

A Critical Role for "Affective Neuroscience" in Resolving What Is Basic About Basic Emotions

Jaak Panksepp
Bowling Green State University

Ortony and Turner (1990) asked "What's Basic About Basic Emotions," and they concluded "very little." They proceeded to advocate a "componential" or "mosaic" view of how emotional systems should be analyzed. Their thesis was flawed by their failure to consider the available neurobehavioral data. Genetically dictated brain systems that mediate affective-emotional processes do exist, even though there are bound to be semantic ambiguities in how we speak about these systems. This commentary summarizes key lines of evidence for coherently operating emotional systems in the brain and advocates the position that the issue of basic emotions can no longer be credibly discussed without adequate consideration of the relevant brain research in the area. The type of conceptual, logical analysis pursued by Ortony and Turner, in the absence of a thorough analysis of the available neurological data, is not an adequate basis for resolving what is basic about basic emotions.

That the experience-hypothesis, as ordinarily understood, is inadequate to account for emotional phenomena, will be sufficiently manifest. If possible, it is even more at fault in respect to the emotions than in respect to the cognitions. The doctrine maintained by some philosophers, that all the desires, all the sentiments, are generated by experiences of the individual, is so glaringly at variance with hosts of facts, that I cannot but wonder how any one should ever have entertained it.

—Herbert Spencer, *Principles of Psychology* (1855, p. 606)

Emotion is a term used for many different purposes. There is a popular view that emotions are inherently more complex and harder to understand than other aspects of human thought. I maintain that infantile emotions are comparatively simple in character and that the complexity of adult emotions results from accumulating networks of mutual exploitations. In adults, these networks eventually become indescribably complicated, but no more so than the networks of our adult intellectual structures.

—Marvin Minsky, *Society of Mind* (1987, p. 328)

The existing lists of basic emotions comprise a menagerie of strange and seemingly incompatible species of dubious evolutionary and epigenetic descent. Using a "top-down" cognitive approach, Ortony and Turner (1990) sought to demolish the empirically supported concept that basic emotions even exist at all. I would submit that they have fallen into the trap of advocating a focus on logical propositions in an area where actual findings and the conceptual frameworks derived from the facts should govern our thinking. Evolved systems of the brain do not follow the rules of propositional logic but only the dictates of enhanced survival and reproductive fitness. Such distal causes may be lost in a dim evolutionary past, but their end results remain engraved on the Rosetta Stone of functional brain anatomy. To determine what is basic about basic emotions we must,

above all else, seek to decipher the puzzle embedded within the brain substrates of emotionality. Many current problems in discussing the basic emotions arise from persistent attempts by theorists to define basic emotions simply with respect to behavioral, psychological, and logical attributes without inclusion of neural systems criteria. The brain evidence needs to be fully evaluated by those who seek to bring clarity to this troublesome area of inquiry. Because Ortony and Turner failed to deal substantively with the available neurobehavioral facts, they could not have accomplished the task they set for themselves—of examining the content of the proposition that *basic* emotions exist.

Ortony and Turner (1990) organized their viewpoint around two overriding issues: (a) whether there is any biological and psychological reality to the categorical notion that basic emotions exist, and (b) whether (or how) a few basic emotions might concatenate into the subjective variety of complex emotions. My aim here is to quarrel only with their conclusions on the first issue. The second cannot be credibly resolved without an adequate resolution of the first. Ortony and Turner used the obvious weaknesses associated with the second issue to convince readers that the empirical foundations for the first issue are equally weak. That is not the case.

My personal reading of the available facts (Panksepp, 1981b, 1982, 1986a, 1986c, 1989a, 1989b, 1989c), which is reasonably close to Gray's (1990), is that strong evidence exists already for at least four distinct executive systems for basic "blue-ribbon, grade A" emotions in the brain. I chose to call them *rage*, *fear*, *expectancy*, and *panic* systems. Although Ortony and Turner implied that these may merely be response systems as opposed to integrative systems, abundant data from human and animal brain interventions suggest the designated brain systems do, in fact, help instigate and mediate many aspects of emotionality, including affective experiences (for summary, see Panksepp, 1985, 1991). This is not to say that the systems are not extremely complex (with multiple neural components), but to argue that a

Correspondence concerning this article should be addressed to Jaak Panksepp, Department of Psychology, Bowling Green State University, Bowling Green, Ohio 43403.

key function of emotional command systems is to rapidly impose coherence on both neuropsychological and bodily functions. Regardless of the many conceptual controversies that still beset the field (e.g., the relevance of facial analysis), it seems essential to deal substantively (i.e., on the level of hard data) with the small number of emotional operating systems that are supported by brain research at the present time. This kind of evidence should be given special status in evaluating basic issues, because this controversy must ultimately be resolved through understanding of the underlying neurodynamic mechanisms.

Responses to the Specific Questions Raised by Ortony and Turner

Ortony and Turner (1990) challenged those of us who have interpreted the available data as congruent with the existence of basic emotional systems to answer four questions. I will respond briefly. First, they asked "What exactly do you mean" (p. 329) by a basic emotion? The psychobiological reply is simple—there appear to be a limited number of executive neural systems in the brain that instigate and orchestrate the various facets of a coherent set of emotive response (physiological, behavioral, and psychological). They do this through various input controls (including cognitive ones) and through hierarchical control over multiple output components. The data-based premise of my approach is that these executive circuits are not just response components but integrative systems that mediate the primal affective states that characterize the basic emotions. The hierarchical construction of these systems in the brain was guided by evolutionary reinforcement (i.e., selection), rather than by the experiences gained by an organism during a single life span. These systems generate a variety of unconditional psychobehavioral tendencies (which could be called *evolutionary operants*), such as offensive attack, flight, separation calls, rough-and-tumble play, and foraging-exploratory activities, which are accompanied by distinct affective feelings in humans, and probably also in other animals.

Although I believe there are other basic emotional systems (e.g., a play-joy system, a sexual craving or lust system, a maternal nurturance-acceptance system, and perhaps greed-possessiveness and dominance systems; Panksepp, 1989a, 1991) than the four mentioned already, they could not be addressed incisively (i.e., at a neuroempirical level) just a decade ago. Some can be now. Stipulating the existence of basic emotional systems without credible neuroscientific evidence is not a productive exercise, for psychobiologists at least. Thus, an important aspect of the psychobiological approach is that all taxonomies must remain open-ended until the brain is better understood. Also, it is axiomatic within the psychobiological approach that all functional neural systems are constituted of neurophysiological subcomponents, but the key issue from a functional perspective is whether the constituent components were intrinsically designed to operate in a coordinated fashion, as appears to be the case for the emotional systems that I have advocated as being basic. This view readily allows additional components of the nervous system to be recruited into the organizational coherence of genetically ordained systems through learning mechanisms. Thus, in addition to synchronizing various instinctual

tendencies, the basic emotional systems are special purpose learning systems. Such a perspective allows the various viewpoints (including categorical, componential, and probably social constructivist ones) to be integrated in such a way as to promote empirical resolution of outstanding issues rather than promoting sterile, polarized controversies.

Second, Ortony and Turner (1990, p. 329) asked "In what sense are you using the word 'basic'?" From a psychobiological perspective, a cogent answer is that the executive circuits for orchestrating certain affective neurodynamic responses are contained within the intrinsic organizational structures of the brain that emerge during the ontogenetic decoding of DNA. Several distinct types of brain systems surely mediate affective processes, and we will need to continue struggling with the refinement of categories, including a consideration of which systems represent evolutionary outgrowths of earlier, more primitive ones. I suggest criteria below that may be useful for identifying bona-fide "blue-ribbon/grade A" emotional systems. Further refinement of such neural definitions can help eliminate the confusions that will be endemic to the field as long as we restrict ourselves to a conceptual, logical level of analysis.

Ortony and Turner (1990) implied that for something to be deemed basic it is unreasonable to believe that it could emerge from other basic systems. I would argue, to the contrary, that from a realistic evolutionary perspective, it is to be expected that all of the basic emotional systems must have emerged from other preexisting brain functions—from older, preexisting components. For instance, my research program on separation distress (*panic*) was based on the premise that this emotional system emerged from evolutionarily preexisting ones that mediated the affective distress of pain (Panksepp, 1981a, 1986c; Panksepp, Herman, Villberg, Bishop, & DeEskinazi, 1980; Panksepp, Normansell, Herman, Bishop, & Crepeau, 1988; Panksepp, Siviy, & Normansell, 1985). Likewise, the dopamine based expectancy system that controls foraging and anticipatory psychomotor arousal is surely an evolutionary outgrowth of more ancient catecholamine systems, such as epinephrine, that originally mediated metabolic arousal (Panksepp, 1981b). By remaining at a surface conceptual level, we may be easily tempted by dubious arguments. For instance, to suggest that frustration is one antecedent of aggression makes fine causal sense (Ortony & Turner, 1990, p. 325), but to infer from this that frustration (a neuropsychological response requiring the computation of unfulfilled expectancies) is a more basic emotive process than rage is dubious from the standpoint of evolution. An earlier selective pressure for the evolution of rage systems may have been the advantage of having invigorated psychobehavioral responses to physical constraint, as would commonly occur in predator-prey encounters. The fact that a form of psychological constraint such as frustration would eventually access the same rage system is adaptively reasonable without postulating the primacy of frustration. Each emotional system has multiple inputs and outputs that evolved at different times. Thus, I believe the word *basic* would be better used merely to indicate that certain brain functions are genetically programmed, without concern for the momentary temporal causal issues that Ortony and Turner highlighted in the example above.

It should be remembered that great deal of basic evolutionary construction may have occurred quite recently in the highest reaches of certain emotional systems in the humanoid brain. For instance, if the common human feelings of shame, guilt, jealousy, and embarrassment arise from higher evolutionary elaborations of separation-distress circuitry, perhaps within frontal-cingulate areas of the brain, as suggested by MacLean (1985) and Panksepp (1989b), then those genetically ordained emotional tendencies could be deemed to be basic functions of the human brain. All this, of course, does not deny that a great deal of learning (and hence the epigenetic addition of idiosyncratic new components) can transpire within the random-access-type memory regions of the brain that are in reciprocal interaction with the various basic emotional system (Panksepp, 1986a, 1988, 1989b, 1989c, 1991).

Third, Ortony and Turner (1990, p. 329) asked "What would count as empirical evidence for or against your claim, and why?" The most powerful initial lines of evidence for the claim that there are basic emotional systems would be that one can elicit coherent emotive psychobehavioral response patterns in animals and corresponding emotional feelings in humans through artificial electrical and neurochemical stimulation of specific brain areas (Panksepp, 1982, 1985). Rather than following the unforgiving rule of computer programming—*garbage in, garbage out*—various brain systems yield behavioral and psychological coherence when electrical "garbage" is administered by indwelling electrodes in the neural trajectories of certain brain regions. These effects can be obtained in the absence of relevant past life experiences (Moran, Schwartz, & Blass, 1983; Roberts & Berquist, 1968), although they can be modulated by them (Valenstein, Cox, & Kakolewski, 1970). Of course, it is critical that the emotional inferences derived from animal neurobehavioral data be validated against human subjective experience, and this has been achieved to a substantial extent with electrical brain stimulation (see Panksepp, 1985, for summary). The fact that many fragmented visceral-affective components can also be evoked by such brain stimulation (e.g., Gloor, 1972) is not an argument against the existence of coherently operating executive systems for certain emotions.

At the present time, the search for neural causes for emotional change in humans can be most readily pursued with psychopharmacological maneuvers. For instance, brain opioids inhibit panic (i.e., separation distress) in animals (Panksepp et al., 1985, 1988), and comparable psychic changes occur in humans. In addition to modern evidence, in Book 4 of Homer's *Odyssey* (Fitzgerald, 1963), we share in a reunion of warriors who participated in the Trojan Wars. To Helen's dismay, thoughts and feelings of celebrants turn darkly to lost compatriots, and

A twinging ache of grief rose up in everyone . . .
But now it entered Helen's mind
to drop into the wine that they were drinking
an anodyne, mild magic of forgetfulness.
Whoever drank this mixture in the wine bowl
would be incapable of tears that day—
though he should lose mother and father both,
or see, with his own eyes, a son or brother
mauled by weapons of bronze at his own gate.

Ethnopharmacologists (e.g., Lewin, 1964) generally believe that Helen sustained the convivial spirits of the celebrants with tinc-

ture of opium. This is not the place to discuss the vast numbers of specific predictions that can be made for each basic emotive system, but merely to note that they flow naturally from existing theoretical structures (see Panksepp, 1981b, p. 362, for various predictions for the expectancy system). To the extent that such predictions do not hold true, various theoretical viewpoints can be disconfirmed and refined. One might reasonably expect Ortony and Turner to answer this same question from the theoretical perspective they have espoused. They have yet to do so.

Finally, Ortony and Turner (1990, p. 329) asked "What would you do with them if you had them?" Perhaps we would finally begin to understand, at a mechanistic level, some of the most important operating systems of the brain, and through that understanding we could potentially alleviate various forms of human or animal suffering in very direct and powerful ways. Such an understanding would also take us much closer to answering philosophical questions concerning the fundamentally affective nature of mind than any previous construct has been able to do. Obviously, such an approach will only highlight general principles rather than the specifics of individual experiences. From the perspective of neuroscience, the taxonomic identification of emotional "primes" (Buck, 1985) is not an end point of inquiries, but only the beginning. Only by studying the details of the underlying brain substrates will we begin to provide substantive answers to such questions as what it means to be angry, to be scared, to be lonely, to be joyous, or to be carried away by desire. Neither a semantic-logical nor a behavioral analysis will ever accomplish this task. The theoretical position advocated by Ortony and Turner can make substantial contributions to this endeavor, but only in the descriptive analysis of the psychodynamics that appear to transpire in the highest reaches of emotion-cognition interactions in the human brain. It is hard to imagine how it might promote the clarification of the nature of existing emotional processes in the brain. Basic emotion theory allows us to proceed with a neurobiological analysis more effectively than any other approach yet proposed, and all higher levels of theorizing about emotional matters should (to the extent it is possible) be anchored by the perspectives offered by neuroscience. Conceptual logical analyses of subjective complexities in humans should not be used to challenge empirically grounded analyses of the basic brain functions that all mammals still share. Ortony and Turner came perilously close to that.

Expectancy as a Paradigmatic Case Study of a Primary Emotive System

Of the four basic emotional systems I have discussed previously (Panksepp, 1982), the *expectancy* system caused the most difficulty for Ortony and Turner (1990). They challenged the idea that this is an emotional system on the basis of the reasonable postulate that emotions have to be "affectively valenced states" and the debatable supposition that expectancies and interests are "not intrinsically valenced" (Ortony and Turner, 1990, p. 317). The necessity of an affective dimension is a fundamental and universal assumption on which all emotion theorists agree. However, Ortony and Turner seem to consider subjectively experienced affect, in conjunction with the more de-

batable and ambiguous attribute of appraisal, as sufficient criteria for identifying emotional processes. That, I believe, is quite inadequate. A more comprehensive general definition of emotion is essential. I would submit that neurological and behavioral criteria, such as those discussed below, provide a new and useful perspective for discussing the nature of emotional systems. I can logically appreciate why Ortony and Turner advocated the view that expectancies can be affect free, but their analysis relied on one usage of the word rather than on the extensive database upon which the specialized psychobiological concept is based (Panksepp, 1981b, 1982, 1986a).

In my own theorizing, the expectancy command system was deemed to be confluent with the trans-dienccephalic self-stimulation system that arises from ventral tegmental areas, and projects through the medial forebrain bundle to the ventral striatum (nucleus accumbens) and various zones of the frontal cortex (Lieberman & Cooper, 1989; Stellar, 1990; White & Franklin, 1989; Wise & Rompre, 1989). Forty years of research on self-stimulation have demonstrated that the underlying circuitry is a positively valenced innate system of the brain that interacts strongly with cognitive structures. My theoretical contribution was to view this system as one that mediates anticipatory incentive processes (foraging-expectancy) rather than drive or consummatory-reward processes (e.g., Panksepp, 1981b, 1982, 1986a; Trowill, Panksepp, & Gandelman, 1969). This conception is congruent with other modern conceptions of the function of this circuitry, such as the Behavioral Activation System of Gray (1987, 1990) and Behavioral Facilitation System of Depue and Iacono (1989).

The discussion of this emotive system becomes more straightforward when such empirical issues are brought to the forefront. I must inquire how Ortony and Turner would theorize about such a well-established affectively valenced neural system of the brain (as well as the other emotive circuits)? Are they really mere response components from which emotions are created, or are they the very wellsprings of emotionality? The evidence strongly suggests the latter for all of the emotional systems I have discussed. It is easy to envision how a vast complexity of emotional experience could emerge from the diversity of interactions between such brain systems and real world happenings (Panksepp, 1986a, 1988). However, I think it would be a mistake to believe that those derivative experiential constructions constitute the essential structure of emotionality, as Ortony and Turner (1990) seemed to imply.

In the future, neural criteria may be especially useful in our attempts to more rigorously define the basic emotions (and hence to help us objectively distinguish basic emotional systems from other basic affective processes of the brain). In addition to the affective valence criterion, I have advocated six neural criteria (Panksepp 1982, 1986a). For didactic purposes, I will discuss them in the context of the troublesome foraging-expectancy system.

1. *The underlying circuits are genetically prewired and designed to respond unconditionally to stimuli arising from major life-challenging circumstances.* This self-stimulation system is affectively competent and capable of controlling behavior in the neonatal rat (Moran et al., 1983). If the trajectory of this system is damaged at an early age, animals are unlikely to survive (Almlie & Golden, 1974). The system also continues to

operate quite effectively in adult animals even though most of their higher cognitive mechanisms have been surgically removed (Huston & Borbely, 1973).

2. *The circuits organize diverse behaviors by activating or inhibiting motor subroutines (and concurrent autonomic-hormonal changes) that have proved adaptive in the face of life-challenging circumstances during the evolutionary history of the species.* The mesolimbic-cortical dopamine circuits, which are deemed to lie at the heart of this system, promote a large number of motivated goal-seeking behaviors (Valenstein et al., 1970). If the system is damaged, a generalized behavioral inertia results (Stricker & Zigmond, 1976), and if the system is stimulated, either pharmacologically or electrically, then a large number of appetitive behaviors and a variety of physiological changes are invigorated (Valenstein et al., 1970; White & Franklin, 1989).

3. *Emotive circuits change the sensitivities of sensory systems relevant for the behavior sequences that have been aroused.* Electrically induced arousal of this system leads to more effective cortical processing, and the effect is restricted to the ipsilateral cerebral hemisphere (Beagley & Holley, 1977). Such stimulation also metabolically arouses broad areas on the ipsilateral side of the brain, including certain cortical areas (Roberts, 1980).

4. *Neural activity of emotive systems outlasts the precipitating circumstances.* It has long been known that the behavioral arousal induced by rewarding brain stimulation outlasts the stimulation. The original drive-decay theory of self-stimulation (Deutsch, 1963) and the priming effects that are commonly induced by activating this circuit (Gallistel, 1969) are premised on the fact that the neural system sustains activity for some time beyond the point of stimulation offset. Many neuropeptides that control emotionality can sustain neural changes for hours following administration into the brain (and hence presumably during release within the brain) (Panksepp, 1986b, 1990c).

5. *Emotive circuits can come under the conditional control of emotionally neutral environmental stimuli.* The self-stimulation-expectancy substrates of the brain exhibit spontaneous learning, as reflected by single cell activity during simple forms of appetitive conditioning (Olds, 1973) and in the spontaneous shaping of unconditional response systems, such as anticipatory sniffing, during systematically administered brain stimulation (for review, see Panksepp, 1981b). Recent evidence indicates that ventral tegmental dopamine cells exhibit anticipatory learning during appetitive conditioning (Schultz & Romo, 1990). Similarly, the meso-limbic dopamine system exhibits vigorous release of dopamine during the anticipatory phase of behavior during appetitive conditioning (Phillips, Blaha, & Fibiger, 1989). Whether the system also responds to the anticipation of aversive events remains unknown. The present theory predicts that this will not be the case, at least not to the extent observed in appetitive conditioning. In this context, it is also noteworthy that the synaptic interactions that mediate learning in the amygdalofugal "fear" system (Panksepp, 1990b) have now been elegantly characterized (LeDoux, Ruggiero, & Reis, 1985; LeDoux, Sakaguchi, & Reis, 1984).

6. *Emotive circuits have reciprocal interactions with brain mechanisms that elaborate higher decision-making processes and consciousness.* Perhaps the most vividly documented evidence for this are the life stories of the Parkinsonian patients

described by Oliver Sacks in *Awakenings* (1973). Just to mention one example of how L-DOPA, the metabolic precursor of dopamine that restores brain catecholamine activity, can induce affective vibrancy in one's dealings with the world, consider the case of Leonard L describing his initial experiences on L-DOPA:

'I feel saved,' he would say, 'resurrected, reborn. I feel a sense of health amounting to Grace. . . . I feel like a man in love. I have broken through the barriers which cut me off from love.' The predominant feelings at this time were feelings of freedom, openness and exchange with the world; of a lyrical appreciation of a real world, undistorted by fantasy, and suddenly revealed; of delight and satiety with self and the world.' (p. 193)

Although tragic tribulations typically followed such initial experiences (as excessive psychomotor arousal was induced), the power of dopamine to fire a positively felt, interest-filled engagement with the world was apparent initially in most patients placed on L-DOPA. The psychic attractions of cocaine and other psychostimulants (and perhaps opiates) emerge largely from the ability of certain molecules to arouse this fundamental emotional system of the brain (Wise & Rompre, 1989). One might also note that the affective expression of interest is quite obvious in newborn humans. In the face of such evidence, the supposition that the expectancy system is not affectively valenced appears most questionable.

Similar types of evidence could be listed for various other basic emotive systems, but not for the large list of affect-laden items such as surprise, disgust, and hunger, which continue to engender controversy in basic emotion theory. Because many items that generate affective feelings do not appear to fulfill the neural criteria enunciated above, I have chosen not to consider them as reflections of bona-fide "blue-ribbon, grade A" emotional systems. This, of course, neither denies their affective reality, nor their basic nature in the brain. They simply belong in a different category. This is not the place to detail the evidence for the four emotional systems that have been provisionally characterized in the brain, but I would mention that recent data related to the rage system is best summarized by Bandler (1988) and Siegel and Brutus (1990); a detailed analysis of fear has been provided by Gray (1987), Panksepp (1990b), and Panksepp, Sacks, Crepeau, and Abbott (1991); expectancy by Panksepp (1981b, 1986a); and separation-distress-panic, by Newman (1988), Panksepp, Siviy, and Normansell (1985), and Panksepp, Normansell, Herman, Bishop, and Crepeau (1988). Recent reviews concerning general issues about brain organization of emotionality can be found in Gainotti and Caltagirone (1989), LeDoux (1987), MacLean (1990), and Panksepp (1989b, 1989c, 1991). To properly evaluate the question "What is Basic about Basic Emotions?" these lines of evidence must be considered in some depth.

It should be emphasized that the taxonomic identification of the basic emotions explains nothing. It merely highlights the types of brain processes that are in dire need of explication. Only when that has been accomplished in detail will we be able to address the types of "mixed" emotions and other complexities that can emerge from the interplay of the basic systems. Surely, the number of possible ways the basic processes can be mixed, blended, and otherwise combined are vast, and one

rarely considered possibility is that much blending occurs in the nonaffective language realms of the brain where semiotic processing occurs. Because little of substance is known about such matters, it seems reasonable to postpone discussion of those issues until the nature of the basic systems is better clarified.

Emotional Systems as Hierarchically Organized Executive Operating Systems

If one envisions emotional command systems as resembling trees, with branches reaching into the higher cortices to interact with perceptual and cognitive processes, the trunk reflecting the ancient executive cores of the systems, and the roots reflecting connections to sensorimotor programming structures of the brainstem (e.g., Figure 3, Panksepp, 1982, p. 414), one can better understand why there is still so much sterile controversy in this field. If the trunks of the basic systems are organized at a relatively low level of the neuro-axis (i.e., at a preverbal, transdiencephalic level), but the systems ramify widely into higher structures that provide a more plastic cognitive resolution to experience (and in humans provide the grist for a multitude of verbal symbols), then one can generate a great deal of confusion concerning the nature of the basic systems by simply focusing on the complexity of the interacting branches. I think this is essentially the level of analysis at which Ortony and Turner (1990) remained in their article, but the lexical ambiguities should not blind us to the existence of trunk lines for certain primes in the ancient subcortical reaches of the mammalian brain. Labeling of these trunk lines will always be problematic, and that is the reason I have personally preferred to use multiple terminologies such as those mentioned by Ortony and Turner (p. 320). Contrary to their suggestion, my intent in employing such usages was not to weaken the conclusion that emotional primes exist, but instead to highlight the fact that no single verbal label can adequately delimit the many psychobehavioral functions in which they participate. They suggested that such systems may be part of the innate motor response components of various emotions, but in fact, the existing brain stimulation and lesion evidence strongly indicates that these subcortical circuits generate (in yet incompletely understood ways) the affective valence of emotional experiences in both humans and animals.

These basic emotional systems can probably participate, as essential ingredients, in a large variety of related affective concepts. Although componential and social constructivist perspectives can make substantial contributions at the highest branches of the emotional "tree" (e.g., Scherer, 1988), they cannot realistically deal with the basic "trunk-line" issues. It should be more widely appreciated that psychology simply cannot elucidate the nature of primal affective processes (or other primary brain processes) without a credible neural analysis (Bunge, 1990; Panksepp, 1990a). Accordingly, the analysis of the trunk-line issues should become biologized (Panksepp, 1991), and philosophically and psychologically oriented investigators should be encouraged to evaluate the evidence and formal nature of existing claims rather than assuming, as Ortony and Turner (1990) appear to do, that they can formulate credible

alternative accounts without a full consideration of the implications of the neurobiological evidence.

Human affective experience ultimately emerges from ancient neurosymbolic systems of the mammalian brain that unconditionally promote survival, and if psychology ever wishes to mature as a rigorous science, it must forcefully advocate the detailed neurobiological analysis of these brain operating systems that are common to all mammals. The categorical, componential, and social constructivist approaches need not battle over primacy issues. They work best in different domains of inquiry. The categorical approach can identify basic operating systems that exist in the brain, and the componential and constructivist approaches can provide schemata of how the genetically endowed systems develop their full resolution by interacting with the vast complexity of the real world. It is certain that all of these types of influences contribute to real-life emotional experiences, but if we do not fully consider the implications of the neuroscientific evidence (which has largely been obtained through the use of the categorical approach in appropriate animal models), how can the remaining approaches guide us to a rigorous understanding of how emotions are truly constructed in the human mind-brain?

References

- Almlie, C. R., & Golden, G. T. (1974). Infant rats: Effects of lateral hypothalamic destruction. *Physiology & Behavior*, 13, 81-90.
- Bandler, R. (1988). Brain mechanisms of aggression as revealed by electrical and chemical stimulation: Suggestion of a central role for the midbrain periaqueductal grey region. In A. N. Epstein & A. R. Morrison (Eds.), *Progress in psychobiology and physiological psychology* (Vol. 13, pp. 67-154). San Diego, CA: Academic Press.
- Beagley, W. K., & Holley, T. L. (1977). Hypothalamic stimulation facilitates contralateral visual control of a learned response. *Science*, 196, 321-322.
- Buck, R. (1985). Prime theory: An integrated view of motivation and emotion. *Psychological Review*, 92, 389-413.
- Bunge, M. (1990). What kind of discipline is psychology: Autonomous or dependent, humanistic or scientific, biological or sociological? *New Ideas in Psychology*, 8, 121-137.
- Depue, R. A., & Iacono, W. G. (1989). Neurobehavioral aspects of affective disorders. *Annual Review of Psychology*, 40, 457-492.
- Deutsch, J. A. (1963). Learning and electrical self-stimulation of the brain. *Journal of Theoretical Biology*, 4, 193-214.
- Fitzgerald, R. (Trans.). (1963). *Homer's The Odyssey*. New York: Doubleday.
- Gainotti, G., & Caltagirone, C. (Eds.). (1989). *Emotions and the dual brain*. Berlin: Springer-Verlag.
- Gallistel, C. R. (1969). Self-stimulation: Failure of pretrial stimulation to affect rats' electrode preference. *Journal of Comparative and Physiological Psychology*, 69, 722-729.
- Gloor, P. (1972). Temporal lobe epilepsy: Its possible contribution to the understanding of the functional significance of the amygdala and of its interaction with neocortical-temporal mechanisms. In B. Elefteriou (Ed.), *The neurobiology of the amygdala* (pp. 423-457). New York: Plenum Press.
- Gray, J. A. (1987). *The psychology of fear and stress* (2nd ed.). Cambridge, England: Cambridge University Press.
- Gray, J. A. (1990). Brain systems that mediate both emotion and cognition. *Cognition and Emotion*, 4, 270-288.
- Huston, J. P., & Borbely, A. A. (1973). Operant conditioning in forebrain ablated rats by use of rewarding hypothalamic stimulation. *Brain Research*, 50, 467-472.
- LeDoux, J. E. (1987). Emotion. In V. Mountcastle, F. Plum, & S. R. Geiger (Eds.), *Handbook of physiology, Section 1: The nervous system, Vol. V. Higher functions of the brain, Part 1* (pp. 419-459). Bethesda, MD: American Physiological Society.
- LeDoux, J. E., Ruggiero, D. A., & Reis, D. J. (1985). Projections to the subcortical forebrain from anatomically defined regions of the medial geniculate body in the rat. *Journal of Comparative Neurology*, 242, 182-213.
- LeDoux, J. E., Sakaguchi, A., & Reis, D. J. (1984). Subcortical efferent projections of the medial geniculate nucleus mediate emotional responses conditioned to acoustic stimuli. *Journal of Neuroscience*, 4, 683-698.
- Lewin, L. (1964). *Phantastica narcotic and stimulating drugs* (2nd ed.). London: Routledge & Kegan Paul.
- Liebman, J. M., & Cooper, S. J. (Eds.). (1989). *The neuropharmacological basis of reward*. Oxford, England: Clarendon Press.
- MacLean, P. D. (1985). Brain evolution relating to family, play and the separation call. *Archives of General Psychiatry*, 42, 405-417.
- MacLean, P. D. (1990). *The triune brain in evolution*. New York: Plenum Press.
- Minsky, M. (1987). *The society of mind*. New York: Simon & Schuster.
- Moran, T. H., Schwartz, G. J., & Blass, E. M. (1983). Organized behavioral responses to lateral hypothalamic electrical stimulation in infant rats. *Journal of Neuroscience*, 3, 10-19.
- Newman, J. D. (Ed.). (1988). *The physiological control of mammalian vocalizations*. New York: Plenum Press.
- Olds, M. E. (1973). Short-term changes in the firing pattern of hypothalamic neurons during Pavlovian conditioning. *Brain Research*, 58, 95-116.
- Ortony, A., & Turner, T. J. (1990). What's basic about basic emotions? *Psychological Review*, 97, 315-331.
- Panksepp, J. (1981a). Brain opioids: A neurochemical substrate for narcotic and social dependence. In S. Cooper (Ed.), *Progress in theory in psychopharmacology* (pp. 149-175). San Diego, CA: Academic Press.
- Panksepp, J. (1981b). Hypothalamic integration of behavior: Rewards, punishments, and related psychobiological process. In P. J. Morgane & J. Panksepp (Eds.), *Handbook of the hypothalamus: Vol. 3, Part A. Behavioral studies of the hypothalamus* (pp. 289-487). New York: Marcel Dekker.
- Panksepp, J. (1982). Toward a general psychobiological theory of emotions. *The Behavioral and Brain Sciences*, 5, 407-467.
- Panksepp, J. (1985). Mood changes: In P. J. Vinken, G. W. Bruyn, & H. L. Klawans (Eds.), *Handbook of clinical neurology, Vol. 1. (45). Clinical neuropsychology* (pp. 271-285) Amsterdam, Elsevier Science.
- Panksepp, J. (1986a). The anatomy of emotions. In R. Plutchik & H. Kellerman (Eds.), *Emotion: Theory, research and experience. Vol. 3: Biological foundations of emotions*. (pp. 91-124). San Diego, CA: Academic Press.
- Panksepp, J. (1986b). The neurochemistry of behavior. *Annual Review of Psychology*, 37, 77-107.
- Panksepp, J. (1986c). The psychobiology of prosocial behaviors: Separation distress, play, and altruism. In C. Zahn-Waxler, E. M. Cummings, & R. Iannotti (Eds.), *Altruism and aggression, biological and social origins* (pp. 19-57). Cambridge, England: Cambridge University Press.
- Panksepp, J. (1988). Brain emotional circuits and psychopathologies. In M. Clynes & J. Panksepp (Eds.), *Emotions and psychopathology* (pp. 37-76). New York: Plenum Press.
- Panksepp, J. (1989a). Les circuits des émotions [the circuits of emotions]. *Science & Vie*, 168, 58-67.

- Panksepp, J. (1989b). The neurobiology of emotions: Of animal brains and human feelings. In H. Wagner & T. Manstead (Eds.), *Handbook of social psychophysiology* (pp. 5–26). Chichester, England: Wiley.
- Panksepp, J. (1989c). The psychobiology of emotions: The animal side of human feelings. In G. Gainotti & C. Caltagirone (Eds.), *Experimental brain research, Series 18: Emotions and the dual brain* (pp. 31–55). Heidelberg, Federal Republic of Germany: Springer-Verlag.
- Panksepp, J. (1990a). Psychology's search of identity: Can "mind" and behavior be understood without understanding the brain? *New Ideas in Psychology*, 8, 139–149.
- Panksepp, J. (1990b). The psychoneurology of fear: Evolutionary perspectives and the role of animal models in understanding human anxiety. In R. Burrows (Ed.), *Handbook of anxiety* (Vol. 3, pp. 3–58). Amsterdam: Elsevier Science.
- Panksepp, J. (1990c). A role for affective neuroscience in understanding stress: The case of separation distress circuitry. In S. Puglisi-Allegra & A. Oliverio (Eds.), *Psychobiology of stress* (pp. 41–57). Dordrecht, The Netherlands: Kluwer.
- Panksepp, J. (1991). Affective neuroscience: A conceptual framework for the neurobiological study of emotions. In K. Strongman (Ed.), *International reviews of studies in emotions* (Vol. 1, pp. 59–99). New York: Wiley.
- Panksepp, J., Herman, B. H., Villberg, T., Bishop, P., & DeEskinazi, F. G. (1980). Endogenous opioids and social behavior. *Neuroscience & Biobehavioral Reviews*, 4, 473–487.
- Panksepp, J., Normansell, L., Herman, B., Bishop, P., & Crepeau, L. (1988). Neural and neurochemical control of the separation distress call. In J. D. Newman (Ed.), *The physiological control of mammalian vocalizations* (pp. 263–299). New York: Plenum Press.
- Panksepp, J., Sacks, D. S., Crepeau, L. J., & Abbott, B. B. (1991). The psycho- and neuro-biology of fear systems in the brain. In M. R. Denny (Ed.), *Aversive events and behavior* (pp. 7–59). Hillsdale, NJ: Erlbaum.
- Panksepp, J., Siviy, S. M., & Normansell, L. A. (1985). Brain opioids and social emotions. In M. Reite & T. Fields. (Eds.), *The psychobiology of attachment and separation* (pp. 3–49). San Diego, CA: Academic Press.
- Phillips, A. G., Blaha, C. D., & Fibiger, H. C. (1989). Neurochemical correlates of brain-stimulation reward measured by ex vivo and in vivo analyses. *Neuroscience & Biobehavioral Reviews*, 13, 99–104.
- Roberts, W. W. (1980). (^{14}C)deoxyglucose mapping of first-order projections activated by stimulation of lateral hypothalamic sites eliciting gnawing, eating, and drinking in rats. *Journal of Comparative Neurology*, 194, 617–638.
- Roberts, W. W., & Berquist, E. (1968). Attack elicited by hypothalamic stimulation in cats raised in social isolation. *Journal of Comparative and Physiological Psychology*, 66, 590–596.
- Sacks, O. (1973). *Awakenings*. New York: E. P. Dutton.
- Scherer, K. (1988). Criteria for emotion-antecedent appraisal: A review. In V. Hamilton, G. H. Bower, & N. H. Frijda (Eds.), *Cognitive perspectives on emotion and motivation* (pp. 295–317). Dordrecht, The Netherlands: Nijhoff.
- Schultz, W., & Romo, R. (1990). Dopamine neurons of the monkey midbrain: Contingencies of responses to stimuli eliciting immediate behavioral reactions. *Journal of Neurophysiology*, 63, 607–617.
- Siegel, A., & Brutus, M. (1990). Neural substrates of aggression and rage in the cat. In A. N. Epstein & A. R. Morrison (Eds.), *Progress in psychobiology and physiological psychology* (Vol. 14, pp. 135–234). San Diego, CA: Academic Press.
- Spencer, H. (1985). *Principles of psychology*. London: Longman, Brown, Green, & Longmans.
- Stellar, J. R. (1990). Investigating the neural circuitry of brain stimulation reward. In A. N. Epstein & A. R. Morrison (Eds.), *Progress in psychobiology and physiological psychology* (Vol. 14, pp. 235–294). San Diego, CA: Academic Press.
- Stricker, E. M., & Zigmond, M. J. (1976). Recovery of function after damage to central catecholamine-containing neurons: A neurochemical model for the lateral hypothalamic syndrome. In A. N. Epstein & A. R. Morrison (Eds.), *Progress in psychobiology and physiological psychology* (Vol. 6, pp. 121–188). San Diego, CA: Academic Press.
- Trowill, J. A., Panksepp, J., & Gandelman, R. (1969). An incentive model of rewarding brain stimulation. *Psychological Review*, 76, 264–281.
- Valenstein, E. S., Cox, V. C., & Kakolewski, J. W. (1970). Reexamination of the role of the hypothalamus in motivation. *Psychological Review*, 77, 16–31.
- White, N. M., & Franklin, K. B. J. (1989). The neural basis of reward and reinforcement: A conference in honour of Peter M. Milner [special issue]. *Neuroscience & Biobehavioral Reviews*, 13(1).
- Wise, R. A., & Rompre, P.-P. (1989). Brain dopamine and reward. *Annual Review of Psychology*, 40, 191–225.

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