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Are LeDoux's survival circuits basic emotions under a different name?

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In his early work, LeDoux distinguished between implicit emotions (defined as motive states) and explicit emotions (defined as states of consciousness). He has recently suggested that emotion terms like "anger" and "fear" should only be taken to refer to feelings, and that motive states are better captured by a new theory of survival circuits. In this commentary, I reject this proposal, and articulate a New Basic Emotion Theory (BET) which suggests that emotion terms should only be taken to refer to motive states, which may or may not involve feelings. Despite these differences, I will argue that there are significant similarities between LeDoux's theory of survival circuits and my own New BET.

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Historically, theories of emotions have tried to define emotions with one of three features: how the emotions feel, how the emotions construe/cognize the world, and how the emotions motivate action. Theories that primarily emphasize the first aspect belong to the Feeling Tradition, theories that primarily emphasize the second belong to the Cognitivist Tradition and theories that primarily emphasize the third belong to the Motivational Tradition [1]. In recent times, I have defended an updated version of Basic Emotion Theory — the New BET — which falls squarely within the motivational camp and emphasizes that basic emotions are not necessarily felt ([2,3,4•,5]; see also [6,7•]). LeDoux [8,9,10••], whose work has long been seen as supportive of BET, has instead recommended that we hand out the motivational aspects of (some) basic emotions to a theory of survival circuits, and identify emotions with feelings exclusively [11].

Although these may seem radically incompatible proposals, there is more agreement between them than meets the eye. This commentary highlights some areas of agreement, diagnoses what underlies the outstanding disagreements, and makes the case that the commonsensical identification of emotions with feelings is not a good reason to define emotions as feelings in scientific inquiry.

My project begins with dissatisfaction with traditional BET, the theory outlined in Ekman's seminal writings [12,13]. Other variants of BET are quite similar to the version I have developed (e.g. [14]), but they have yet to gain the traction they deserve. By speaking of a *New* BET, I aim to emphasize not so much the novelty of my account as some features of basic emotions that have been denied or neglected in previous iterations of BET, in the hope that they will occupy center stage moving forward.

Ekman [12] understood emotions like anger, fear, happiness, sadness, surprise, and disgust as *affect programs* selected to solve recurrent evolutionary problems, where an affect program is a causally powerful latent variable that mediates between stimuli and responses. The challenges include things like '[f]ighting, falling in love, escaping predators, confronting sexual infidelity, experiencing a failure-driven loss in status, responding to the death of a family member' ([15], 117).

An important assumption of traditional BET is that affect programs are *input-open* and *output-closed* programs: although learning can affect which stimuli activate the program through an appraisal process, the output of the program is relatively inflexible (see [16] on closed behavior programs). As Ekman and Cordaro ([17], 366) put it, once an affect program is up and running, a 'cascade of changes (without our choice or immediate awareness) occurs in split seconds in: the emotional signals in the face and voice; preset actions; learned actions; the autonomic nervous system activity that regulates our body'.

On this view, the job of an affect program is to match evolutionary challenges with automatic responses that constitute an effective strategy to cope with them. This is not to say that Ekman thinks of basic emotions as reflexes. He is clear that they are *not* reflexes, in part because he takes reflexes to be easy to elicit and reliably shown, whereas basic emotions are elicited by appraisals that differ from person to person [18].

But Ekman's characterization of basic emotions makes their mode of operation *reflex-like*: once activated, affect programs lead to a mandatory cascade of responses. From

this follows the central empirical hypothesis of traditional BET: there should be bodily signatures for each basic emotion consisting of highly correlated and emotion-specific changes at the level of facial expressions, autonomic changes and preset and learned actions.

The problem is that high correlations and specificities have not been demonstrated empirically with respect to anger, fear, happiness, sadness, surprise, and disgust [19–21]. What to do then? Constructionists have proposed abandoning entirely the 'latent variable' model distinctive of BET, replacing it with an 'emergent variable' model according to which emotions do not cause facial expressions, autonomic changes and preset and learned actions but rather emerge from them. For instance, on Barrett's [22•,61] version of constructionism, which combines themes from psychological constructionism, social constructionism and predictive coding models in neuroscience, the emergence of emotions results from acts of categorization of an underlying state of core affect.

I have proposed instead a 'probabilistic latent variable' model that preserves the 'hard core' of basic emotion theory while modifying its 'protective belt' of auxiliary assumptions [3,23]. The hard core of BET, that is, the set of non-negotiable assumptions of the research program, includes first and foremost the assumption that basic emotions are evolutionary adaptations to a specific set of evolutionary challenges in the form of pan-cultural affect programs with homologs in other species (see also [24,25]).

Two auxiliary hypotheses the New BET modifies concern the *terminology* used to designate affect programs and their *mode of operation*. Traditional BET labels basic emotions with folk psychological categories. Using these categories without qualification entitles BET's opponents to find counterexamples by gathering data about anything to which the folk psychological categories apply — that is, anything we call anger, fear, happiness, sadness, disgust, surprise in ordinary English and are able to elicit within the narrow confines of a lab.

What I take the empirical data to have revealed so far is that folk emotion categories contain instances that are massively variable with respect to facial movements, autonomic changes, and preset and learned actions (for the latest on bodily signatures, see [26–33]). This variability is what we should expect with respect to categories like anger, fear, happiness and so on, because such categories were not introduced into the language to carve nature at its joints, but rather to negotiate social transactions among language users. If folk emotion categories happened to carve nature at its joints without having been introduced for that purpose, this would be an unlikely and happy coincidence.

Although we could continue looking for bodily signatures with ever more sophisticated means of detection, I believe the time has come for concluding that the unlikely coincidence we were looking for has not materialized. Folk emotion categories do not designate natural kinds: their extensions are too heterogenous for any scientifically interesting generalizations to be true of all of their members [19,20,34,35].

But just as the fact that the folk psychological category of memory is not theoretically homogeneous [36] is compatible with the existence of a plurality of theoretically homogeneous kinds of memory, so the fact that the folk psychological categories of anger, fear and so on are not theoretically homogeneous is compatible with the existence of a plurality of theoretically homogeneous kinds of anger, kinds of fear, and so on. My central suggestion is that BET is understood from here on as a theory aiming to capture precisely what one of these more homogeneous kinds of emotions looks like.

What I propose, then, is a shift of methodological perspective. The New BET explicitly engages in a process of *explication* of folk emotion categories, aiming to transform them into narrower categories whose members, unlike the members of the original folk emotion categories, can be embedded in scientifically interesting generalizations [37]. I label these narrower categories as *basic* anger, *basic* fear, *basic* happiness, *basic* sadness, *basic* disgust, *basic* surprise, and so on, to emphasize that I am defining sub-types of anger, fear, happiness and so on, rather than the broader folk psychological categories. This is exactly what theorists of memory have done after realizing that memory as commonsensically understood encompasses diverse sub-systems, which they have referred to as *short-term* memory, *long-term* memory, etc. and investigated independently of one another.

Critics of BET will need to update their critical strategies too. If BET theorists are in the business of explicating folk emotion categories, criticizing them in light of empirical data about folk emotion categories no longer cuts it. A critique of a theory of basic fear based on data about fear writ large is like a critique of a theory of short-term memory based on empirical data about memory writ large: if such data pertain to, say, long-term memory, they are not relevant.

This being said, not everything goes in a project of scientific explication. An explication may be criticized on two main fronts [37]: because the explicated category is not similar enough to the folk category it transforms (similarity problem) and because the explicated category is not theoretically fruitful (fruitfulness problem), in the sense that no scientifically interesting generalizations apply to all of its members.

The fact that folk emotion categories are populated by instances that are highly variable in their physical features does not speak to either the similarity problem or the fruitfulness problem: what matters is whether the instances that *do* meet the *explicative definition* of basic emotion are similar enough to emotions as folk psychologically understood and, most importantly, whether they can be embedded in generalizations that are scientifically interesting for the purposes of scientific psychology and neuroscience. I have argued elsewhere that both things are true of the explicative definition of basic emotions, which is similar enough to the folk category of emotion to count as explicating it, and which individuates a fruitful scientific concept ([3]; see also [38•]).

LeDoux [9,10••] has made a different terminological choice, proposing that we use neologisms — defense survival circuit, thermoregulation survival circuit, feeding survival circuit, etc. — to designate those subcortical motivational mechanisms that have emerged as solutions to recurrent evolutionary challenges (with a broader set of challenges than basic emotion theorists have envisioned). In addition, LeDoux has suggested that we retain folk psychological terms like anger, fear, happiness, sadness, disgust, surprise and so on for the exclusive designation of feelings.

LeDoux's proposal is that feelings are 'cognitively-based experiences', namely experiences that result from the engagement of cortical circuits that contribute to working memory and related higher cognitive functions. Such experiences have a many-to-many mapping with survival circuits. A feeling of fear may emerge when the defense circuit is active, as when we feel fear of a bear, but also when the thermoregulation circuit is active, as when we feel fear of freezing to death, or when no survival circuit is active, as when we fear that a certain politician will win the elections [10••].

What we have here are two alternative labeling strategies with a common purpose: keeping separate the *motivational notion* of a behavioral program from the *experiential notion* of a feeling. Although some basic emotion theorists like Panksepp [39] have argued that the same circuits responsible for organizing adaptive responses to evolutionary challenges are responsible for the feelings with which basic emotions are associated, I agree with LeDoux that adaptive behaviors and feelings are implemented by different circuits.

But whereas LeDoux refers to subcortical motivational mechanisms as 'survival circuits' (e.g. the defense circuit), reserving folk emotion terms like 'fear' solely for the designation of cortically implemented feelings, I refer to the subcortical motivational mechanisms as 'basic emotions' (e.g. basic fear), and understand feelings as feelings *of* a specific emotion (e.g. feelings *of* fear, which include feelings *of* basic fear and feelings *of* other types of fear the New BET has nothing to say about). On my view, the activation of a basic affect program does not necessarily involve the generation of any feeling. This allows us to ascribe basic emotions to infants and non-human animals even in the absence of agreed upon dependent measures for studying feelings in creatures without language (but see [39,40]).

Under what circumstances do feelings emerge? Like LeDoux, I am sympathetic to higher order (HO) theories of consciousness, which hold that any given mental state manifests itself in consciousness when such state is the target of another higher-order representation in the form of either a perception (Higher-Order Perception or HOP theories; e.g. [41]) or a thought about such state (Higher-Order Thought or HOT theories; e.g. [42]). I remain neutral on whether the higher-order representation must be occurrent or merely dispositional (see [43] for discussion). I am also attracted by the idea LeDoux and Brown [44••] have defended that the higher order representations required for consciousness are cortically implemented by so-called general networks of cognition, which involve regions in the prefrontal cortex, posterior parietal cortex, and insular cortex that underlie attention, working memory, and metacognition.

To sum up, I understand subcortically implemented basic emotions as motivational mechanisms for the production of adaptive behavior which become phenomenologically conscious when cortically powered higher order mental states make them the target of a representation. It follows that conscious basic emotions involve two distinct mental states: a basic emotion and a higher order mental state whose content is that one is having a basic emotion. A basic emotion which is not the target of a higher order mental state remains unconscious, but it continues to motivate behavior.

The second auxiliary assumption the New BET modifies, taking a further step away from traditional BET, concerns the *mode of operation* of basic affect programs. As I mentioned earlier, Ekman allowed basic emotions to be elicited by an open range of stimuli, but he also assumed that, once activated, a basic emotion program produces a mandatory set of responses at the level of facial expressions, autonomic changes and preset and learned actions. This is what led to the decades-long search for the bodily signatures of basic emotions.

This hypothesis, however, never made much evolutionary sense to begin with, because in order to solve abstractly defined evolutionary problems like dealing with dangers or slights, basic emotions cannot afford to produce anything more than impulses to behavior that are flexibly adaptable to the specific circumstances of elicitation, with rare exceptions in correspondence of elicitors

which demand instantaneous responses (e.g. suddenly looming objects for basic fear). Consequently, the New BET proposes that basic emotions are *input-output open* affect programs that bring about prioritized action tendencies in response to life challenges in ways that allow for learning to affect both what activates the program (input) and what responses the program brings about (output). This proposal merges Ekman's [12] insights about basic emotions as evolutionary adaptations with Frijda's [45] insights about emotions as action tendencies with control precedence.

Importantly, the New BET conceives of basic emotions in an *anti-essentialist* way, assimilating them with what Boyd [46] has characterized as *homeostatic property cluster* (HPC) *kinds*. Unlike essentialist kinds, which 'must possess definitional essences that define them in terms of necessary and sufficient, intrinsic, unchanging, ahistorical properties' ([46], 146), HPC kinds are defined by clusters of relational, changing and historical properties that co-occur in an important number of cases due to a multiplicity of imperfect homeostatic mechanisms and that can be featured in theoretically interesting generalizations on account of this co-occurrence. As Boyd has persuasively argued, these are the only types of natural kinds we are likely to find in the special sciences, where it is commonplace to have multiple combinations of properties sufficient for being a natural kind member, and no properties necessary for kind membership (e.g. the natural kind *species* in biology).

I offer basic emotions as good examples of HPC kinds which lack essences and fixed boundaries, show massive internal variability due to the need of adapting responses to changing circumstances, lack one-to-one mappings with any folk psychological categories, but nevertheless carve nature at its joints in the sense that they are instantiated by clusters of theoretically important properties that co-occur on account of underlying causal mechanisms (affect programs).

An additional area of agreement between LeDoux's theory of survival circuits and my New BET concerns the role we both give to cortical regulation in making survival circuits and basic affect programs evolutionary adaptive. In order to provide an efficient solution to an evolutionary problem like, say, defense from threats, it is vital that the subcortical mechanisms in charge of what LeDoux calls the *defense system* and what I call *basic fear* interact with cortical 'cognitive control circuits' with a regulative function [47]. This will lead to instrumental — rather than reactive — defensive behaviors that offer an optimal compromise between speed and flexibility in dealing with threats.

In effect, LeDoux and I interpret survival circuits/basic affect programs as *special-purpose* mechanisms that reflexively generate a 'global motive state' — instantiated by changes in preparatory physiology and brain arousal — while leaving it up to a *general-purpose* cognitive system to produce adaptation to the circumstances, thereby instantiating the two-level control structure typical of many complex animal behaviors [48]. As LeDoux ([8], 2875) puts it, '[a] notable consequence of activating a survival circuit is that a global (body-wide) state emerges in the organism', which he labels the 'defensive organismic state' in the case of threats. We both agree that such global motive state does not necessarily involve a subjective feeling, and that it can be associated with a wide variety of instrumental defensive behaviors that go well beyond automatically triggered reactive responses, although LeDoux is more tentative than I am in granting the defensive organismic state causal powers over behavior.

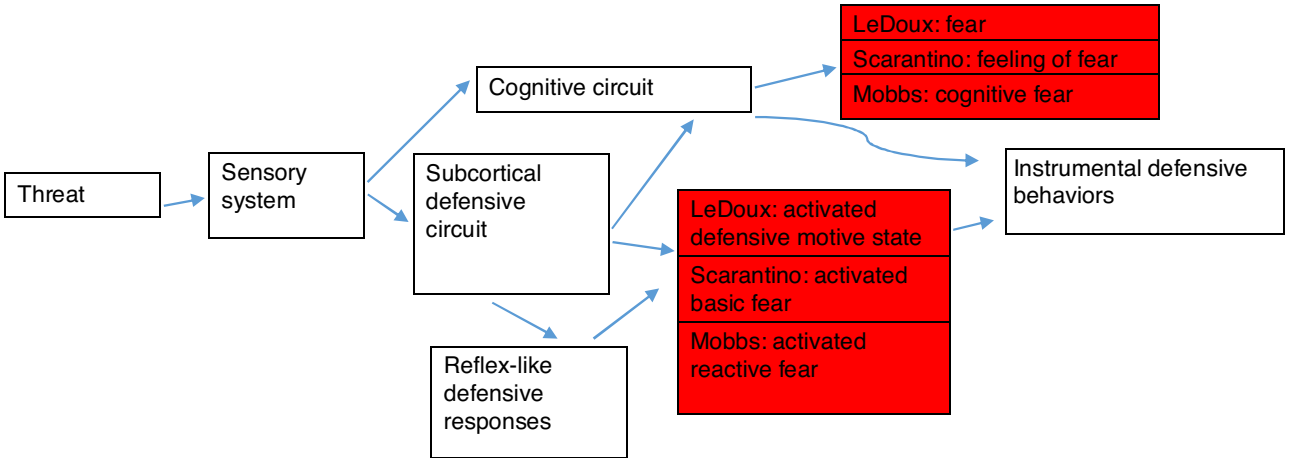
The taxonomy I offer has interesting points of contact with Mobbs [49] distinction between *reactive* and *cognitive* fear, but also some differences. Unlike LeDoux, Mobbs is open to using the (qualified) term fear for the scientific designation of subcortical defensive circuits understood in behavioral terms. His proposal is to label what LeDoux calls the *defense circuit* and what I call *basic fear* as *reactive fear*, understood as a type of fear that automatically produces reflex-like defensive behaviors such as freezing or fight-or-flight, the sorts of behaviors observed across species when predators attack (Fanselow and Lester [50] refer to these as *circa-strike* defense behaviors).

Mobbs [49] distinguishes *reactive fear* from *cognitive fear*, and defines the latter using two primary criteria: cognitive fear involves a feeling, and it emerges when the agent has time to 'organize and strategize escape' with respect to an imminent threat (if the threat is merely potential or actual but non-imminent, the resulting coping mechanism is what Mobbs calls *anxiety*). I continue to think that we should not mix phenomenological and motivational dimensions, so I propose we distinguish between the *motivational state* in which escape is being strategized and the *experiential state* corresponding to having a feeling connected to strategizing escape. I call the former the *interplay between basic fear and cognitive regulation*, and I call the latter the *feeling of fear*.

I note that the feeling of fear can in principle emerge also in association with reactive fear, as long as reactive fear is made the target of a higher-order representation. The difference that matters for my taxonomy is only the second one Mobbs [49] focuses on, namely the one between circuits responsible for reflex-like behaviors and circuits responsible for the cognitive regulation of the global organismic state that emerges jointly with reactive fear. On this revised understanding, what Mobbs [49] calls cognitive fear simply corresponds to the activation of a global 'defensive organismic state' whose

purpose is to strategize about escape. It is true that this phase of cognitive regulation will often involve feelings of fear, but there is no good reason in my view to make this definitionally true of cognitive fear.

The following chart recapitulates the major commonalities between LeDoux's model, Mobbs' model and my model, using defense as an example, and highlighting in red the terminological differences I have just discussed:



To sum up, LeDoux thinks of fear as being necessarily felt, Mobbs thinks of cognitive fear as being necessarily felt (but not so of reactive fear), and I think of basic fear in purely motivational terms (basic fear may or may not be felt), but we are very much in agreement when it comes to our understanding of the mode of operation of evolved threat avoidance systems, and specifically of the interplay between reflexive and instrumental defensive responses.

One may be tempted to conclude that (some) survival circuits are nothing other than basic emotions under a different name, but this would be too hasty. There is a substantive disagreement that drives the different terminological choices LeDoux and I have made. On LeDoux's view, the central task for a scientific theory of emotions is to explain how feelings come about. On my view, the central task for a scientific theory of emotions is to explain how emotions motivate behavior. LeDoux used to believe that a theory of emotions should be able to explain both feelings and motivation. In his early work, he distinguished between *implicit emotions* (defined as motive states) and *explicit emotions* (defined as states of consciousness) [51,52].

He recently concluded that the implicit-explicit distinction, although viable in memory science and other areas of cognitive science, is confusing when used in the affective sciences. This is because the gravitational pull of common sense — which LeDoux assumes identifies emotions with feelings — is so strong that theoretical claims about implicit emotions will be conflated with theoretical claims about explicit emotions. As LeDoux puts it by way of example, 'although I consistently emphasized that the amygdala circuits operate nonconsciously, I was often described in both lay and scientific contexts as having shown how feelings of fear emerge from the amygdala' ([10••], 1).

I have three responses to this line of argument. The first is that common sense is all over the map when it comes to what folk emotion terms stand for. Although it is true that ordinary language users customarily describe emotions as feelings, a substantive portion of ordinary usages takes it for granted that emotions are motive states. Folk psychological explanations of behavior often rely on emotions — Maria slapped Lucas *because* she was angry, Tom shot the bear *because* he was afraid. In such explanations, emotions play the role of latent variables that cause behavior rather than states of consciousness.

My second response is that we should not let common sense drive any of the theoretical choices scientists make. This is why philosophers such as Quine [53] have argued that there are no conceptual truths in science: even the most cherished, commonsensical and intuitive of assumptions — for example, the Euclidean assumption that two parallels never meet — may have to be abandoned to increase our scientific understanding of natural phenomena — for example, our understanding of non-Euclidean space-time in Einstein's General Relativity.

Why should the affective sciences be the exception to this rule, and allow common sense to make the identification of emotions with feelings true *by definition*? LeDoux mentions the dangers of misunderstandings in 'lay and scientific contexts' if emotions are not defined as feelings. I do not think the avoidance of misunderstandings in lay contexts is enough of a payoff to justify the theoretical cost of letting common sense constrain what a scientific

definition of emotions should look like. I bet there was quite a bit of lay confusion when Pluto was demoted from the list of planets, but this is no reason for astronomers to reconsider the new Pluto-excluding definition of planet they issued in 2006.

This is not to say that there are no good arguments for assimilating emotions with feelings exclusively. After all, my own account presupposes that there are good arguments for assimilating emotions with motive states exclusively. My point is that none of such arguments should rely on common sense — other, scientifically driven reasons about the theoretical fruitfulness of one conceptual scheme over another need to carry the day.

Finally, LeDoux may be underestimating the extent to which defining emotions as feelings would foster, rather than avoid, misunderstandings in scientific contexts. This is because the majority of contemporary research programs in the affective sciences are moving away from the identification of emotions with feelings that has characterized the bulk of the history of emotion theory [1]. Basic emotion theorists — admittedly with a few exceptions — have tended to distinguish basic emotions from feelings. In Ekman's [12] writings, it is explicitly argued that feelings are not a 'sine qua non' characteristic of basic emotions.

Theorists influenced by the James–Lange theory of emotions as perceptions of bodily changes like Damasio have also drawn the emotion-feeling distinction, suggesting that emotions and feelings play different functions. An 'emotion is a collection of changes in body state connected to particular mental images' with the function of initiating automatic and stereotyped bodily responses, whereas a feeling is the 'experience of such changes in juxtaposition to the mental images that initiated the cycle' with the function of 'open[ing] the door for some measure of willful control of the automated emotions' ([54], 80).

Scherer [55], who is an appraisal theorist, has described subjective experience as just one of five components of emotions (the others being an appraisal component, an autonomic physiology component, an action tendency component, and a motor expression component), allowing emotions to be instantiated whenever three of these five components co-occur, from which it follows that some emotions will not involve feelings at all (see also [56,57,62]).

Psychological constructionists are arguably the most prone to identifying emotions with feelings, but several constructionist accounts allow for unfelt emotions. For example, Russell [19] has described emotion episodes as having core affect as one of their parts, where core affect is a neurophysiological state that is consciously accessible as a feeling. But Russell has emphasized that core affect need not be accessed as a feeling (it has to be accessible but not accessed) for an emotion episode to be instantiated.

The bottom line is that there is a real danger that affective scientists who read LeDoux's results about the involvement of cortical circuits in *fear* will translate them through their own conceptual scheme (e.g. [58–60]) and mistakenly conclude that LeDoux has shown that the motivational system which evolved to deal with dangers is cortically implemented. If I am right that affective scientists of many different theoretical persuasions are abandoning the identification of emotions with feelings, distinguishing between *basic fear* as a motivational state and the *feeling of fear* may be a more effective way to avoid misunderstandings in scientific contexts than reserving the term *fear* for the feeling exclusively.

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