Feelings: What Are They & How Does the Brain Make Them?

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Abstract: Traditionally, we define "emotions" as feelings and "feelings" as conscious experiences. Conscious experiences are not readily studied in animals. However, animal research is essential to understanding the brain mechanisms underlying psychological function. So how can we make study mechanisms related to emotion in animals? I argue that our approach to this topic has been flawed and propose a way out of the dilemma: to separate processes that control so-called emotional behavior from the processes that give rise to conscious feelings (these are often assumed to be products of the same brain system). I will use research on fear to explain the way that I and many others have studied fear in the laboratory, and then turn to the deep roots of what is typically called fear behavior (but is more appropriately called defensive behavior). I will illustrate how the processes that control defensive behavior do not necessarily result in conscious feelings in people. I conclude that brain mechanisms that detect and respond to threats non-consciously contribute to, but are not the same as, mechanisms that give rise to conscious feelings of fear. This distinction has important implications for fear and anxiety disorders, since symptoms based on non-conscious and conscious processes may be vulnerable to different factors and subject to different forms of treatment.

The human mind has two fundamental psychological motifs. Descartes's proclamation, "I think, therefore I am,"[1] illustrates one, while Melville's statement, "Ahab never thinks, he just feels, feels, feels," exemplifies the other.[2] Our Rationalist inclinations make us want certainty (objective truth), while the Romantic in us basks in emotional subjectivity. Psychology and neuroscience recognize this distinction: cognition and emotion are the two major categories of mind that researchers study. But things were not always quite like this.

Rational thought has always been treated as a product of the mind, and emotions were traditionally viewed as belonging to the body.[3] Descartes, following Plato's lead, said that humans differ from animals in that we have a rational mind (a soul), but are similar to animals in that we have bodily passions (emotions) that interfere with reason. Somewhere along the way, two things happened to give us our more

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integrated modern view. First, we began to consider human emotions as mental states; and second, many began to attribute mental states, including both thoughts and feelings, to animals. Darwin, for example, viewed emotions as "states of mind," some of which are shared by both humans and other animals.[4] Today, emotions are commonly conceived of as mental states that are felt (consciously experienced) when well-being is affected in some way: we feel fear when threatened, anger when frustrated, joy when things go well, sadness when we lose a friend or loved one, and compassion when we see someone suffer.

If we assume that emotions are feelings, that feelings are states of consciousness, and that states of consciousness are inner private experiences predicated on the awareness of one's own mental activity, questions arise about the scientific study of the brain mechanisms underlying emotions in animals. Emotions and other states of consciousness can – within limits and with some difficulty – be studied in humans, but the study of consciousness in animals is, to put it mildly, challenging.[5] At the same time, due to ethical and technical limits of investigations in humans, work on detailed brain mechanisms of emotion depends on animal research. How do we get around this stumbling block?[6]

Behaviorism, which flourished in the first half of the twentieth century, is a school of thought in psychology that rejects the study of conscious experience in favor of objectively measurable events (such as responses to stimuli). Due to behaviorism's influence, researchers interested in emotion in animals have tended to take one of two approaches. Some have treated emotion as a brain state that connects external stimuli with responses.[7] These researchers, for the most part, viewed such brain states as operating without the necessity of conscious awareness (and therefore as separate from feelings), thus avoiding questions about consciousness in animals.[8] Others argued, in the tradition of Darwin, that humans inherited emotional states of mind from animals, and that behavioral responses give evidence that these states of mind exist in animal brains.[9] The first approach has practical advantages, since it focuses research on objective responses of the body and brain, but suffers from the fact that it ignores what most people would say is the essence of an emotion: the conscious feeling. The second approach puts feelings front and center, but is based on assumptions about mental states in animals that cannot easily be verified scientifically.

When I was getting started in my studies of emotion in animals in the mid-1980s, I adopted a third approach to try to get around these problems.[10] I treated *emotions* in terms of essentially non-conscious brain states that connect significant stimuli with response mechanisms, and *feelings* as conscious experiences arising from these non-conscious brain states.[11] My theory, therefore, emphasized the importance of feelings, but I argued that the brain mechanisms that control emotional responses and those that generate conscious feelings are separate. By separating processes that non-consciously detect and respond to significant stimuli from those that create feelings, emotional mechanisms could be studied in animals without having to solve the problem of whether animals feel emotion, while at the same time honoring the importance of feelings in the human mind and brain.

I have used this strategy for many years in my research on fear in animals, focusing on the mechanisms that detect threatening stimuli and orchestrate defensive responses to deal with the danger.[12] The purpose of this strategy has not been to deny that feelings or other states of consciousness exist in animals, but instead to focus research on questions that can be addressed scientifically, regardless of how the animal consciousness debate turns out. In the meantime, since feelings are an essential factor in human mental life and in psychiatric disorders that afflict humans, conscious feelings can and should be studied in humans. Further, because circuits that operate non-consciously to control emotional responses nevertheless contribute to feelings in humans, research on these same circuits in animals is relevant to human feelings.

As useful as the strategy has been, there has always been something awkward about the scientific separation of emotion (a non-conscious response process) from feeling – the conscious experience of emotion. It is messy, since the terms *emotion* and *feeling* are typically used interchangeably in everyday speech. There is no requirement that scientific language conform to lay meaning (and in fact some argue that a language of science will replace lay terms);[13] but when the terms in question are about mental states that we all experience and talk about, it is harder to escape the compelling pull of the vernacular.[14] This is one challenge psychology faces that most other sciences do not.

In an effort to grapple with this terminological uneasiness, I began rethinking the way we use words like emotions and feelings.[15] This led me to consider the natural history of what we have been calling emotion in animals, a journey that led me to conclude that the roots of so-called emotional behavior are so deep, so old, that it makes no sense to use a term like emotion to describe these behaviors in any organism, including humans. The term emotion is so intricately entwined with conscious feelings that to use it in any other way simply invites confusion. Instead of differentiating between emotion and feeling, I stick with the everyday meaning of the terms, using them interchangeably to refer to the mental states that people experience when they face situations in which survival is challenged or enhanced.

In the remainder of this essay I use the emotion of fear as an example of the points I want to make. I first explain the way that I and many others have studied fear in the laboratory, and then turn to the deep roots of what I long called fear behavior (but now call defensive behavior, as explained below). I offer a different way of talking about fear and other mental states.[16] I conclude by discussing my view about what conscious feelings are, how they relate to non-conscious processes, and how they come about in the brain.

A staple in laboratory studies of fear and its underlying brain mechanisms has been a procedure called *Pavlovian fear conditioning*.[17] (I prefer to use the more neutral term *Pavlovian threat conditioning* to circumvent aforementioned problems associated with discussing "fear" in animals.)[18] In threat conditioning, an insignificant stimulus, such as a tone, occurs in conjunction with an aversive stimulus, typically footshock. Through this pairing, the tone by itself eventually acquires the ability to elicit freezing behavior (a defensive anti-predator behavior in which the animal remains motionless for the purpose of avoiding detection or minimizing attack)[19] and supporting physiological responses (such as changes in heart rate, blood pressure, and other autonomic nervous system adjustments) that help the organism cope with the impending danger. Much has been learned about the neural circuits, cells, synapses, and molecules that make it possible for animals to learn in this way, especially through studies of rodents (particularly rats).[20]

One of the advantages of Pavlovian threat conditioning is that it can be used across a wide range of species. Human studies cannot provide as much detail about neural mechanisms, but have confirmed to a first approximation that the same brain areas and connections discovered in rats also exist in humans.[21] For example, through studies of rats, we know much about the various subregions of the amygdala that receive the tone and shock, integrate them, store a memory of the association, and use that association to control defensive responses.[22] Subregions of the amygdala are not within the imaging resolution of currently available technology for studying the human brain, but we assume that circuits are likely to be similar because the basic circuitry found in rats also exists in nonhuman primates and performs similar functions in rodents and primates.[23]

Invertebrates are also responsive to Pavlovian threat conditioning.[24] While these animals have different neural circuits than vertebrates, they offer advantages for exploring molecular mechanisms related to intracellular signaling cascades and gene expression. Many of the discoveries made in invertebrates have subsequently been confirmed in rodents.[25] And if they apply to rodents, they likely apply to other mammals, including nonhuman primates and humans.

While studies of detailed brain mechanisms are not possible in humans, studies of our species have the distinct advantage of being able to explore conscious states.[26] Still, we must be careful not to confuse feelings with responses elicited by a threat. When threatened by a stimulus created through threat conditioning or by an innate threat, humans have behavioral and autonomic nervous system responses that anticipate the threat and help prepare the body to cope with the danger that may ensue; further, the amygdala is activated.[27] The person may feel fear, but this does not mean that the same brain circuits create feelings of fear.

For example, the amygdala is activated and physiological responses are expressed even to subliminal (non-conscious) presentations of threat stimuli.[28] In these cases, the subjects are not aware of the stimulus and do not report any particular feeling.[29] Amygdala activation thus does not tell us that fear is felt in a human, and certainly does not alert us to fearful feelings in animals. Confusion results because fearful feelings are often correlated with these amygdala-dependent responses. But correlation does not mean causation; we cannot generalize from stimulus-response mechanisms, which occur widely in animal life, to conscious feelings of fear.[30]

That said, amygdala-based and other defensive circuits do contribute indirectly to feelings of fear, but feelings of fear require more than just amygdala-driven responses in the brain and body. My proposal is that all organisms have the ability to detect and respond to threats, but only organisms that can be conscious of their own brain's activities can feel fear.

Laboratory studies of so-called emotional behavior in animals involve tasks that pose challenges to, or opportunities for enhancing, well-being. Stimuli (such as shocks, food, drink, warmth, and sexual stimulation) are used to motivate responses that help the animal either cope with or benefit from the stimuli (prevent or reduce the impact of a shock or give access to food, drink, warmth, or sex). When humans experience these events, we can have feelings of fear (when threatened) or pleasure (when eating, drinking, having sex, or becoming warm after being in the cold). These behaviors and feelings are so intertwined in us that we think of them as one and the same: we often describe the feelings as emotions and the behaviors as emotional behaviors.

When descending the evolutionary tree in search of the origins of these so-called emotional behaviors, one quickly finds oneself jumping to lower and lower branches, ending up at the base of the trunk and eventually even digging down into the roots of the tree. Every living organism, from the oldest to the most recent, has to do these things to stay alive and pass its genes on to its offspring. Organisms must detect danger, identify and consume nutrients and energy sources, balance fluids by taking in and expelling liquids, thermoregulate, and reproduce. You do these things, but so do the bacterial cells living in your lower intestine.[31]

This realization turns the scientific language of emotion on its head. What are commonly called emotion functions in humans and animals are not emotional functions at all. They do not exist to make feelings. They are survival functions essential for the continued life of the individual or the species.[32] And in humans, survival functions are sometimes – perhaps often – associated with feelings. But the systems that underlie these functions operate independently from feelings in humans. For example, as noted above, the circuits that control so-called fear responses are not themselves the wellspring of feelings of fear. This raises the question of how feelings of fear or other emotions come about.

The problem of understanding feelings is thus reducible to the problem of understanding consciousness. Consciousness is unobservable except by introspection, and attributing it to others requires a certain degree of faith in unprovable assumptions. The question is: which unprovable assumptions are we willing to make scientifically? Because all human brains are wired in the same way, I am on fairly safe ground in assuming that you have the same basic factory-installed brain functions that I do. While the human brain is similar in many ways to the brains of other mammals, even other vertebrates,[33] it is also different in very significant ways.[34] I thus restrict my discussion of conscious feelings to humans, which makes the problem more manageable. Still, consciousness is a complex and contentious topic that cannot be discussed exhaustively here. I will therefore simply summarize how I believe conscious feelings come about.

I pursued my Ph.D. working with the cognitive neuroscientist Michael Gazzaniga in the late 1970s. Gazzaniga was famous for his work on split-brain patients,[35] in whom the nerve connections between two sides of the brain are surgically cut in an effort to control otherwise intractable epilepsy. Their misfortune has been a source of many important discoveries about how the brain and mind work. I will just mention one set of findings that Gazzaniga and I made that solidified his ideas about consciousness and that sparked my interest in understanding how the non-conscious aspects of the brain work.[36]

Since typically only the left hemisphere of the brain has the capacity for speech, stimuli presented to the right hemisphere of a split-brain patient cannot be talked about. But the right hemisphere can indicate that it saw and perceived a stimulus by using the left hand (corresponding to the right hemisphere) to select a matching picture. For example, in one study we simultaneously showed the patient's left hemisphere a chicken claw and the right hemisphere a snow scene. The patient's left hand then selected a picture of a shovel. When the patient was asked why he made this choice, his left hemisphere (the speaking hemisphere) responded that it saw a chicken and you need a shovel to clean out the chicken shed.[37] The left hemisphere thus used the information it had available to construct a reality that matched the two pieces of information available: it saw a picture of a chicken and it saw its hand selecting a shovel. Given the patient's rural background, it made sense to him that a shovel and chicken claw go together since a shovel could be used to clean the chicken shed. In other studies, by presenting commands to the right hemisphere, we induced it to wave, stand, or laugh, and asked the left hemisphere, "Why did you do that?" The left hemisphere responded with answers like "I thought I saw a friend out the window so I waved," "I needed a stretch so I stood up," and "You guys are funny."

On the basis of such findings, Gazzaniga developed his theory of consciousness as an interpreter of experience, a means by which we develop a self-story that we use to understand those motivations and actions that arise from non-conscious processes in our brains.[38] In his view, much of what we do in life is controlled by non-conscious processes that we only come to understand by monitoring and interpreting their expression in behavior or in other body states. Since graduate school, I have been trying to understand how systems that operate outside of conscious awareness, such as those that control the expression of defense responses in the presence of threats, work.

When Gazzaniga and I were doing these studies in the 1970s, consciousness research was not in vogue in psychology or neuroscience. The effects of behaviorism were lingering, but in addition, cognitive science had introduced the idea that the mind is basically a non-conscious information processing device.[39] Consciousness can result from this processing, but the underlying non-conscious processing was the main focus of the field.

In the ensuing decades, scientific interest in consciousness skyrocketed. Much progress has been made in pursuing the neural correlates of consciousness, especially by focusing on how the brain creates conscious perceptions of visual stimuli.[40] Most researchers in this field seem to agree that we are not conscious of representations that occur in the primary visual cortex (the part of the visual cortex that first receives stimuli). Some argue that later stages of visual cortex create our conscious visual perceptions and that this is all that is needed for a conscious experience.[41] Others say that while necessary, the visual cortex alone is not sufficient to produce conscious experience of visual phenomena, and that other circuits and functions are required.[42] For example, one argument is that for an individual to be consciously aware of a visual stimulus, the stimulus has to be attended to,[43] which engages additional cortical areas, including the prefrontal cortex and parietal cortex.[44] Attention also allows the raw visual stimulus to be integrated with memory so that the stimulus can be recognized as a particular object, and even an object that may have had certain personal significance in the past. These attention-controlled representations that include objects and memories are often said to occur in a cognitive workspace[45] sometimes called "working memory" (the capacity to hold information in mind temporarily while doing mental work).[46] Different theories propound different ideas about how information that enters working memory ends up being consciously experienced. For example, according to higher-order theories of consciousness, you must have a thought about a stimulus representation in order to be conscious of it (this is in some ways reminiscent of Gazzaniga's interpreter).[47] The global workspace theory of consciousness, on the other hand, says that information has to be broadcast widely from working memory to other areas that then send signals back to the workspace, resulting in further broadcasting and amplification of the signal and thereby creating the conscious perception.[48] A variety of other cognitive theories also emphasize the importance of attention and working memory in consciousness.[49]

I cast my lot with the general view that emphasizes the role of working memory as a gateway into consciousness, and I remain neutral about what happens next. My goal is not to solve the consciousness problem, but to understand how consciousness – whatever it may be – makes feelings possible. In my view, once information about the presence of a threat is directed to working memory the stage is set for a conscious feeling – an emotion such as fear – to occur. Working memory is not the same thing as consciousness, but in my opinion most of the conscious experiences we have depend on working memory.

So let us pursue the idea that human emotions are conscious experiences that occur when attention directs information about the operation of non-conscious processes to working memory. An important class of non-conscious processes that contribute to feelings are those associated with the activity of what I referred to above as survival functions (functions related to defense, energy management, fluid balance, thermoregulation, and reproduction). The brain circuits that instantiate these functions are survival circuits (certain feelings can also arise without engagement of survival circuits, but I will not focus on those here).[50] But how, concretely, can the operation of the threat/defense survival system trigger the conscious feeling we call fear?

The capacity to detect and respond to threats is an ancient survival mechanism present in all animals, and likely evolutionarily predates both the capacity to be consciously aware of a threat to well-being and the capacity to consciously experience an inner feeling of fear in response to the threat. Circuits that detect and respond to threats in our brains are not fear circuits, not emotion circuits; they do not make feelings. Hard-wired survival circuits are often mistakenly described as emotion circuits (I did this for some time). But these circuits did not evolve to make feelings. They arose, and continue to exist, simply to help animals stay alive and well.

When a threat activates one of these hard-wired circuits, the result is the establishment of a global motivational state in the organism, a condition that spreads throughout the brain and body to mobilize the organism's resources to deal with the danger. Needs and goals that are unrelated to the threat are supplanted by the here-and-now requirements of the situation. The only relevant motivation is self-preservation. The global organismic state that occurs when an organism is in danger can be called a *defensive motive state*.[51] This state includes activity in circuits that control both innate reactions (survival circuits) and goal-oriented actions that help cope with danger.

Motivational states like these not only occur in mammals (monkeys, dogs, cats, rats, bats, whales), but also in other vertebrates (birds, reptiles, fish) and many invertebrates (flies, bees, slugs, worms). All organisms thus have such mechanisms that help them survive in the face of threats. Defensive motive circuit activation greatly influences behavioral and cognitive activities. When a motive state related to danger is active, we become sensitive and hyper-responsive to stimuli associated with danger. The same occurs if a motive state related to food, drink, or sex occurs.

Feeling afraid is an additional factor that can help promote survival, but it is not the most common response in nature. Feeling afraid only occurs in organisms that can be conscious that they are in danger, and I reserve judgment about which organisms other than humans fall into this category. We know humans have conscious feelings but it is far more difficult to know *scientifically* whether other animals do. Thus, the existence of a motive state, and so-called emotional behavior, is not one and the same as the existence of a conscious feeling. Unless an organism's nervous system has the capacity to consciously experience the motive state, conscious feelings cannot occur.

We know that the human brain can experience emotions in conjunction with motive states. However, all we know scientifically about other animals is that their brain and body respond in certain ways in the presence of stimuli that trigger these motive states. This leads some to argue that we can use behavior to tell us about feelings in animals.[52] But, as previously noted, defensive motive states and corresponding bodily responses can be triggered in humans subliminally and without any feeling;[53] thus, we should not call upon consciousness to explain things in animals that do not require consciousness in humans. Neither, however, should we ignore consciousness entirely. I believe we should address the question of feelings, but in organisms in which we can evaluate them (humans). Again, this is not meant as a denial of animal consciousness, but instead is a decision to deal only with what we can measure scientifically, as opposed to speculating about the implications of those measurements.

One reason why it is so tempting to attribute consciousness to animals is that we have a very strong tendency to interpret the behavior of others in light of how we feel when we act in a certain way. This serves us fairly well in our dealings with most other humans, but begins to cause problems scientifically when we attribute human emotions to infants or animals, since we have no way of verifying what they experience. Consider infants. Subcortical circuits that control innate "emotional" (survival) behaviors develop earlier than cognitive circuits of the cortex. Experts on infant development say that infants can *act* emotional long before they can actually feel emotion.[54] While one could object to this conclusion by saying it is impossible to know what an infant is feeling, that is exactly the point: in the absence of a subject's ability to verbally report (as with infants or animals), it is impossible to know whether he or she is conscious or non-conscious. Ultimately, then, the question of whether animals act but do not feel, or whether they both act and feel, cannot be answered, as we have no direct way of finding out what animals do or do not experience.

Two important questions should be raised about motive states. First, are they causes of defensive behavior or instead are they, like defensive behavior, a consequence of survival circuit activation? The former is the conventional view.[55] My hypothesis, by contrast, is that the motive state is the collective response of the brain to survival circuit activation. Defensive responses thus contribute to defensive motive states rather than the other way around. The second question is whether the motive state itself contributes to conscious feelings by entering working memory, or whether working memory instead only has access to the individual neural components that constitute the motive state. The answer is not known at this point.

Some are concerned that a shift in terminology toward *threat* and *defense*, and thus away from *fear*, will make the work we do on animals less relevant to humans. I think the opposite is the case. By being clear about which processes underlying fear and anxiety involve consciousness and which do not, we greatly expand our ability to elucidate the processes and their relevance to clinical disorders.

People with pathological fear and anxiety suffer from their subjective feelings. If we want to understand the mechanisms underlying the genesis and maintenance of the subjective feelings of fear and anxiety that so trouble these individuals, we need to understand how implicit (non-conscious) motive states operate in the brain. For example, the fact that people with phobic disorders are hyper-attentive to threat stimuli related to their phobia and exhibit exaggerated responses to such stimuli is easily accounted for in terms of an overactive defensive survival and motivational circuits.[56]

The brain and body consequences of defensive motivational circuit activation generate many (though not all) of the factors that go into a conscious feeling. But the mechanisms of defensive motivational states are not one and the same as the mechanisms that generate feelings. Feelings require more than the presence of a motivational state. That state has to be consciously experienced in order to be consciously felt. This involves the integration of thoughts and long-term declarative memories with defensive state information in working memory.

Even if we never resolve the question of whether other animals have conscious feelings of fear or anxiety, progress on how threats create non-conscious defensive motive states in animals, and how such states can be regulated through drugs or behavioral treatments, could help many people. For one thing, simply turning down the degree of brain and body arousal associated with the motive state will alter the conscious experience of fear or anxiety. But also, successful regulation of the motive state reduces the sensitivity to trigger stimuli and also tones down the heightened reactivity to such triggers that occur in anxiety disorders.

Darwin was right that we have inherited hard-wired circuits from our animal ancestors. These are survival circuits. Their job is to detect significant situations and control behaviors that keep us alive in the face of challenges and that also help us thrive in the presence of opportunities. But Darwin was wrong that we inherited emotional states of mind, such as feelings of fear, from other animals.[57] Survival circuits in subcortical brains are not inherited storehouses of feelings. Feelings are parasitic on the capacity for conscious awareness – which crucially depends on cognitive processes related to attention and working memory – and made possible by cortical circuits.

To understand how the brain makes feelings, consider an analogy to cooking soup.[58] Salt, pepper, garlic, and water are common ingredients in many if not most soups. Put in chicken and it suddenly by definition becomes chicken soup. The amount of salt and pepper can intensify the taste without radically changing the nature of the soup. You can add other ingredients, like celery, turnips, or tomatoes, and still have a variant of chicken soup. Add roux and it becomes gumbo, while curry paste pushes it in a different direction. Substitute shrimp for chicken in any variant and the character again changes. None of these are soup ingredients per se; they are things that exist independent of soup, and that would exist if a soup had never been made. Similarly, emotional feelings emerge from non-emotional ingredients. Specifically, they emerge from the coalescing of non-emotional ingredients in consciousness.[59] The particular ingredients, and the amounts of each, define the character of the feeling. The pot in which feelings cook is working memory.

A defensive motive state provides many of the key ingredients in fear: direct input from the amygdala to cortical areas, brain arousal, body feedback, and initiation of goal-directed behavior.[60] When information about these various activities and their particular neurally encoded characteristics coalesce in working memory via attentional control, together with information about the external stimulus and long-term memories about what that stimulus means, then the resulting feeling that emerges is some variant of fear. Whether we feel concerned, scared, terrified, alarmed, or panicked depends on the particular characteristics of the internal factors aroused in the brain, factors from the body, and information about the stimulus and its context. In the presence of these neural ingredients, feelings emerge in consciousness similarly to the way the essence of a soup emerges from its ingredients.

Motive states are created from general-purpose mechanisms (such as sensation, memory, arousal, body feedback, and memories and thoughts) but the resulting state is specific to the motivational demands of the moment. A defensive motive state is different from a reproductive (sexual) motive state. And even within a category, the nature of the motive state can vary considerably depending on the circumstances – as can the resultant feeling (for example, consider concern versus fear versus panic).

Emotions resulting from non-conscious motive states emerge in consciousness in a bottom-up fashion, but emotions can also be built from cognitive processes in a top-down fashion without the involvement of motive state ingredients. So-called social emotions are like this (for example, feelings of compassion, pride, and shame). These arise from our assessment of our circumstances.[61] While fear is a prototypical bottom-up emotion, it can also arise from top-down influences. We can think our way into fear and activate a defensive motive state this way. Additionally, we can have intellectual fears, such as the fear of failing in life, of our eventual death, or of alien abduction, that depend on top-down processes rather than simply emerging bottom-up from a motive state as a result of external stimuli.

The enormous complexity of the various conscious manifestations of fear in an individual suggests that there is no one thing that the term *fear* refers to, and there is certainly no "fear module" in the brain that is responsible for all of the states to which we apply the label "fear."[62] Fear, the conscious feeling of being afraid, is what happens when we are aware that certain ingredients have come together to compel a certain interpretation of the state we are in.[63] Anxiety, that sense of worry or apprehension one has when dwelling on the past and/or anticipating the future, is a variation on this theme.

In order to understand feelings like fear, anger, sadness, and joy, we first have to understand how non-conscious, non-emotional ingredients are assembled in consciousness. While consciousness is a hard problem,[64] we do not have to wait on its solution to make progress. There is much to be learned about the non-emotional, non-conscious ingredients that contribute to conscious feelings. Because these are shared to some extent by humans and other animals, we can study the processes across species regardless of whether the species in question have the capacity to be conscious that these states are occurring. The question of whether other animals have feelings is thus reducible to the question of whether they have mechanisms that allow them to be conscious of their own brain states. While we may never answer this question, we have much to learn about human feelings from studies of their non-conscious underpinnings in the brains of humans and animals alike.

ENDNOTES

1 Rene Descartes, *Principia Philosophiae* (Amsterdam: Louis Elzevir, 1644). Available in translation in the public domain at http://www.gutenberg.org/ebooks/4391.

2 Herman Melville, *Moby Dick* (New York: Penguin, 1930).

3 Beth A. Dixon, "Animal Emotion," *Ethics & the Environment* 6 (2001): 22–30.

4 Charles Darwin, *The Expression of the Emotions in Man and Animals* (London: Fontana Press, 1872).

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