2000). This claim is consistent with the viewpoint that emotions should be defined by their species-general aspects, and because the experience of emotion is typically assumed to be a characteristic specific to humans, it should not be considered part of an emotional response per se. From this point of view, studying emotional experience might be important in its own right, but it will not shed light on the fundamentals of what emotions are. As the upcoming discussion shows, however, data from other response systems produce the same general pattern of findings that can be observed in self-reports of emotion experience: The data fail to consistently configure into discrete, distinct categories. All told, they call into question the idea that there are bounded and distinct kinds of emotion.

Facial and Vocal Signals. Darwin inspired the modern-day view that emotions seek expression on the face and, in doing so, set psychological science on the path of a natural-kind view of emotion. In his book *The Expression of the Emotions in Man and Animals*, Darwin (1859/1965) relied on the commonsense idea that mental states cause behaviors, including sets of coordinated facial movements called expressions. By referring to a set of facial movements as an expression, Darwin implied that there is an internal, emotional state that seeks an outlet in behavior. Information about a person's mental state was presumed to be encoded in and communicated to others through expressive behavior. More recent times have seen an ongoing, lively debate over the relation of emotion to the face, and to a lesser extent the voice (e.g., see Ekman, 1994; Izard, 1994; Keltner & Ekman, 2000; Russell, 1994, 1995; Russell et al., 2003). For the purposes of this article, the important question is whether the face and voice broadcast or display precise, specific information about the internal, emotional state of a person (here called the sender). If emotions are natural kinds, then facial and vocal behaviors should configure into clear categories that can be distinguished from one another.

Researchers have typically used two kinds of studies to approach the question of whether the emotional state of an individual is displayed on the face or in the voice: *perception-based* studies (examining whether people can validly read emotions in other people's faces and voices) and *production-based* studies (examining whether people produce consistent and specific sets of facial movements or vocal patterns for different emotional states). I examine each type of evidence briefly, with an emphasis on disconfirming findings.

Most emotion researchers will acknowledge that perception-based studies of emotion provide what is probably the strongest evidence for the natural-kind view of emotion. In perception-based studies of emotion, perceivers (the people observing facial or vocal cues) are asked to assign a sender's observable behaviors (i.e., facial muscle movements or vocal signals) to emotion categories. It is assumed that to perform with above-chance accuracy, perceivers must be able to decode or extract emotional information from those behaviors. Such decoding is thought to take place automatically and reflexively (Ekman, 1993), and decoding abilities are thought to be innate (Buck, 1999; Izard, 1994; Tomkins, 1962) and pan-cultural (Ekman, 1994). Perhaps more than any other area of inquiry, research on what has been termed the "recognition of emotional expressions" has been taken as evidence for the view that certain discrete emotions are natural kinds.

There is considerable controversy surrounding the issue of whether or not facial movements and vocal sounds are universally recognized as belonging to particular categories of emotion. Meta-analytic and narrative reviews clearly indicate that perceivers from different cultures agree better than chance on the best label to assign to posed, static facial configurations (Elfenbein & Ambady, 2002a, 2002b; Russell, 1994). Russell and Fernández-Dols (1997) termed this "minimal universality." In one recent meta-analysis (Elfenbein & Ambady, 2002a), facial depictions of emotion were correctly categorized across cultural boundaries at levels significantly greater than chance (average cross-cultural accuracy = 58%, $r = .95$ after correction for chance guessing).[7] *Contempt* (43.2%), *fear* (57.5%), and *disgust* (60.6%) had the lowest accuracy rates, and *happiness* the highest (79.1%). Listeners also do significantly better than chance at classifying vocal cues (Hess, Scherer, & Kappas, 1988; Johnstone & Scherer, 2000; Wallbott & Scherer, 1986). In a recent meta-analysis, vocal depictions of emotion were similarly categorized across cultural boundaries at very high levels of accuracy (mean accuracy = 85%, $\pi = 84$, where 50% is chance performance and 100% is perfect performance; Juslin & Laukka, 2003). The cross-cultural accuracy rates for vocal judgments were lowest for *happiness* (74%) and highest for *sadness* and *anger* (91%). At first glance, these are very impressive statistics. But above-chance accuracy is only part of the picture.

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[7] This effect size refers to a single-sample t test for the null hypothesis that the average percentage accuracy across cultural groups is zero. It represents a test of whether participants are more accurate in judging facial actions from another culture than they would be if such stimuli were completely unintelligible to outgroup members.

First, the conclusion of universal recognition is undermined by what has been called an in-group advantage: People are generally more accurate at judging emotional behaviors depicted by members of their own cultural group than at judging those depicted by members of a different cultural group (Elfenbein & Ambady, 2002a, 2002b, 2003a; Russell, 1994). In one study, emotion judgments made by participants from the same cultural group as the people depicting the emotional behaviors were an average of 9.3% more accurate than cross-cultural judgments, $r = .55$ (Elfenbein & Ambady, 2003a). An in-group advantage has also been seen for vocal cues (same-culture advantage of 7% reported by Juslin & Laukka, 2003). This in-group advantage (at least for face perception) decreases as people gain exposure to the out-group (Elfenbein & Ambady, 2002b, 2003b).

Second, the accuracy of emotion perception is influenced by many different factors. For example, Elfenbein and Ambady (2002b) reported that cross-cultural accuracy rates vary with the research team that conducts the study. Studies conducted by Ekman and Matsumoto, Izard, Scherer, or Nowicki were associated with greater cross-cultural accuracy than were studies conducted by other researchers, in large part because these researchers employed methods that were more likely to produce large cross-cultural accuracy rates. There has been considerable debate over the extent to which existing studies on perceivers' judgments suffer from a myriad of methodological problems that lead to an underestimation of cultural variation in emotion perception. For example, forcing perceivers to choose from a short list of emotion labels is thought to inflate agreement (Russell, 1994). Providing perceivers with more labels or allowing perceivers to free-label lowers agreement (e.g., Banse & Scherer, 1996; Russell, 1994).[8] Having perceivers judge spontaneous facial movements, or posed emotional faces (produced by targets asked to pose a particular emotion), rather than imitated emotional faces (produced by targets instructed to pose specific sets of muscles) significantly reduces agreement (effect size for an overall decrease in accuracy was not reported, but for detailed statistics, see Elfenbein & Ambady, 2002b; for examples of this effect, see Motley & Camden, 1988; Yik, Men, & Russell, 1998). Similar effects have been demonstrated for judgments of spontaneous versus depicted vocal cues (W.F. Johnson, Emde, Scherer, & Klinnert, 1986; Pakosz 1983). There has been some disagreement, however, about whether these methodological concerns fundamentally call cross-cultural accuracy rates into question (Ekman, 1994; Izard, 1994; Russell, 1995).

Third, there is the issue of whether the emotion-perception studies are ecologically valid. There are three types of ecological-validity concerns. One concern is that in emotion-perception studies, perceivers are often asked to judge stimuli that have been culled carefully from a larger sample of behaviors. Meta-analytic findings of face-perception studies indicated that cross-cultural accuracy rates were higher for studies that used culled stimuli than for those that did not (Elfenbein & Ambady, 2002b). There is a similar problem in vocal-perception studies. For example, one very influential study (Banse & Scherer, 1996) attempted statistical classification of only 16.9% of the vocal samples that were actually recorded. It is difficult to interpret the findings from meta-analyses like the one by Juslin and Laukka (2003) when the utterances being classified are carefully selected to represent only a small subset of those that occur within the lab.

A second ecological-validity concern, as noted earlier, is that in many studies, participants judge portrayed, rather than actual, instances of emotional behavior in other individuals. Studies of emotion perception in the face commonly use posed facial configurations that depict caricatures of emotion (e.g., Ekman & Friesen, 1976). In contrast to a prototypical expression (an expression that is closest to the average set of features for a given emotion), a caricature departs from the central tendency of its category in a way that will make it maximally distinctive from other categories. For example, an *anger* prototype would depict the average set of facial movements that have been identified as naturally occurring in actual *anger* episodes, whereas an *anger* caricature depicts facial movements that are exaggerated to maximally distinguish it from facial depictions of other emotions, such as *fear*. Caricatured stimuli are easier to categorize than prototypic stimuli when the categories in question are highly interrelated (Goldstone, Steyvers, & Rogosky, 2003). The fact that caricatures give the clearest results in emotion-perception studies may be indirect evidence that the categories of *anger*, *sadness*, *fear*, and so on are themselves highly interrelated without firm boundaries. Nor is there ecological validity for judging acted vocal behaviors, because vocal portrayals do not necessarily have the same acoustic characteristics that are observed in naturally produced vocal expressions (for a discussion, see Bachorowski & Owren, 2003).

The third ecological-validity concern relates to recent evidence that the typical emotion-perception task itself (asking people to label a face or match a face with an emotion category exemplar such as a word or story, in the absence of context) is a highly Westernized task, and may have little validity for members of non-Western cultures (Mesquita, 2003). This argument could be easily extended to the task of judging vocal signals out of context, and suggests that the evidentiary base for cross-cultural emotion perception was derived from a culturally biased task.

Evidence from developmental psychology also calls into question the idea that perceivers have an innate ability to extract discrete emotional information from the face. First, face-perception ability does not appear to be innate. Although infants

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[8] Exact meta-analytic estimates of this effect are not available for face-perception studies (see Elfenbein & Ambady, 2002b). Nor are they available for voice-perception studies, although response format did not significantly predict a decrease in accuracy rates when included with a number of interrelated moderators of accuracy effects (see Juslin & Laukka, 2003).

do show an early preference for faces, this preference is due to general, perceptual preferences, and newborns do not recognize faces as faces per se (for a review, see Turati, 2004).

Second, it is tempting to believe that young children are able to sort faces into emotion categories (e.g., Barrera & Maurer, 1981; Haviland & Lelwica, 1987; Ludemann & Nelson, 1988; Montague & Walker-Andrews, 2001; Nelson & Dolgin, 1985; Nelson, Morse, & Leavitt, 1979; Serrano, Iglesias, & Loeches, 1992), but careful study reveals that children categorize on the basis of features of the face (e.g., whether or not the mouth is showing teeth), rather than the meaning attributed to the set of features. For example, smiles (associated with happy faces) expose teeth, whereas frowns and grimaces (associated with sad and angry faces) do not. When infants (between 4 and 7 months old) in one study distinctly categorized happy versus angry and sad faces, they did so using the feature of "toothiness" (Caron, Caron, & Myers, 1985). Indeed, even at 9.5 months, they failed to discriminate toothy smiles from toothy anger expressions (Caron et al., 1985).

Neither of these points, in and of itself, is sufficient to challenge the view that emotions are innately recognized in the face, because innate abilities need not materialize at birth and can develop as neural systems mature (Elman et al., 1996). What does seem certain, however, is that the conceptual knowledge about emotion that is necessary to support emotion perception (Barsalou, Niedenthal, Barbey, & Ruppert, 2003; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005) is not available to young children, so that children's early emotion concepts do not support the perception of distinct categories of emotion like *anger* and *sadness*. Children do not possess the full adult taxonomy of emotion concepts until the age of 5 (Widen & Russell, 2003). Two-year-olds favor a few emotion labels (e.g., "happy" and "sad") to describe the entire domain of emotion, and the number of labels children use increases with age. Children use emotion terms, at least initially, to refer to extremely broad categories of "positive" and "negative," so that the words do not mean the same thing for a child as for an adult (Widen & Russell, 2003). Children slowly learn to differentiate within positive and negative categories until they have acquired concepts for *anger*, *fear*, and so on. These findings on concept development are consistent with evidence that children's "errors" in labeling emotion faces are systematic rather than random, revealing a structure of similarity; for example, children initially associate faces and labels largely on the basis of valence (Bullock & Russell, 1984, 1985, 1986; Hosie, Gray, Russell, Scott, & Hunter, 1998; Russell & Bullock, 1986).

It is possible that even if children develop emotion concepts much later than was first assumed, they acquire representations for emotion categories that are real in nature. That is, the emotion concepts that are necessary for emotion perception may derive from the statistical structure of emotional responding as it actually occurs. This leads to the question, then, of whether people actually produce facial and vocal cues that are clearly and unambiguously diagnostic for *anger* and *sadness* and *fear*.

In general, production-based studies of emotion in the face and voice provide considerably weaker evidence for the natural-kind view than do the perception-based studies. In production-based studies of the face, researchers measure facial muscle movements during emotionally evocative events to determine whether there are signature sets of muscle movements for particular categories of emotion. This can be done most objectively with facial electromyographic (EMG) measurements. Behavioral coding schemes like the Facial Action Coding Scheme (FACS) combine perception-based and production-based coding, because trained observers decompose visible facial movements into specific action units (Ekman & Friesen, 1978; Ekman, Friesen, & Hager, 2002; Hjortsjö, 1969). In studies of the voice, researchers objectively measure the acoustic properties in voice samples taken during emotionally evocative events. Using these methods, it is possible to determine whether facial and vocal behaviors reveal something like natural-kind categories of emotion.

Even though the emotion-perception literature suggests that people often automatically and effortlessly "see" *anger*, *sadness*, *fear*, and so on in the faces and voices of other people, and are able to assign face and voice stimuli to these categories more consistently than would be expected by chance, it is generally the case that purely instrument-based measures of actual facial and vocal behaviors do not provide strong evidence for qualitatively different categories of emotion. Although behavioral cues can seem inherently emotional to a perceiver, there is little consistent evidence that those behaviors broadcast fixed, encoded messages about the discrete emotional state of the sender (for several recent reviews, see Bachorowski & Owren, 2003; Kappas, 2002; Russell et al., 2003; Turner & Ortony, 1992).

With respect to the face, one recent summary of the literature observed that the bulk of existing evidence has failed to support the hypothesis of distinct patterns of automatic facial EMG activity for *anger*, *sadness*, *fear*, and other emotion categories (Cacioppo, Berntson, Klein, & Poehlmann, 1997; Cacioppo et al., 2000). This assessment is consistent with the evidence from animal communication research, which has shown clearly that nonhuman animals rarely produce involuntary, reflexive displays (Seyfarth & Cheney, 2003a). Behavioral coding schemes that rely on observer-based judgments, such as FACS (Keltner & Ekman, 2000; Keltner & Kring, 1998), produce more encouraging support for the idea of emotion specificity in facial movements, however. There remains considerable debate over whether the acoustic properties of the voice reveal the emotional state of a person (see Bachorowski, 1999).

Yet there are additional issues of concern. Facial movements and vocal behaviors do not necessarily have what Seyfarth and Cheney (2003a, 2003b) referred to as "informational value" regarding the internal state of the sender. For example, take the human smile. Smiling faces are easily and effortlessly categorized as *happy* and show the largest cross-cultural accuracy rates (Russell, 1994). Yet smiles have low informational value because people can smile when they are not happy, and people can feel happy without smiling. As a consequence, a smile does not provide a perceiver with reliable information about the internal state of the sender. For example, smiling is influenced by the status of the target (LaFrance & Hecht, 2000). In general, facial behaviors like smiles are more likely to occur with an audience than without; indeed, they rarely occur without one (e.g., Fernández-Dols & Ruiz-Belda, 1995; Fridlund, 1991; Kraut & Johnston, 1979; Ruiz-Belda, Fernández-Dols, Carrera, & Barchard, 2003). The type of social interaction partner influences the vocal acoustics of laughs (Devereux & Ginsburg, 2001). These sorts of audience effects are not unique to humans. Birds, frogs, and most mammals exhibit them (Seyfarth & Cheney, 2003b).

In addition, a single facial movement or vocal behavior can be associated with many categories. This indicates that facial movements and vocal signals have what Seyfarth and Cheney (2003a, 2003b) referred to as low "referential specificity." For example, as already noted, smiling is not always associated with happiness. A smile can mean that one feels pleasant (e.g., Cacioppo et al., 2000; Davidson, Ekman, Saron, Senulis, & Friesen, 1990; Lang et al., 1993), embarrassed (Keltner, 1995), like a failure (Schneider & Josephs, 1991), or subordinate to someone else (LaFrance & Hecht, 2000). Of course, there may be distinctive types of smiles that signal distinctive mental states, but the consistency of such relationships remains to be demonstrated empirically. People also laugh for many reasons. For example, they laugh to appease others (e.g., R.M. Adams & Kirkevold, 1978; Deacon, 1997; Dovidio, Brown, Heltman, Ellyson, & Keating, 1988) or to indicate sexual interest (Dunbar, 1996; Grammer, 1990). In general, many communicative behaviors in primates have multiple meanings, depending on their context (de Waal, 2003).

There is also evidence that infants, like adults, fail to produce communicative behaviors with high informational value and referential specificity for particular emotion categories. For example, infants produce configurations of facial behaviors typically identified as "expressions" in situations in which the corresponding emotion is unlikely (e.g., Camras, 1991; Camras, Lambrecht, & Michel, 1996; Camras, Malatesta, & Izard, 1991; Matias & Cohn, 1993). Conversely, infants often fail produce the predicted set of facial behaviors in situations in which the corresponding emotion is likely (Camras, 2000; Camras et al., 2002; Hiatt, Campos, & Emde, 1979). In general, it seems that infants have a range of facial behaviors that they use to express negative affect (cf. Camras, 1992; Camras, Oster, Campos, & Bakemand, 2003) or intensity (Messinger, 2002). This is consistent with the evidence from adults indicating that facial EMG measurements coordinate more clearly for positive versus negative affect (Cacioppo et al., 2000) than for discrete emotion categories per se. Similar findings are apparent in studies of infant crying (for a review, see Bachorowski & Owren, 2002). Infant cries are very potent signals with salient acoustic properties that help caregivers judge an infant's level of distress and urgency of need, but there is little empirical work to support the commonly held notion that infants give distinctive cries when hungry, uncomfortable, or in pain (Gustafson, Wood, & Green, 2000).

Taken together, this evidence suggests that facial movements and vocal signals do not necessarily display information about the sender's emotional state (cf. Russell et al., 2003), even though people routinely perceive those behaviors as coordinated expressions. Despite the persistent claims for universal emotional expressions that appear in virtually every introductory psychology textbook, in many scientific papers, and in the popular media, the evidence is far from clear that the face and voice display precise information about discrete emotional states, thereby giving evidence that there are natural kinds of emotions. There is some evidence in support of the natural-kind view, but there is also accumulating evidence against it.

Clearly, the face and voice are rich sources of human (and nonhuman animal) behavior that play a crucial role in guiding social interaction. People who violate social norms are treated more leniently if they smile than if they do not (LaFrance & Hecht, 1995). People who imitate their social interaction partner's facial movements are better liked than those who do not imitate their partner's facial movements (Chartrand & Bargh, 1999). Some facial configurations better activate brain areas implicated in classical conditioning than do others (Whalen et al., 1998). Vocal acoustics give us clues to a speaker's identity (Edmonson, 1987), indicate his or her arousal level (e.g., Bachorowski, 1999; Bachorowski & Owren, 1995; Kappas, Hess, & Scherer, 1991), and are thought to elicit affective responses in listeners (Bachorowski & Owren, 2001). And although it may be the case that perceivers can reliably assign communicative behaviors to specific emotion categories, with the number of such categories ever expanding (e.g., Keltner, 2003; Shiota, Campos, & Keltner, 2003), it is far from clear that such behaviors are necessarily displays of natural emotion kinds. Even evidence that appears to support the idea that the face and voice broadcast emotion can potentially be explained by alternative formulations that do not rely on the assumption of natural kinds. I return to this point later in this article.

Peripheral Nervous System Responses. James (1884) proposed one of the most compelling ideas in the psychology of emotion: that emotional states have specific and unique patterns of somatovisceral changes, the perception of which constitutes an emotion. James took for granted that emotions are feelings, and much of his theorizing was an attempt to explain the experience of emotion. Although many researchers rejected the idea that emotion should be equated with its experience (also rejecting his idea that peripheral nervous system changes are antecedents, rather than consequences, of an emotion), many emotion scholars were taken with the hypothesis of autonomic specificity. Indeed, James inspired a century of research whose goal was to uncover the invariant autonomic nervous system (ANS) pattern that corresponded to *anger*, *sadness*, *fear*, and several other emotions. The assumption was that ANS patterns evolved because they subserve patterns of motor behavior that are adaptive, preparing the organism for quite different actions (Ekman, 1999).

Although James was attempting to dispel commonsense views of emotion, the sort of autonomic specificity that he is credited with proposing is largely consistent with the commonsense belief that different emotions are associated with signature visceral sensations (cf. Cacioppo et al., 2000). People have well-developed beliefs about the patterns of bodily cues that distinguish discrete emotional episodes, and these beliefs display great stability across individuals within a culture, as well as across cultures (e.g., see Pennebaker, 1982; Scherer, Wallbott, & Summerfield, 1986). For many emotion researchers, evidence for distinct autonomic patterning would be considered conclusive proof that there are natural kinds of emotion.

The issue of autonomic specificity for different categories of emotion remains controversial, even after 100 years of research. Although individual studies sometimes report distinct autonomic correlates for different emotion categories (e.g., Christie & Friedman, 2004; Ekman, Levenson, & Friesen, 1983; Levenson, Ekman, & Friesen, 1990; Stemmler, Heldmann, Pauls, & Scherer, 2001), it is not possible to confidently claim that there are kinds of emotion with unique and invariant autonomic signatures. Meta-analytic reviews of this literature generally find that categories like *anger*, *fear*, *sadness*, *disgust*, and *happiness* cannot be fully differentiated by autonomic activity alone (Cacioppo et al., 1997, 2000). Instead, peripheral nervous system responses appear to configure consistently for conditions of threat and challenge (Quigley, Barrett, & Weinstein, 2002; Tomaka, Blascovich, Kelsey, & Leitten, 1993; Tomaka, Blascovich, Kibler, & Ernst, 1997) and for positive versus negative affect (Cacioppo et al., 2000; Lang et al., 1993). For example, relative to positive affect, negative affect is associated with higher diastolic blood pressure ($d+ = .54$), increases in cardiac output ($d+ = .47$), increases in heart rate ($d+ = .17$), and decreases in electrodermal response duration ($d+ = -.29$; see Table 11.2 in Cacioppo et al., 2000).[9]

Still, it is important to note that some distinctive differences in emotion categories were noted in the meta-analytic summaries of Cacioppo and his colleagues (see Table 2.2 in Cacioppo et al., 1997). Heart rate responses were larger and respiration rate was lower for *fear* than for *sadness* ($d+ = .15$ and $-.39$, respectively). Instances of *anger* were associated with changes in the vasculature (e.g., larger increases in total peripheral resistance, higher diastolic blood pressure, and smaller increases in cardiac output) more than were instances of *fear* ($d+ = .52$, $.43$, and $-.66$, respectively) and *sadness* ($d+ = .72$ for differences in diastolic blood pressure). Nonspecific skin conductance responses were consistently larger with *anger* than with *fear* ($d+ = .32$). Just what these findings mean, however, is unclear.

First, most of the meta-analytic results reported by Cacioppo et al. (2000) were characterized by high heterogeneity. Although there were mean differences in some ANS responses across emotion categories, the effect sizes varied in magnitude and statistical significance across studies, suggesting that simply averaging effects for a given emotion from different studies is not tenable. In much the same way that statistical main effects have little meaning in the context of a significant interaction, discussing average effect sizes in the context of significant effect size heterogeneity is ill advised. Such heterogeneity likely indicates that unspecified variables are moderating the relations between emotion categories and these peripheral nervous system responses.

Second, there may be alternative explanations for the observed relations between emotion categories and the few autonomic effects that were noted. The vascular patterns that differentiate *anger* and *fear* also distinguish between threat and challenge appraisals (e.g., Blascovich & Mendes, 2000; Mendes, Reis, Seery, & Blascovich, 2003; Tomaka et al., 1993, 1997). In attempting to generate *fear* and *anger*, researchers may have inadvertently manipulated threat and challenge appraisals, leading to the observed vascular effects. Similarly, skin conductance reactivity is associated with increased attention allocation (Blakeslee, 1979; Frith & Allen, 1983), and may have little to do with emotional responding per se.

Third, and perhaps most important, ANS activity is mobilized in response to the metabolic demands associated with actual behavior (cardiosomatic coupling; Obrist, Webb, Sutterer, & Howard, 1970) or expected behavior (suprametabolic coupling; Obrist, 1981). Although preprogrammed autonomic reactions might support certain behaviors (especially for basic behavioral stances that are mediated by brainstem areas), such behaviors tend not to have a one-to-one correspondence with specific emotion categories. A brief review in the next section indicates that behaviors are specific, context-bound attempts to deal with a situation (Bradley, 2000; Cacioppo et al., 2000; Davidson, 1994; Lang, Bradley, & Cuthbert, 1990). Functional demands vary with situations, making it likely that instances of the same emotion can be associated with a range of behaviors. For example, Lang et al. (1990) noted that the behaviors associated with *fear* can range from freezing to vigilance to flight. Research in animal learning has also documented cases of fearful or defensive aggression in which animals will attack when they are under a threat from which they cannot escape (Blanchard & Blanchard, 1977, 2003). If autonomic activity is in the service of behavior (or expected behavior), and if a heterogeneous range of behaviors is associated with a given emotion category, then

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[9] $d+$ is a weighted measure of effect size (d).

emotion-specific autonomic patterns are unlikely on a priori grounds. Autonomic specificity may occur for behavior, not for an emotion category.

Interestingly, although basic-emotion theorists often claim James as their intellectual predecessor, James did not appear to hypothesize an invariant ANS pattern for each category of emotion. Although James's writings are laced with detailed descriptions of the bodily symptoms that characterize anger, grief, fear, and the like, he explicitly stated in several places that variability within each emotion category is the norm. According to James (1894/1994), there can be variable sets of bodily symptoms associated with a single category of emotion, and he explicitly rejected the idea that a single set of bodily symptoms could describe all instances of a given emotion category across individuals:

> Surely there *is* no definite affection of 'anger' in an 'entitative' sense. (p. 206; italics in the original)

This quote, in particular, is striking because many researchers who claim James as their intellectual predecessor have gone on to assume that a distinct autonomic profile defines the essential nature of each emotion category.

Taken together, the evidence from somatovisceral studies is problematic for the notion of emotion-specific autonomic patterning. This literature is marked by the inconsistent findings across studies, and alternative explanations have yet to be tested. Despite the fact that several published articles have concluded that the evidence for emotion-specific autonomic patterning is inconclusive at best (e.g., Cacioppo et al., 1997, 2000; Cacioppo, Klein, Berntson, & Hatfield, 1993; Zajonc & McIntosh, 1992), the idea that ANS responses differentiate discrete emotion categories remains popular. And James continues to be credited with this hypothesis, despite the fact that he explicitly argued against this idea.[10]

Voluntary Behaviors. The idea that there is a specific instrumental behavior that occurs for each category of emotion derives from several sources. At the simplest level, the commonsense theory of emotion is a theory about action. Why did you act? Because you were having an emotion. Ryle (1949) argued that people use emotion words to indicate that someone is likely to behave in a particular way. And, as Frijda (1986) noted, emotions are hypotheses to explain behavior. Behaviors, especially those that are not attributed to an external purpose or reason, invite emotion-based explanation. In a general sense, people tend to identify behaviors with the intention of the actor (cf. Dennett, 1987; Gilbert, 1998), even when they are describing themselves. In his principle of serviceable, associated habits, Darwin (1859/1965) argued that emotion categories are distinguished by expressive behaviors. Researchers who seek to define emotion in terms of species-general aspects have embraced the idea that distinct behaviors occur in the service of distinct emotional states. Because humans share some of their neural circuitry with other animal species (be they primates or rodents), researchers assume that it makes sense to define emotion by what these species all have in common: emotional behavior. And the often-used assumption is that there is one behavior for each putative emotion circuit. For example, Panksepp (1994, 1998, 2000) argued that basic emotions are neural entities that provide organisms with relatively complex behavioral potentials (hereditary plans for behavior).

In psychology, perhaps the best-known model of emotion that identifies emotion categories with instrumental behaviors comes from Frijda (1986; also see Arnold, 1960). Frijda defined an emotion as an "action tendency," or a readiness to achieve or maintain a particular sort of relationship with the environment. Action tendencies are motivational states, rather than a readiness to perform specific behaviors. The actual behaviors that are performed to realize any given action tendency will vary on the basis of contextual demands and other constraints. For example, *anger* is the urge to attack, but there are many different ways to implement an attack (one can yell, hit, withdraw, or be exceedingly kind). *Fear* is the urge to separate oneself from an aversive event, but there are many behaviors that can achieve this aim (one can freeze or flee). It is not clear whether the action-tendency model is a natural-kind model of emotion, however. On the one hand, each emotion category is defined by the intent to engage with the environment in a particular way, rather than by a specific behavior per se. On the other hand, certain categories of emotion, such as *fear*, *anger*, and *joy*, are thought be associated with programs for behavioral systems that can be put into a state of readiness.

The most straightforward evidence for whether each emotion category has specific, defining instrumental behaviors comes from the animal learning literature. The simple answer seems to be that behavioral responses correspond to situational demands (Bouton, 2005), rather than to specific emotion categories per se. Behaviors are specific, context-bound attempts to deal with a situation (Cacioppo et al., 2000; Lang et al., 1990). A *fear* situation, defined by the presence of threat (e.g., a predator), will be associated with different behaviors (e.g., vigilance, freezing, flight, attack) depending on the functional demands of that specific situation. In rats, for example, the threat (or defense) system is organized so that an animal will engage in different behaviors depending on its psychological distance from a predator (Fanselow, 1994; Fanselow & Lester, 1988; for a more detailed discussion, see Bouton, 2005). When a predator is some distance away, the animal might orient but engage in its regular

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[10] Evidence against autonomic specificity does not bear on the question of whether the perception of somatovisceral cues influences emotional feeling. Indeed, there is evidence that individuals who are interoceptively sensitive (measured using a heartbeat detection task) report experiencing more intense emotion than those who are insensitive (Critchley, Wiens, Rotshtein, Öhman, & Dolan, 2004; Wiens, Mezzacappa, & Katkin, 2000), and also emphasize feelings of activation and deactivation more when reporting their emotion experience (Barrett et al., 2004).

behaviors (although behaviors might be timed and coordinated to minimize detection by predators). As the psychological distance between the animal and the predator decreases, the animal might freeze (and autonomic responses correspond to this behavior). When the predator is very close, or perhaps actually strikes, the animal might jump, flee, or even return the attack, supported by the needed physiological responses. Similar behavior-situation links have been observed for systems that secure desired objects, like food (Timberlake, 1994, 2001) and sexual partners (Akins, 2000; Akins, Domjan, & Gutierrez, 1994; again, see Bouton, 2005).

Not only are different behaviors associated with the same emotion category, but also one type of behavior can be associated with many categories. For example, varieties of attack behavior (e.g., defensive, offensive, predatory) are associated with different types of stimulus situations and are caused by different neural circuitry (Blanchard & Blanchard, 2003).

Neural Circuitry. Following the path set by Cannon (1929, 1931) and Bard (1928; Bard & Rioch, 1937), many theorists assume that kinds of emotion have specific neural causes (e.g., Buck, 1999; Damasio, 1999; Dolan, 2002; Ekman, 1992; Izard, 1993; LeDoux, 1996; Panksepp, 1998). Although brain-mapping studies of emotion in humans began with the study of brain-damaged patients, it has been recent neuroimaging studies of emotion-related phenomena that have captured the imagination and interest of emotion researchers. Over the past decade, several neuroimaging studies have been conducted in attempts to discover separable neural circuits for *anger*, *sadness*, *fear*, *disgust*, and *happiness*.

The key question for the natural-kind view of emotion is whether *anger*, *sadness*, *fear*, and so on correspond to some natural division of emotional events within the human brain. That is, are different emotions caused by distinctive neural circuits? Because neuroimaging studies in humans are only just now beginning to develop methods to map the neural circuitry within the human brain, this question remains unanswered. In the meantime, some researchers have attempted to determine whether *anger*, *sadness*, *fear*, *disgust*, and *happiness* are associated with increased activation in distinct locations within the human brain. So, are there brain markers for these categories of emotion?

Two recent meta-analyses have summarized emotion-location correspondences from neuroimaging studies conducted over the past 10 years (Murphy et al., 2003; Phan et al., 2002). Taken together, they do not provide strong evidence that emotion categories can be unambiguously localized in the human brain. Within their broader scopes, both studies tested the hypothesis that *fear*, *anger*, *sadness*, *disgust*, and *happiness* have distinct neural circuits. Both meta-analyses summarized the correspondence between each emotion category (as defined by everyday English words) and a frequency count of the number of significant peak voxel effects within particular brain locations, comparing these counts with what would be expected by chance.[11] This frequency-count approach contrasts with the typical meta-analytic procedure of estimating an average effect size across a series of studies and then computing the probability that the observed result would have been obtained if the null hypothesis were true. Both meta-analyses summarized findings from PET and fMRI studies of the functional neuroanatomy of emotion in healthy, unmedicated adults. For the correspondence analyses, the meta-analyses culled studies from approximately the same time period and summarized a largely overlapping set of findings (although Murphy et al. sampled a larger set of studies for other analyses reported in their article).

In general, the pattern of findings from these meta-analyses is very similar to the pattern of findings for the psychophysiological data on emotion: Unique activation patterns for each category of emotion were difficult to discern, and those that materialized were less consistent than expected (results are summarized in Table 1). Furthermore, alternative explanations were not ruled out in cases in which consistency was observed.

The two meta-analyses showed the most agreement with one another in identifying a *fear*-amygdala correspondence. The correspondences were lower than what might be expected if the amygdala represented a core *fear* system in the brain, however. Phan et al. (2002) reported that 60% of studies involving *fear* showed increased activation in the amygdala, whereas Murphy et al. (2003) reported (in their Fig. 3) that fewer than 40% of the studies showed a *fear*-amygdala correspondence (although the proportion increased to just over 60% when only studies using face stimuli were considered). In addition, alternative explanations for the *fear*-amygdala correspondence, such as it is, need to be ruled out before it can be used as evidence for the natural-kind status of *fear*. Stimulus features such as novelty (e.g., Schwartz et al., 2003; Wilson & Rolls, 1993; Wright et al., 2003) or uncertainty (Davis & Whalen, 2001; Kim, Somerville, Johnstone, Alexander, & Whalen, 2003; Whalen, 1998) may have driven this correspondence. Furthermore, it is not clear whether the amygdala activations were specific to fear stimuli. Simple perceptual cues (e.g., eye gaze) modulate whether or not viewing facial caricatures of fear elicits amygdala activation (R.B. Adams, Gordon, Baird, Ambady, & Kleck, 2003), and even someone with amygdala damage can correctly classify fear caricatures when her attention is directed toward the eyes of the stimuli (Adolphs et al., 2005).

Phan et al. (2002) and Murphy et al. (2003) partially agreed on the localizations for *disgust*. Phan et al. reported that 60% of studies involving disgust showed increased activation in the basal ganglia, and Murphy et al. (Fig. 3) found that approximately 70% reported activation of the globus pallidus (a part of the basal ganglia). Murphy et al. also reported that approxi-

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[11] Both meta-analyses included all peak voxel effects that were reported as “significant” in the individual studies, irrespective of the size of the cluster or the number of peaks within a cluster.

TABLE 1

Summary of Two Recent Meta-Analyses of Emotion-Location Correspondences

	Location	
Emotion	Phan, Wager, Taylor, & Liberzon (2002)	Murphy, Nimmo-Smith, & Lawrence (2003)
Anger	None	Lateral orbital frontal cortex
Sadness	Subcallosal anterior cingulate cortex	Rostral supracallosal anterior cingulate, dorsomedial prefrontal cortex
Disgust	Basal ganglia	Insula, operculum, and globus pallidus
Fear	Amygdala	Amygdala
Happiness	Basal ganglia	Rostral supracallosal anterior cingulate, dorsomedial prefrontal cortex

Note. Subcallosal cingulate cortex is considered the ''visceral'' aspect of the anterior cingulate cortex (Brodmann's area, BA, 25); it is connected to medial orbital frontal cortex and is associated with autonomic control. Supracallosal anterior cingulate cortex is considered the ''cognitive'' aspect of the anterior cingulate cortex (BA 24 and 32); it is connected to dorsomedial prefrontal cortex and dorsolateral prefrontal cortex, and is associated with attention and working memory functions (Koski & Paus, 2000). Globus pallidus is part of the basal ganglia.

mately 70% of studies involving disgust engaged the insula as well. (Phan et al. did not find that insula activation was associated with disgust, but rather found that insula activation was associated with negative emotions more generally.) It is difficult to know how to interpret these findings, given that both the basal ganglia and the insula are heterogeneous structures that support a number of different psychological functions. Perhaps the empirical picture will be clarified by future studies employing imaging methods with higher spatial resolution, as functional regions within the brain are likely to be much smaller than these very broad regions.

The two meta-analyses strongly diverged in their localization of *anger*. Phan et al. (2002) did not find a significant localization for instances of *anger*, whereas Murphy et al. (2003, Fig. 3) reported that more than 80% of the studies found activation in lateral orbital frontal cortex. The analyses also diverged in their localizations for *happiness*. Phan et al. reported that nearly 70% of studies showed activation of the basal ganglia, whereas Murphy et al. (Fig. 3) indicated that nearly 60% of studies reported increased activation in the rostral supracallosal anterior cingulate cortex and dorsomedial prefrontal cortex.

At first glance, the two meta-analyses also appear to disagree on the localization for *sadness*, but a more detailed inspection of the results indicates there may be some consistency. Phan et al. (2002) reported that 60% of the studies examining the neural correlates of *sadness* showed activations in medial prefrontal cortex (mPFC). By conventional standards, this *sadness*-mPFC localization was not different from what would be expected by chance. Yet aspects of supracallosal anterior cingulate cortex (ACC)—most notably, Brodmann's area 32—share transition cortex with areas of mPFC. And Murphy et al. (2003) localized *sadness* in activations of the supracallosal ACC (with about 50% of *sadness* studies showing increased activation there).

The ACC/mPFC-*sadness* correspondence may have an alternative explanation, however. Many of the studies using sad-related stimuli (e.g., at least 10 of the 14 studies summarized in Fig. 3a in Murphy et al., 2003) involved cognitive demand. Phan et al. (2002) reported that cognitively demanding emotional tasks (such as remembering an event intended to induce an emotional response or rating emotional stimuli) specifically engaged rostral portions of the ACC more than did passive emotional tasks (merely viewing and experiencing stimuli). Given these findings, it is not clear that one can claim a specific correspondence between mPFC activation and *sadness* per se without first ruling out the possibility that the cognitive induction procedure accounted for these findings. Consistent with this alternative is the finding (reported in Fig. 3b, Murphy et al.) that none of the 3 studies involving sad facial configurations produced increased activation in supracallosal ACC.

There are additional points worth making about these meta-analyses when considering their value for testing the natural-kind view of emotion. First, the similarities between the meta-analytic approaches of Phan et al. (2002) and Murphy et al. (2003) outweigh their differences, and so neither the sampling of studies nor the procedures used explain the inconsistent results obtained. Second, both meta-analyses combined data from a variety of experimental paradigms, including emotion induction (present a stimulus to induce an emotional state) and emotion perception (view posed photos of facial expressions). It might be argued that induction and perception studies should, in fact, be kept separate, at least for the moment (although recent views of embodied cognition posit that emotion perception and emotion experience are inextricably linked and are subserved by the same processes; e.g., Barsalou, Niedenthal, et al., 2003; Niedenthal et al., 2005). Third, the findings from both meta-analyses should be considered preliminary at best, because of the inherent limitations in the signal source and spatiotemporal resolution of current neuroimaging techniques. More sophisticated experimental control and better spatial resolution will very likely produce more conclusive findings in the future.

For example, according to work by Whalen and his colleagues (Kim et al., 2003, 2004; Whalen et al., 2001), more precise imaging of the amygdala has revealed that different portions are associated with different psychological functions. The ventral lateral aspect of the amygdala (corresponding to the basal and lateral nuclei) is thought to compute a quick, initial assessment of a stimulus's predictive value (to what extent it will predict a subsequent threat) and shows increased activation (relative to neutral baselines) for *anger* and *fear* face caricatures. The more dorsal aspect of the amygdala (corresponding to the central nucleus) marshals attention and other output systems to gather more information to better assess the predictive value of the stimulus (and to allow the person to better predict its stimulus value the next time it is encountered) and shows increased activation to *fear*, as compared with *anger*, caricatures. Overall, then, although it may appear as if facial depictions of *fear* produce the largest signal increases in the amygdala (relative to facial depictions of other emotions), discussing activations in the amygdala as a whole masks functional distinctions that may be meaningful to understanding its role in emotional processing. Whalen's findings are consistent with the interpretation that part of the amygdala functions to assign affective significance (LeDoux & Phelps, 2000) to sensory, primarily visual, stimuli in humans (Simpson et al., 2000), as well as with the idea that the amygdala is involved in gating affective responses more generally (Berridge, 1999; Gallagher & Holland, 1994; Holland & Gallagher, 1999; Weiskrantz, 1997). They are also consistent with the view that the amygdala is involved in processing potentially positive information, as well as potentially threatening information (e.g., Baxter & Murray, 2002; Cahill et al., 1996; Canli, Sivers, Gotlib, & Gabrieli, 2002; Hamann, Ely, Hoffman, & Kilts, 1999; Lane, Chua, & Dolan, 1999; Mather et al., 2004).

Some researchers may not be troubled by the lack of emotion specificity in the recent neuroimaging work because they argue that specificity will not be found at the level of neuroanatomical structure, but instead will occur in neurotransmitter or neurochemical substrates of the brain. Yet, at this level, too, it is important to of consider alternative hypotheses. For example, some scientists view dopamine as a reward neurotransmitter (Buck, 1999; Panksepp, 1998; Shizgal, 1997; Wickelgren, 1997) that plays a specific role in desire or "wanting" rewards, rather than in the experience of pleasure or "liking" (Berridge, 1999; Berridge & Robinson, 1998). Others view dopamine as specific to the emotion of *anger* (Calder, Keane, Lawrence, & Manes, 2004; Lawrence, Calder, McGowan, & Grasby, 2002). Yet, there is evidence to suggest that dopamine neurons respond to events that extend beyond reward and *anger* stimuli. The dopamine system in the nucleus accumbens is associated with negative affective motivational states more broadly (Berridge & Robinson, 1998; Reynolds & Berridge, 2002, 2003). In addition, it has been argued that dopamine has a more general effect on behavior, gating the extent to which stimuli can access motor circuitry (Horvitz, 2000, 2002). Dopamine marks the salience of an event, such that when the dopamine neurons respond strongly to an incoming event, that event is given privileged access to voluntary motor-output systems (i.e., to the basal ganglia). The idea is that there are multiple routes for environmental stimuli to access higher-order brain regions; dopamine activity plays a central role as a gatekeeper for stimuli to access higher-order, voluntary motor regions of the brain (Nieoullon & Coquerel, 2003).

Finally, some researchers might argue that the majority of the data that I have reviewed in this article comes from the human literature, and that the most compelling evidence for the natural-kind view comes from the study of basic behavioral systems within the mammalian brain. I did not review evidence from the animal literature in any detail. Behavioral neuroscientists have indeed made a careful study of the neural mechanisms supporting certain behaviors, and it is clear that this research has made important contributions to understanding emotional processing in some form. What is not clear is how this evidence bears on the neural circuitry for specific categories of emotion. Although there is good evidence that specific behaviors (e.g., freezing) may depend on specific brainstem and subcortical nuclei (e.g., Panksepp, 1998), there is little evidence to suggest that each behavior must be associated with any single emotion category (although perceivers can effortlessly assign them to one). Freezing may be an innate behavior, and may be part of the Western script for *fear*, so that perceivers automatically and effortlessly conceptualize freezing as a *fear* behavior, but this does not constitute evidence that freezing behavior is innately linked to a module of *fear* responding. Given the lack of synchronization in outputs, and the heterogeneity of behavioral responses within an emotion category, discovering the circuitry for one behavior, like freezing, does not constitute evidence that the circuitry for *fear* has been isolated in the mammalian brain. The careful study of how nonhuman animal brains control certain important behaviors is just that—a careful study of important behaviors.

INTERPRETING THE EVIDENCE

A brief review of the emotion literature indicates that, even after 100 years of research, the scientific status of emotions as natural kinds remains surprisingly unclear. In every domain of emotion research, there is some evidence for the view that emotion categories like *anger*, *sadness*, and *fear* carve nature at its joints. But there is also steadily accumulating evidence against the natural-kind view. Strong correlations among self-report, behavioral, and physiological measures of emotion do not consistently materialize as expected, calling into question the idea that *anger*, *sadness*, *fear*, and so on are homeostatic property clusters that can be identified in observable data. It is difficult, if not impossible, to characterize any emotion category by a group of instances that resemble one another in their correlated properties. That is, it is difficult, if not impossible, to empirically identify the extensions of each emotion category.

Nor does the empirical record provide strong evidence for distinct causal mechanisms for each emotion. Emotion categories such as *anger*, *sadness*, and *fear* have thus far not clearly and consistently revealed themselves in the data on feelings, facial and vocal behaviors, peripheral nervous system responses, and instrumental behaviors. The jury is still out on whether there are distinct brain markers for each emotion, but so far the available evidence does not encourage a natural-kind view. An individual study here or there might produce evidence to distinguish between two or more emotions, but inconsistency in findings across studies is thus far the norm, and the specificity of correspondences between emotions and brain locations has not been adequately addressed.

How should this evidentiary record be viewed? My goal in this article was to highlight the accumulating evidence that is inconsistent with a natural-kind view. Should such evidence be dismissed, or should it be taken seriously as disconfirming evidence? The weighting and interpretation of such evidence strikes to the heart of the debate over the nature of emotion.

There are reasons to consider dismissing the disconfirming evidence. Within any one of the research areas I have reviewed, it is possible to find caveats to explain why the expected findings have not materialized. Self-reports are flawed, and experience may be epiphenomenal to emotion. Facial EMG measurements are too coarse grained to capture complex sets of facial movements, and perceiver-based judgments of facial movements provide stronger evidence for the natural-kind view. Most psychophysiological studies measure only a few output channels, providing a less than optimal test of the autonomic-specificity question. And neuroimaging investigations of emotion are just beginning, tend to confuse emotion perception with emotion induction, and do not give sufficient spatial resolution (not to mention the fact that research participants must lie immobilized inside a scanner). It is possible that distinct, natural kinds of emotions will reveal themselves if only scientists can find the right eliciting stimuli, employ better measurement tools, or use more sophisticated and precise research designs.

There are also reasons to take the disconfirming evidence seriously, however. When the findings for the face, the body, the brain, and subjective experience are viewed together, a pattern begins to take shape, but this pattern is not one that reveals natural boundaries for *anger*, *sadness*, *fear*, and other emotion categories. Instead, the self-report, behavioral, physiological, and neural evidence seem to point to the same conclusion—that perhaps it is time to take the null hypothesis more seriously. If the natural-kind view is held to the same empirical standard as other emotion models, then it is fair to say that the supporting evidence is equivocal at best. The existing data point to the real possibility that there are no mechanisms for *anger*, *sadness*, and *fear* in the brain waiting to be discovered, producing a priori packets of outcomes in the body. Emotions may not be natural kinds, which raises the question of whether they are the appropriate categories to support a cumulative science.

There are several arguments against dispensing with the natural-kind view of emotion, however. First, this view has been valuable. It is simple to state—emotions are packets of responses that result from mechanisms in the brain and body that derive from our animal past—and it is this simplicity that has led to elegant and clear hypotheses that have guided emotion research for almost a century. In fact, the view that emotion categories carve nature at its joints has inspired the research that has produced much of the evidence that we now have, and that we currently argue about (cf. Ekman, 1992). It has also allowed us to make progress on some circumscribed questions (e.g., understanding the neural module for specific behavioral stances in rodents and humans).

Second, some researchers might argue that moving beyond a natural-kind view of emotion means denying evolution. One salient aspect of the natural-kind view is that distinct kinds of emotion have been sculpted by evolution and are homologous across nonhuman (especially mammalian) species. Yet it is possible to assume that emotion-related systems in the brain were shaped by evolution without assuming the existence of natural emotion kinds. Evolution may have preserved processes that are broadly affective (cf. Barrett, 2006; Russell, 2003). It is also possible to hold an evolutionary view without assuming that affective or emotional homologies are pervasive in mammalian systems. There have been changes to the human brain (particularly the expansion of the neocortex and its reciprocal connections to affect-related subcortical areas; Barton & Aggleton, 2000; Barton & Dunbar, 1997) that have been shaped by evolutionary pressures related to social functioning and group size. These changes make strict homologies between humans and other mammals unlikely (cf. Berridge, 2003).

Third, some researchers might believe that arguing against natural kinds of emotion is synonymous with claiming that emotions do not exist. This, of course, is not the case at all. Most of us (at least in this culture) have felt angry and have seen anger in other people. The question is whether *anger* and other similar emotion categories have an ontological status that can support induction and scientific generalization, and allow for the accumulation of knowledge. If emotions are entities with essences or causal homeostatic mechanisms that cause feelings, physiology, and behavior, then science is on the right track; it should be possible to clearly and unambiguously specify the criteria for *anger* (i.e., specify the members that the category refers to), making it possible to study *anger* and accumulate evidence about it. But if emotions are not natural kinds, then they do not have ontological status as causal entities. As a consequence, emotions may not be the answer for why people do things. Rather, they may be the question—the things whose perception needs to be explained. In this view, emotions do not refer to the things being classified, but rather are classification schemes that people impose on their world during perception.

Finally, some people who read this article will argue that the natural-kind standard is simply too high for psychology and far exceeds the usual standards that psychological scientists employ. If the natural-kind standard is too high, then by definition emotions are not natural kinds, and a denial of the natural-kind view is trivial. In this case, a strong empirical case against the idea of emotions as natural kinds is neither revealing nor productive.

Creating a straw man and knocking him down is never productive for any field of inquiry. But is the natural-kind view a "straw man"? I would argue it is not. Many of the most influential models in our science assume that emotions are biological categories imposed by nature, so that emotion categories are recognized, rather than constructed, by the human mind. And the most optimistic read of the existing evidence is that it is inconclusive, by whatever criteria are used. If emotions like *anger*, *sadness*, and *fear* cannot be clearly and consistently identified by their physiology, their facial muscle movements, or any other objective measure, then how can scientists verify their presence so as to study them?

To be sure, dispensing with the natural-kind view of emotion will be difficult. This view is compelling. It fits with the way we talk about emotion every day. We say, "You made me angry," as in "You triggered my anger reflex." *Anger* explains why we yelled, and perhaps even justifies it. This idea underlies, often implicitly, our construal of emotions in self and others. The natural-kind view of emotion is also reinforced by our experiences. Because we perceive *anger* in ourselves and in others, we believe *anger* exists as an entity to be discovered somewhere in the brain or body. We believe that our experiences reveal reality to us. Experiences of *anger*, *fear*, and so on feel like they erupt or "happen to us," as the causal entity—the emotion—hijacks our mind and body and sometimes causes us to behave in ways that we would rather not (that interfere with the more reasoned responses that we identify as part of our human selves).

The natural-kind paradigm is also consistent with a host of assumptions that generally guide scientific inquiry. It matches our assumptions about psychological constructs. Most psychological theorizing is based on classical measurement theory, according to which a latent construct exists and causes a set of observable behaviors whose correlation (due to their common cause) indicates the presence of the construct (called an effect indicator model; Bollen & Lennox, 1991).

The natural-kind view is also consistent with a basic form of essentialism that captures well how people think about the events and objects in their everyday lives (Bloom, 2003). People's naive intuition that emotions have essences may be an example of psychological essentialism (Medin & Ortony, 1989). People need not have a clue about what the essence of a category is to continue believing in it. It has been argued that psychological essentialism is an adaptive and universal way of parsing the world (Gelman & Hirschfeld, 1999; see also Quine, 1977). But as Quine pointed out, psychological essentialism may produce a bias in how we formulate scientific theories about the world.

If Quine (1977) was right, then psychology's failure to move beyond the idea of emotions as natural kinds comes with a large price tag: Some of the most fundamental questions about human emotion remain unanswered. Moreover, the majority of the empirical findings related to emotion do not seem to line up in a cumulative fashion when as a field we proceed with the procrustean process of trying to fit the data neatly into discrete categories.

SUGGESTIONS FOR A NEW PARADIGM

A new scientific paradigm for the study of emotion means conducting better studies with better research tools. More important, it also means learning to ask different sorts of questions about emotion. In the past, the field has been shaped by questions such as "Is X an emotion?" "How many emotions are there?" "Which specific pattern of antecedent events, neural activity, physiology, and motor behavior defines each emotion?" "How do we evoke pure instances of emotion, uncontaminated by contextual influences?" and "How do we regulate and control emotions after they have been triggered?" Conceptual challenges to these kinds of questions are met with accusations about denying the biological or evolutionary nature of emotion or even denying the existence of emotion. Emotional responding exists, can be functional, and is very likely given to us by evolution. But that does not necessarily mean that *anger*, *sadness*, and *fear* are useful categories for conducting science.

In fact, there is no clear and simple research agenda for understanding emotional responding that rivals the natural-kind paradigm. Perhaps the time has come to build one. There are many models that can serve to inspire such an endeavor (e.g., Averill, 1980; Barrett, 2006; Clore & Ortony, 2000; Harré, 1986; Ochsner & Barrett, 2001; Owren, Rendell, & Bachorowski, 2005; Rolls, 1999; Russell, 2003; Shweder, 1993, 1994; Smith & Ellsworth, 1985; Solomon, 2003a; White, 1993). Although these models differ from one another in their surface features, they all assume that observable instances of emotion emerge from the interaction of more basic psychological processes. And if a new emotion paradigm were to use constructs and ideas that are already well established in other areas of psychology, then this would contribute to psychology's development as a cumulative science. What follows is my prescription for some of the features that might characterize a new paradigm for the scientific study of emotion.

Different Questions

It might be profitable to begin by asking questions about emotion that the natural-kind paradigm ignores. If emotions are emergent phenomena, then what are the fundamental processes that cause feelings and behavior? If there are no emotion circuits that are hardwired into our brains at birth, then what is the evolutionary legacy to the newborn, and what role do epigenetic forces play? Why do people automatically and effortlessly perceive emotion in themselves and others when instrument-based measures do not reveal the existence of emotion, and what is the functional value of these perceptions? Why do scientists typically theorize about and focus their empirical efforts on prototypical emotional episodes, when such episodes are quite rare and the nonprototypical cases are more frequent in our everyday lives? Is there an intrinsic role for language in the emergence of an emotional response? How is it that emotional events take on different gestalts across cultures? Is there really, as assumed, a sharp and deep distinction between emotion and other phenomena such as memory, attention, and perception? It would be misleading to say that these questions have been ignored by psychology, but perhaps they should take center stage in defining the paradigm that guides emotion research in the future.

An Inductive Approach

A new paradigm for the scientific study of emotion might take a more inductive approach (Barrett, 1998b; also see Rozin, 2001). Asch (1952/1987) made this observation more generally about social psychological science:

> If there must be principles of scientific method, then surely the first to claim our attention is that one should describe phenomena faithfully and allow them to guide the choice of problems and procedures. (p. xv)

Rather than beginning with an abstract, theoretical construct (e.g., *anger*) that we try to identify in human behavior, perhaps we could concentrate our empirical efforts on identifying which observables (e.g., cardiovascular changes, facial expressions, startle responses, electroencephalographic recordings, subjective experience, conscious thoughts) are implicated across instances of emoting and observe, rather than prescribe, their relationships in varying circumstances and time frames. If instances of emotion can be characterized by empirical coherences, then no matter where we begin the investigation, our observations should eventually demonstrate reliable patterns of relationships among the necessary components of emotion. Alternatively, new constructs may emerge, and they may have little resemblance to folk or commonsense categories of emotion.

Here is an example of one such approach. Observations of subjective reports of emotion experience (e.g., Barrett, 2004; Barrett & Russell, 1999; Russell & Barrett, 1999), peripheral nervous system activation (Bradley & Lang, 2000; Cacioppo et al., 1997, 2000), facial movements (Cacioppo et al., 1997, 2000; Messinger, 2002), vocal cues (Bachorowski, 1999) and expressive behavior (Cacioppo & Gardner, 1999), and neural activations (Wager, Phan, Liberzon, & Taylor, 2003) are consistent with one another in providing a strong empirical basis for hypothesizing that a general affect system constitutes the most basic building block of emotional life (for a review, see Barrett, 2006). There are debates over the most scientifically viable way to represent this affective system, but one candidate is a recently defined affective substrate, called *core affect*.

Core affect is characterized as the constant stream of transient alterations in an organism's neurophysiological state that represents its immediate relationship to the flow of changing events (Barrett, 2006; Russell, 2003; Russell & Barrett, 1999). The term "core" in "core affect" is meant to refer to a specific construct that is distinct from the more general construct of "affect" (i.e., referring to anything emotional), and signifies several important ideas about this form of affective responding (for a discussion, see Barrett, 2006). Core affect may be a basic kind of "core knowledge" (Spelke, 2000) that is supported by hardwiring present at birth (Bridges, 1932; Emde, Gaensbauer, & Harmon, 1976; Spitz, 1965; Sroufe, 1979) and is homologous in other mammalian species (Cardinal, Parkinson, Hall, & Everitt, 2002; Schneirla, 1959). The term "core" also signals the idea that objects and events have affective meaning to the extent that they can influence the homeostatic (core affective) state of the individual. Computations of value (whether an object is helpful or harmful) are represented as perturbations in a person's internal milieu—what we are referring to when we say that a person has an affective reaction to an object or stimulus. They are means by which information about the external world is translated into an internal code or representations (Damasio, 1999; Nauta, 1971; Ongur & Price, 2000). The intensity of a core affective response (the degree of sympathetic and parasympathetic activation at a given moment in time) results in a perceived urgency to act that is independent of the specific action taken (the specific action being tailored to the particular situation at hand). The term "core" also signifies that this form of affective responding forms the "core" of experience. Core affect (i.e., the neurophysiological state) is available to consciousness, and is experienced as feeling good or bad (valence) and to a lesser extent as feeling activated or deactivated (arousal; for a review, see Russell & Barrett, 1999). In a sense, core affect is a neurophysiological barometer of the individual's relation to an environment at a given point in time, and self-reported feelings are the barometer readings.

The empirical case supporting the hypothesis that core affect is a natural kind is suggestive, and the critical experiments have yet to be done. Yet, if the core affect view bears up well under empirical scrutiny, then much of the detailed and careful behavioral neuroscience research might be reinterpreted as shedding light on basic affective processes, rather than on specific emotion categories such as *fear*. Behaviors like freezing might reveal an animal's core affective state, even as perceivers automatically and effortlessly categorize freezing as an instance of *fear*.

Accounting for the Existing Evidence

Finally, any new paradigm for emotion research will have to take account of the evidence that already exists. For example, if coordination among the face, the body, and subjective experience are the exception rather than the rule in emotional responding, then the dissociations that are routinely observed are not mysterious and do not require additional explanation. Instead, it is the presence of coordination that requires explanation. Instances with coordinated outputs are rare, but perhaps they are significant, or important in some way.

Furthermore, perhaps one of the most important questions that remains is why perception-based judgments routinely produce evidence in support of emotion categories, even as instrument-based measurements do not. How is it that people can automatically and effortlessly see *anger*, *sadness*, and *fear* in others, and experience these emotions as feeling states, even though scientists have not clearly and consistently located them in the brain and body? As ordinary people, we demand explanation of the instances that we call “anger,” “sadness,” “fear,” and so on. It is our task as scientists to explain how these instances arise. The goal of a new emotion paradigm would be to account for the experience of feeling *anger*, or seeing *anger* in another person, without assuming that these percepts derive from stereotyped, specific patterns of somatovisceral activity, brain activation, and behavior.

One hypothesis, termed the *conceptual-act model*, is that discrete emotions emerge from a conceptual analysis of core affect (Barrett, 2006). Specifically, the experience of feeling an emotion, or the experience of seeing emotion in another person, occurs when conceptual knowledge about emotion is brought to bear to categorize a momentary state of core affect. The conceptual knowledge that is called forth to categorize affect would to be tailored to the immediate situation, represented in sensorimotor cortex, acquired from prior experience and supported by language. Categorizing the ebb and flow of core affect into a discrete experience of emotion corresponds to the colloquial idea of “having an emotion.”

Together, core affect and conceptual knowledge about emotion constitute a highly flexible system that can account for the full richness and range of experience that makes up human emotional life. The ability to categorize confers some adaptive advantage, and so is likely evolutionarily preserved, even if the specific categories are not. Many cultures may have similar basic-level emotion concepts, not because these categories have some biological priority, but because these concepts are optimal tools for communicating in the kind of social environment that humans typically occupy (living in large groups with complicated relational rules).

The conceptual-act model has much in common with some of James’s original views (see Barrett, 2006). It also shares common ground with appraisal models of emotion in the sense that emotions are described by their eliciting conditions rather than by their patterns of outputs. The conceptual-act model is most closely aligned with those appraisal models of emotion in which appraisals are not literal cognitive mechanisms for computing the meaning of a situation, but instead describe the set of rules for what emotional contents are felt when (e.g., Clore & Ortony, 2000; Ortony et al., 1988). Categorization processes enact the rules, guiding the emergence of an emotional episode. The implication, then, is that learning about how individuals acquire and use abstract conceptualizations will shed light on what emotions are and what functions they serve. Of course, the conceptual-act model is just one hypothesis. It requires empirical test, and there may be other, better ways to account for why people see *anger*, *sadness*, *fear*, and other emotions that are not in evidence biologically.

Finally, any new emotion paradigm must be able to account for the findings that are consistent with the natural-kind view of emotion. For example, there is emerging evidence that emotion experiences are reliably linked to specific stimuli or behaviors. People report discrete emotions in response to evocative stimuli, such as movie clips (e.g., Gross & Levenson, 1995; Philippot, 1993). Specific emotional feelings produce categorization effects (Niedenthal, Halberstadt, & Innes-Ker, 1999), influence risk assessments and other forms of decision making (Lerner, Gonzalez, Small, & Fischhoff, 2003; Lerner & Keltner, 2000, 2001; Lerner, Small, & Loewenstein, 2004), and affect attitudes about out-group members or the ease of persuasion (DeSteno, Dasgupta, Bartlett, & Cajdric, 2004; DeSteno, Petty, Rucker, Wegener, & Braverman, 2004). These effects are real. And it is an open question whether some other model of emotion can account for them as well as, or better than, the natural-kind view.

CONCLUSION

If the science of emotion is to proceed, then we must evaluate the empirical status of the natural-kind view and treat alternative models seriously, even if they do not match commonsense or deeply held beliefs. Doing so may expose the road to a new and more successful scientific paradigm with which to understand the nature of emotion. An alternative paradigm need not deny the existence of emotions, but might deny emotions any explanatory power. A new paradigm would not deny the importance of evolutionarily preserved responses, but might deny emotions any privileged status as innate neural circuits or modules. A new paradigm should never deny the important research findings of prior decades. Rather, it is a requirement that such research be reinterpreted within the newer framework if that framework is to be viable.

Giving up the natural-kind view may seem unintuitive, but it is not uncommon. In psychology, as in many domains of science, natural-kind theories are quickly becoming a thing of the past. It was once assumed that memory (e.g., M.K. Johnson, 1992; M.K. Johnson & Hirst, 1993; Schacter, 1996), personality (Mischel, 1984; Mischel & Shoda, 1995), intelligence (Gardner, 1983), and concepts (Barsalou, Simmons, Barbey, & Wilson, 2003) were fixed entities, each with an identifiable essence. Now they are viewed more as emergent features of the mind. For the sake of scientific progress, it has been necessary to develop models of these phenomena that focus on more basic psychological processes. Memories, personalities, intelligence, and concepts exist to be explained, and are best thought of as products of distinct but interacting psychological processes with accompanying neural systems. Perhaps the same fate awaits emotion.

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