

Emotion, motivation and function

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Biological approaches to emotion require that adaptive function is an organizing principle in defining the emotion. The emotion of fear is taken as the complete behavioral, physiological and experiential components of a system that evolved for antipredator defense. In part, fear is a motivation that selects and drives overt defensive action. But the emotion also contains the autonomic changes supporting these behaviors and the conscious experience that accompanies danger. Fear has the ability to overwhelm consciousness so that that nothing but phylogenetically selected action occurs. By filling consciousness fear prevents flexible behaviors and that is one reason why anxiety disorders can be so debilitating. Anxiety, fear and panic are states within the emotion that correspond to different levels of threat.

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Introduction

I have long advocated that the emotion of fear should be conceptualized as the brain and behavioral systems that evolved to protect organisms from external threats with the main source of selection being predators [1•]. Here I will first relate this view to various ways that emotions have been conceptualized generally and to show how this approach addresses problems inherent in the study of emotions. I conclude with an overview of the rich network of defensive behaviors that characterize the mammalian emotion associated with fear.

Why do we have emotions? Why do humans, and other animals, experience fear [2••]? If fear is a real biological

process the answer to the ‘why’ question is the same answer given to virtually everything that exists in biology. Emotion serves some function that provides a selective advantage. It should be recognized that in higher animals what contacts selection pressure, the thing that is selected for, is behavior. Reproduction, energy intake and defense are behaviors that make direct contact with the consequences of selection pressure. Selection cares more about the ends (behavior) and less about the underlying mechanisms. If emotion is a real biological entity it exists in the service of behavior and must be tied to specific classes of behavior. Following this idea the emotion of fear is the complete brain, body and behavioral system that supports defense. In this article I make a distinction between fear as an emotional system and the state of fear. The emotional system of fear refers to the entire complex of brain mechanisms, bodily changes, subjective experience and suite of behaviors that serve defense. Within that emotion, the state of fear is a particular component of the suite that occurs at a particular level of danger. Anxiety and panic are two other component states that are part of the emotion [3••]. Initially this piece concentrates on the emotional system. How the state of fear fits into the broader system is developed in the final section.

Emotion versus motivation

The terms emotion and motivation are inextricably linked. For example, incentive motivation theory was intended to explain the drive behind behavior and also the emotions of hope, fear, disappointment and relief [4•,5,6]. A convenient way to use this terminology is that fear as a motivator selects a particular set of behaviors from the response repertoire and provides the drive or force behind the behavior. Motivation is one component of the emotion but emotion is a broader term. It includes motivation but also the subconscious physiological processes that support the overt behaviors as well as the subjective conscious experience that accompanies the emotion. The emotion exists even if a single component is eliminated. When lesions of the lateral hypothalamus eliminate hypertension in response to threatening stimuli fear is still present [7]. And while patients that suffer hippocampal damage after a trauma are unable to remember the traumatic experience they still develop all the symptoms of post-traumatic stress disorder (PTSD) [8,9,10•].

Dimensional versus categorical theories of emotion

There are two distinct classes of theories of emotion, categorical and dimensional. The categorical approach views each emotion as an independent discrete entity

[11[•],12]. A categorical view would say that fear and joy are independent functional entities. For example, Ekman has argued that fear is its own distinct universal state that differs from other aversive emotions such as anger and disgust [12]. One danger of such a view is that it can lead to a proliferation of individual emotions, unless some rules are taken to limit what is conceived of as an emotion. This sort of condition led to the demise of instinct theory where theorists continually proposed additional instincts for particular behaviors [13^{••},14].

Dimensional approaches provide for much greater parsimony by proposing that there are a limited number of continuous dimensions that emotional experiences fall on. The most simple of these comes from incentive motivation theory that proposes a single hedonic dimension anchored at one end by aversiveness and the other by pleasurable (appetitive) [5,15[•]]. Within this view stimuli that predict danger and stimuli that predict the absence of pleasant events such as food are emotionally equivalent; they move the organism toward the aversive end of the continuum. Likewise stimuli that predict the absence of danger and those that predict food are equivalent shifting emotion and corresponding behaviors toward the appetitive end [5]. Virtually all dimensional theories rely on a hedonic continuum but additional orthogonal dimensions are added to capture a greater range of experiences [16[•]]. Something capturing intensity is a common addition, such as Schlosberg's proposal of a dimension corresponding to 'level of activation' [16[•]]. As long as the number of dimensions is limited the theory maintains some level of parsimony because seemingly different states are collapsed into a single place on the continuum becoming more-or-less equivalent.

I believe that it is the use of a single hedonic continuum that undermines dimensional theories. Incentive motivation theories equate fear and pain, suggesting that fear is nothing more than the conditionable component of pain [17,18]. A stimulus like shock is an unconditional pain stimulus that moves emotional expression toward the negative hedonic end. Stimuli associated with pain become fear stimuli because they acquire this ability. Pleasurable events like food and water are similarly collapsed. However, I have argued that fear and pain are categorically different. Fear and pain serve different biological functions, defense on one hand, recuperation on the other [1[•]]. They promote completely different behaviors and fear-induced analgesia allows fear to powerfully inhibit pain [19]. It is illogical to think that fear and pain are aspects of a single emotion when they are mutually incompatible. Similarly, thirst and hunger have an antagonistic role to each other [13^{••},20]. One could try and pull fear and pain apart by adding multiple dimensions but that comes at the cost of exactly the parsimony that makes dimensional theories attractive.

My position on fear clearly seats it within the categorical view. However, to maintain a healthy degree of parsimony successful categorical theories must impose constraints or rules in defining categories. Therefore, I have advocated a quadral requirement for defining an emotion [21]. One must specify: *Evolutionary or phylogenetic function*; thwarting predation in the case of fear. *Antecedent conditions* that activate the emotion; signals for threat promote fear. *Consequent conditions* are the measureable behaviors that occur when the emotion is activated and serve to fulfill the function, defense in the case of fear. *Circuitry*: the brain must have a definable circuit that mediates between the antecedent and consequent conditions.

The subjective emotional state of fear: primary or indicative?

When we are threatened we become keenly aware of our fear; it dominates our consciousness. The power of fear to dominate consciousness must come from the biological importance of defense. One failure to defend means no future reproduction, while a single failure to mate has far less long-term consequences for reproductive success. When we are afraid we must concentrate on defense; we do not have the luxury of thinking about anything else. Indeed, we need to put aside any feelings of hunger and pain as well. But what is the role of the conscious subjective experience of fear from this functional perspective? One possible function is that by dominating consciousness fear can readily suppress systems supporting voluntary behavior allowing rapid and automatic execution of phylogenetically programmed defensive behaviors. Thus the conscious experience of fear is an indicator of the activation of an emotion that is far richer than simply what we are aware of. Like freezing and hypertension the subjective report of fear is one of the consequent conditions of this emotion. Strong fear must fill consciousness to preclude anything but defense.

When I say fear is functional I mean function in the ultimate phylogenetic sense and not in the proximal ontogenetic sense. Fear motivation limits the behavioral repertoire to responses that have a phylogenetic history of defending members of the species [22[•]]. These behaviors occur even if at the particular moment they are deleterious. This suppressive effect of the conscious experience of fear helps explain this loss of behavioral flexibility. In the laboratory rat this manifests as the well-known failure for rats to learn arbitrary responses to avoid shock, even if they are perfectly capable of making those responses to obtain food [22[•]]. Indeed, modern studies of instrumental avoidance typically incorporate fear reduction procedures such as extinction, large numbers of trials with mild shock to promote habituation and/or discard the most fearful animals, which is often a substantial portion [23[•],24,25]. Indeed, damaging the circuits responsible for fear often facilitate performance of instrumental avoidance [26].

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