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The Neuro-Evolutionary Cusp Between Emotions and Cognitions

Implications for Understanding Consciousness and the Emergence of a Unified Mind Science[1]

Abstract

The neurobiological systems that mediate the basic emotions are beginning to be understood. They appear to be constituted of genetically coded, but experientially refined executive circuits situated in subcortical areas of the brain which can coordinate the behavioral, physiological and psychological processes that need to be recruited to cope with a variety of survival need (i.e., they signal evolutionary fitness issues). These birthrights allow newborn organisms to begin navigating the complexities of the world and to learn about the values and contingencies of the environment. some of these systems have been identified and characterized using modern neuroscientific and psychobiological tools. The most fundamental emotional systems can now be defined by the functional psychobiological characteristics of the underlying circuitries—characteristics which help the organism coordinate behavioral, physiological and psychological aspects of emotionality, including the valenced affective feeling states that provide fundamental values for the guidance of behavior. The various emotional circuits are coordinated by different neuropeptides, and the arousal of each system may generate distinct affective/neurodynamic states and imbalances may lead to various psychiatric disorders. The aim of this essay is to discuss the underlying conceptual issues that must be addressed for additional progress in understanding the nature of primary process affective consciousness.

Key words

Brain, emotions, consciousness, affect, cognition, emotional disorders, neuropeptides, psychiatric implications.

Concepts without factual content are empty; sense-data without concepts are blind. The senses cannot think, The understanding cannot see. By their union only can knowledge be produced.—Immanuel KANT, *The Critique of Pure Reason*

SUSANNE LANGER (1951) in contemplating the status of emotional processes in her own time, worried that everything that falls outside of the domain of analytic, propositional, and formal thought is merely classed "*as emotive, irrational, and animalian… All other things our minds do are dismissed as irrelevant to intellectual progress: they are residuals, emotional disturbances, or throwbacks to the animal estate*" (p246, my italics in this and all other quotes). Several generation later, Joe LEDOUX (1996), "the leading expert on the emotional brain" (GAZZANIGA et al. 1998, p516), promoted a modern variant of that intellectual tradition by suggesting that: *"The brain states and bodily responses are the fundamental facts of an emotion, and the conscious feelings are the frills that have added icing to the emotional cake"* (p302). In essence, LEDOUX, as well as many other neuroscientists believe that affective experiences—those intangible and presumably unmeasurable subjective events —are of little importance for a scientific understanding of emotions.

My personal view on these issues is quite different: I accept the importance of all of the above levels of analysis, but would also suggest that an understanding of affective processes in both humans and other mammals should be deemed an essential ingredient for the field to consider. In accepting the likelihood that the basic emotional feelings are fundamental representations of complex, causally efficacious, organic processes within mammalian brains—emergent properties that are realized in the dynamic organizations of neuronal networks—I have called for my colleagues to "*consider one simple bit of logic: If affective feelings do exist in the minds of other organisms and have causal consequences on their behaviors, we will never adequately un-*

derstand their brains, or our own for that matter, unless we incorporate various new functional concepts into our thinking." (PANKSEPP 1999, p164).

In short, I believe that a neural understanding of emotional feelings—those apparent underlying regulators of many behavioral choices—remains one of the most important topics for our science and our society to pursue. In part, this position is based on the recognition that for any lasting understanding, complex brain phenomena need to be viewed from several mutually complementary perspectives. Neurophysiological terminology is not sufficient to conceptualize many global brain processes. The neurobiological nature of feelings can be scientifically approached through the conjoint cross-species implementation of *behavioral, psychological* and *neural* perspectives—namely, through a triangulation that is essential for the pursuit of a substantive *affective neuroscience* (PANKSEPP 1998a).

At the same time, I, along with most investigators in the field, accept as given that substantial amounts of emotional processing within the brain (e.g., unconditional responses) are achieved by neural networks that in themselves probably elaborate no conscious emotional feelings. Indeed, in line with FREUD's original suggestion, most investigators now agree that much of what goes on in the brain is dynamically on automatic pilot and unconscious. At the same time it seems likely that a great deal of time and effort in brain evolution was devoted to the establishment of intrinsic values—the various feelings of goodness and badness that are internally experienced indicators of survival utility, elaborated within ancient regions of the brain shared by all mammals in remarkably homologous ways. This is not to say that these emergent feelings are not thoroughly biological in their essential underlying form, but to accept that psychology has a major role to play in unraveling the nature of such processes within the brain. The simple fact that other animals avidly consume and get "hooked" on the same drugs as humans—becoming dependent on molecules that promote essentially similar neuropsychological processes in all mammals—provides one robust line of support for such a thesis. The essential substrates for such desires are subcortical (IKEMOTO/PANKSEPP 1999; MCBRIDE/MURPHY/IKEMOTO 1999; WISE 1996).

There are many other equally compelling lines of evidence that investigators who do not wish to confront the central issue of human and animal feelings, and other aspects of their psychological lives, commonly choose to ignore. At the same time, the pursuit of substantive knowledge in this area is remarkably difficult, and perhaps the prevailing agnostic view is a preferred tactic for various socio–political reasons (i.e., sustaining consensus and grant support). But it is ultimately not a wise path: All too commonly it fails to consider the whole corpus of evidence on such topics. It can undermine our ability and willingness to confront the reality of the emergent neurodynamics that may constitute primitive forms of consciousness. It also promotes a neodualism that is harmful for scientific understanding—sustaining a division of mind and matter introduced by DESCARTES for outdated religious and political reasons. The unified nature of basic emotional processes across all mammalian species—with essential subjective and objective aspects that must be studied conjointly—is a monistic perspective that I would encourage all to accept. My aim here will be to share an overview of how affective neuroscientific strategies for understanding mind could help us correct our neglect of those affective processes that Susan LANGER and other thoughtful observers of the human/animal condition encouraged us to consider during the past century.

Toward a confrontation with affective consciousness: background issues

Let me first affirm once more that it has long been obvious to critically minded observers that many of the emotional acts that humans and animals exhibit reflect no conscious intent. Many impulsive emotional acts are projectile, reflexive responses to environmental stimuli, and the rules for those responses are ingrained within seemingly straightforward types of neuronal circuits. For instance, animals do not learn to exhibit a startle response to a sudden sound or a withdrawal response to sudden pain or rapidly approaching threats. These responses are much closer to reflexes than intentional actions, even though a process is set in motion in the brain that can govern future actions. However, there is an intermediate class of emotional action tendencies that do contain a germ of intentionality—for instance, the tendency of animals spontaneously to seek resources. Although no higher level conscious intent is required for animals to become appetitively energized when confronted by an abundance of various environmental rewards, their behavioral engagements have more complex neural underpinnings than those that govern stimulus-bound reflexes. The underlying SEEKING system provokes animals to exhibit a flexible appetitive presence in the world. Many emotional responses reflect "intentions in action" to use SEARLE's (1983) discriminating terminology, even though they may not constitute "intentions to act" (which may require higher cognitive processes). Emotional feelings, I believe, are realized more in the neural substrates of the former than the later.

The exploratory and investigatory behaviors of animals seeking resources have an outward character suggesting that they emerge spontaneously from certain ingrained types of neural organization—see IKEMOTO/PANKSEPP (1999) for a most recent review. Such "instinctual" behaviors flow as naturally as a river cascading down a waterfall. Such spontaneous emotive behaviors have a flexibly characteristic *presence* suggesting they do represent the fundamental urges of an organism. There are many emotive behavior patterns such as this in the intrinsic behavioral repertoires of all species. The fact that such basic emotional action tendencies arise spontaneously from an intrinsic form of neural organization does not automatically mean that they do not have immediate repercussions on a primary-process form of consciousness. There are good reasons to believe such behaviors arise from neural systems whose substrates constitute the very foundation of all subsequent forms of consciousness: If these systems are damaged, the adaptive competence of animals is severely compromised. To the best of our knowledge, these neural systems create the experiential immediacy of an internally felt presence in the world, a proposition that can be tested in humans, the question being—when the underlying systems are artificially activated does internal experience have a quality of belongingness or one of artificial imposition?

Because such "intentions in action" are not created by "intentions to act," many behavioral neuroscientists, including those prominently interested in emotions, have chosen to remain skeptical of the possibility that other animals have consciously experienced emotional feelings. Indeed, many assert that if such mental faculties do exist, they may have little to do with the way brains control behavior. As already noted, LEDOUX (1996) has been a prominent advocate of such an epiphenomenalist perspective in cognitive neuroscience. In my estimation, *unsubstantiated disbelief*—skepticism about reasonable possibilities that have substantial empirical support—can be as much of a barrier to scientific progress as *unsubstantiated belief*. I would submit that the concept of emotional feelings is not in the later category, but that agnosticism on the issue *is* rapidly becoming an exemplar of the first. In areas such as emotion research, we should not remain eternally silent on such matters, as some behavioral neuroscientists would prefer. That is rapidly becoming a potentially immoral stance, as we recognize that the probable existence of emotional states in other animals is very high. In any event, to understand the brain, we must be willing to entertain the reality of various psychological processes, as created through poorly understood neurodynamics.

Certain investigators, as committed to a rigorous scientific understanding of the fundamental nature of emotions as the skeptics and agnostics, feel that there is no rational alternative but to seriously consider the existence of a primordial form of affective consciousness in other organisms and to analyze the role of such processes in behavioral choices (BUCK 1999; DAMASIO 1999; PANKSEPP 1998a, 1998b, 2000a). The weight of evidence is simply too large for us to ignore the possibility that affective feelings are fundamentally created by brain systems that generate "intentions in action" rather than simply being created by the higher associative and language abilities of the human brain, as claimed by some prominent investigators (ROLLS 1999). Here I will advance the view that primary-process "affective consciousness" is constructed fundamentally from the intrinsic capacities of certain neural circuits—the basic emotional systems of the brain—which operate in goal-directed and valenced ways, working in harmony with basic, thoroughly biological, self-representational systems of the brain.

These distinct points of view—one asserting that the topic of emotional subjectivity, especially in other animals, is simply not workable from any credible scientific perspective, and the other asserting that it is—are presently in deep conflict. In my estimation, the argument against animal feelings comes ultimately from an unforgiving, anthropocentric form of solipsism combined with a pernicious form of neo-dualism. It is remarkable that it is supported by so many neuroscientists, for there is no well-argued data base supporting that view… only the philosophical residue of CARTESIAN dualism. The evidence for animal subjectivity comes from i) an enormous number of approach and avoidance tests, ii) various consummatory choice and stimulus preference studies that have been conducted on many other mammals, and iii) the remarkable homologies in the neuroanatomies and neurochemistries for such affective tendencies in all mammals. The weight of existing evidence (although there is no "knockout" *final proof*—an impossible task in science) is that other animals do have internally experienced feelings that have consequences for their behaviors.

The ultimate resolution of this issue should be of considerable interest to investigators of the human mind, especially since an understanding of the "higher" forms of awareness may be critically dependent on our ability to understand some of the "lower" substrates of felt existence. Indeed, there is now an increasing enthusiasm to deal with those subtle brain processes we know as moods and feelings, which appear to be part of the genetic birthright we share with many other creatures, for they have powerful influences on the way our cognitive activities operate and hence in all aspects of the way we live our lives (DAMASIO 1994, 1999). These are the systems that create a foundation of meaning for higher life decisions. Some of us believe that a true understanding of the organization of mind and ground of being must be premised on a neuroscientific probing of those ancestral value-processes that evolution provided to help complex creatures like mammals navigate successfully through the world.

From an evolutionary perspective, honed by the remarkable recent advances in molecular biology, it is now certain that many of our fundamental abilities are remarkably similar to those of our brethren animals. The underlying "mechanisms/processes" can only be understood if we are willing to simultaneously take several perspectives to the organized nature of complexity—with one critical but often neglected one being a data based cross-species, experiential point of view. We can probably understand the nature of human hunger by studying the subcortical energy regulatory systems of rats. We can do the same for thirst, anger, fear, and the many other vexations and pleasures of the shared, primitive regions of mammalian brains.

A psychobiological confrontation with these ancient emotional systems, and the intrinsic values they create (as monitored indirectly via the various approach and avoidance behaviors animals exhibit), shall be of foremost important in decoding how consciousness first emerged on the face of the earth (PANKSEPP 1982, 1998b). Through the ability of emotional systems to conditionally encode every-day activities with values, many of our cognitive activities remain tethered to affective principles. As many have suspected, we tend to approach things *because* they have made us feel good (in the various ways that is possible), and we avoid things because they make us feel bad. Other animals presumably operate essentially in the same manner, even though the cognitive strategies we use to fulfill our desires and to avoid our travails are surely more sophisticated and long-sighted than in most other animals. Of course, the different species often employ very different sensory, motor and cognitive tools to achieve emotional and motivational homeostasis.

This naturalistic view of human and animal existence lost credibility abruptly with the success of the behaviorist revolution early in the 20th century and it was sustained by the subsequent advent of digital computational models of mind and the emotion-free cognitivism of the second half of the century. As a result of those schools of thought, which marginalized the importance of emotional and motivational feelings in the governance of human and animal lives, several generations of thinking along lines advocated here were lost. Only recently are some returning to reconsider such evolutionary roots of mental existence.

The issues I shall focus on here were aired by previous generations of thinkers (e.g., COGAN 1802; DARWIN 1998; FREUD 1981b; SHAND 1920 just to name a few), and they are re-emerging once again to the forefront of evolutionary and neuro-epistemological thought (DAMASIO 1999; MACLEAN 1990; PANKSEPP 1998a, 1998b). My basic premise here will be that the evolution of higher brain mechanisms was critically guided by the preexisting neurobiological exigencies of organisms (i.e., subcortical emotional and motivational abilities), which are generally more similar among living mammalian species than their higher cortico-cognitive functions which have diverged more considerably (see BUDIANSKY 1998 and HAUSER 2000, for a recent overviews of cognitive differences). However, even there we will find a great deal of convergent evolution because of the basic needs all animals share. In sum, my guiding premise is that a knowledge of the "lower" affective functions will constitute essential substrates for understanding the operation of higher brain–mind functions: Unless we come to terms with the deeply organic nature of our basic drives—the various emotions and motivations—we may never understand the multi-faceted nature of consciousness(es).

Evidence concerning many of the basic emotional systems we share with the other mammals has recently been summarized (PANKSEPP 1998a). Here I will largely focus on the types of higher brain dynamics (or cognitive "modules" in the debatable parlance of modern evolutionary psychology) that may exist in human cortico-cognitive areas that establish many of our more sophisticated behavioral priorities. In general, it will be important to have formal proposals, as well as empirical tests, of specific types of "affect-logic" that emerge from higher regions of the mind that have evolved to deal with basic emotional and motivational issues (CIOMPI 1997; WIMMER 1995; WIMMER/CIOMPI 1996).

There are presently three major strands of experimentally-based neurobiological thought in this area: i) One strand is emerging from modern evolutionary psychology which is postulating mind–brain "modules" that arise all too often from an "arm-chair" Pleistocene-oriented logical analysis of human mind and behavior (TOOBY/COSMIDES 2000). ii) Another is emerging from modern cognitive neuroscience, which generally takes a massive corticocentric focus, that often seems to be deny, or at least ignore, the existence of powerful emotional forces in the deep recesses of the brain–mind (e.g., GAZZANIGA et al. 1998; GAZZANIGA 2000). iii) Finally, the third and most solidly evolutionary approach is highly focussed on subcortical issues and has arisen from the recognition that the basic emotions may reflect organizational principles at the very foundations of the mammalian mind (DAMASIO 1999; MACLEAN 1990; PANKSEPP 1998a). The three could work well together toward a comprehensive mind science, but that will require better understanding, appreciation and integration of each others' premises and data bases than presently exists. The philosophical community is also becoming remarkably interested in such issues (e.g., GRIFFITHS 1997), and investigators should become immersed in *all* the available scientific evidence rather than constraining themselves to the most prominent human psychological tradition that was heavily based on a facial-analysis of emotions that emerged in the 70s (e.g., EKMAN 1998). The animal neurological traditions should not be ignored by philosophers, for that is the only way we can resolve the foundational processes.

My aim here will be to provide a historical overview of some of the above issues and to push forward the idea that one way we can come to understand the natural order of the human mind is to clarify a variety of interrelated themes that arise from the ancestral nature of the brain–mind: i) to decode the basic nature of the biological value-generating systems that are built into mammalian brains as ancestral birthrights, ii) to discuss how these and related systems actually generate "valence-tagging" of previously neutral perceptual events; iii) to understand how the aforementioned interactions govern more complex layers of thinking and perceiving; iv) to suggest how experimental work on the basic affective processes of the brain may interweave with those subtle brain process(es) generically known as consciousness; v) to discuss how the above lines of inquiry may have important implications for understanding the essential nature of volitional activities and free will, as well as vi) the understanding psychiatric disorders. This will be followed by vii) some examples of how the intrinsic plasticity in the underlying system may establish temperamental states and habitual ways of being within organisms. After providing overviews of each of these topics, I will conclude with my personal views on the possibility that affective processes will ever be simulated computationally.

I. Biological Value Encoding Processes of the Brain

I have recently summarized the nature of brain emotional systems both in synoptic (PANKSEPP 1982, 1991, 2000a, 2000b) and comprehensive archival ways (PANKSEPP 1998a), including recent chapters on separation distress (PANKSEPP et al. 1988), play (PANKSEPP 1993b), fear (PANKSEPP 1990) and seeking systems (IKEMOTO/PANKSEPP 1999), which are the specific emotional processes that have been the focus of my research during the past three decades. I will not aspire to any detailed coverage of facts here, but will simply highlight the main conceptual themes that the current evidence supports, including a revitalized form of psychoanalytic thinking.

A synopsis of affective neuroscience

In general, the executive emotional systems are conceived to generate a variety of internally experienced affective states and related "evolutionary operants" or instinctual behavioral tendencies that emerge from widespread brain systems that have at least 6 attributes: As I suggested in 1982, they are able to 1) directly evaluate the meaning of certain sensory inputs (e.g., the smell of predators in prey species); 2) they modulate attentional and sensory-motor sensitivities relevant for the evoked behavioral tendencies (e.g., hunger sensitizes olfactory acuity); 3) they control diverse physiological and hormonal conditions of the body which bring many organ systems in line with the concurrent behavioral demands (e.g., adrenaline secretion is adaptive for all behaviors that require motor arousal); 4) they sustain animals in specific feeling (mood) states for relatively prolonged periods of time (e.g., separation protest vocalizations and feelings of distress are typically be sustained until social reunion occurs or despair sets in). All of the above are also 5) modulated by various cognitive activities (i.e., appraisals can provoke emotions) and which 6) also modulate cognitive activities (i.e., emotions channel thoughts and code memories). The manner in which the seventh major attribute, affective experience, is generated remains most mysterious of all, but there is a great deal of relevant data that can guide our thinking. My best estimate is that centromedial mesencephalic systems, such as those of the periaqueductal gray (PAG) are absolutely essential (BANDLER/KEAY 1996; PANKSEPP 1998b), even though these system are in strong interaction with higher brain areas such as the cingulate, frontal and insular cortices, which surely elaborate felt emotional experiences. For a summary of details concerning this system, see WATT (1999b). In any event, the notion that affect is an irrelevant issue for understanding how the brain controls behavior will hopefully soon become a minority view, even among those rigorous animal behaviorists who have been trained to avoid any tinge of anthropomorphism. Now that we know how much we share genetically, behaviorally and probably psychologically, such issues need to be evaluated on a case by case basis rather than dismissed by fiat. Obviously, this strategy is bound to succeed more in the analysis of primitive brain systems that all mammals share homologously rather than higher systems where there has been much more evolutionary divergence.

I doubt if many investigators of the relevant system would claim that there are no intrinsic emotional systems in the brain as many did just a few years ago. It is now certain that the brain contains a variety of genetically ingrained emotional systems for generating specific classes of emotional behaviors (PANKSEPP 1998a). To all appearances, affective experience is a rather direct manifestation of the arousal of these systems. When these systems are electrically stimulated, humans report urges to act and describe emotional experiences that have a feeling of belongingness, as opposed to being alien to the self. Presumably, the arousal of the various emotional command systems could be distinguished subjectively from each other by humans as being fundamentally distinct feelings, but such issues were never addressed during the era when such brain stimulation studies were most actively pursued (see PANKSEPP 1985 for review). Of course, the essential role of these primitive systems should not be taken to mean that the higher cortical projection areas have no role in experienced feelings. The clinical evidence indicates that they most certainly do, but largely in a modulatory/regulatory capacity. The core mechanisms for affect appear to be subcortically situated.

The brain emotional "command" systems that have been provisionally identified in experimental animals, along with their major anatomies and neurochemistries are summarized in Table 1. I will not attempt to provide any more detail in the limited space available here, especially since they have been thoroughly summarized recently (PANKSEPP 1998a). However, I would emphasize that we are only on the near shore of substantive human work in this area and even critical animal work on such issues remains quite meager because there is currently little institutional support for work which is attempting to fathom how affect is elaborated within the mammalian brain. Most still believe that such issue reside in the realm of intuitive hunches rather than the predictive landscape of mainstream science. Considering the existence of cross-species affective neuroscience type research strategies, that bias is blatantly incorrect. In any event, there would have to be a major shift in both our research priorities and strategies for this type of work to proceed at a reasonable pace. For now, I would simply emphasize that the type of detailed knowledge of the underlying neural substrates that needs to be obtained simply can not be achieved without behavioral brain research in other animals, along with careful evaluation of permissible manipulations in humans (e.g., KNUTSON et al. 1998). I personally believe this kind of knowledge would be invaluable for a new and hopefully highly humanistic phase of biological psychiatry where psychoanalytic approaches become, perhaps for the first time, widely used tools for new types of inquiries into the psychodynamics of the human mind.

In any event, now that we know a great deal about these intrinsic emotional systems in the brains of other mammals, we could (at least in theory) arouse a variety of distinct emotional tendencies in humans by artificial means (i.e., various types of direct brain stimulation), and ask how those systems contribute both to behavioral choices and mental states. Of course most such work is ethically problematic, unless retired neuroscientists interested in such issues were more willing to be guinea pigs for future inquiries. However, to the extent that we can selectively arouse such systems using peripheral pharmacological maneuvers, we could validate that the behavioral indices we utilize in animals are not leading us astray. The development of molecules that can activate specific neuropeptidergically orchestrated emotional systems may eventually allow us to evaluate very discrete possibilities rather directly. They may also lead to a to a new revolution in biological psychiatry where very specific feelings can be modulated by

Basic Emotional Systems	Key Brain Areas	Key Neuromodulators
General + Motivation SEEKING/Expectancy	Nucleus Accumbens—VTA Mesolimbic and mesocortical outputs Lateral hypothalamus—PAG	DA (+), glutamate (+), many neuropeptides, opioids (+) neurotensin (+)
RAGE/Anger	Medial amygdala to Bed Nucleus of Stria Terminalis (BNST). medial and perifornical hypothalamic to dorsal PAG	Substance P (+), ACh (+) , glutamate (+)
FEAR/Anxiety	Central & lateral amygdala to medial hypothalamus and dorsal PAG	Glutamate (+), many, neuropeptides, DBI, CRF, CCK, alpha–MSH, NPY
LUST/Sexuality	Cortico-medial amygdala, Bed nucleus of stria terminalis (BNST) Preoptic and ventromedial hypothalamus Lateral and ventral PAG	Steroids (+), vasopressin, & oxytocin, LH–RH., CCK.
CARE/Nurturance	Anterior cingulate, BNST Preoptic Area, VTA, PAG	oxytocin (+), prolactin (+) dopamine (+), opioids (+/–)
PANIC/Separation	Anterior Cingulate, BNST & Preoptic Area Dorsomedial Thalamus Dorsal PAG	opiods(–), oxytocin (–) prolactin (–) CRF (+) glutamate (+)
PLAY/Joy	Dorso-medial diencephalon Parafascicular Area Dorsal PAG, Tectum	opioids (+/–), glutamate (+) ACh (+), Any agent that promotes negative emotions reduces play

Table 1. General summary of the key neuroanatomical and neurochemical factors that contribute to the construction of basic emotions within the mammalian brain. The monoamines serotonin and norepinephrine are not indicated since the participate in non-specific ways in all emotions. The higher cortical zones devoted to emotionality, mostly in frontal, cingulate, insular, and temporal areas, are not indicated. Key: CCK = choleocystokinin, CRF = corticotrophin releasing factor, DBI = diazepam binding inhibitor, ACh = acetylcholine, MSH = Melanocyte Stimulating Hormone, NPY = Neuropeptide Y.
– inhibits prototype, + activates prototype. (Adapted from PANKSEPP 1998a and WATT 1999a)

pharmacological influences on specific affect systems of the brain. These lines of thought raise the possibility of some very interesting *psychoethological* work that could be pursued in humans, perhaps implemented with psychoanalytic free-associative, active listening procedures as outcome measures.

I single out the psychoanalytic tradition because it was a line of 20th century thought that continued to accept the importance of affective processes in our attempts to understand the mind. Even though psychoanalytic approaches were not robust enough to reveal the internal nature of emotions, FREUD did develop a provisional conceptual scheme—of id, ego and superego functions—where the drive-like neural "forces" within the id were the primal powers around which the rest of the mental apparatus revolved. While FREUD realized that his system of thought depended critically on our ability to understand the id, he and his colleagues had no reasonable way to probe the internal neural structures of the various "drives" that constituted that conceptual brain–mind. However, FREUD presciently *suggested that the id, cut off from the external world, has a world of perceptions of its own*. I translate this to mean that affective processes, being very ancient in brain evolution, do not need cognitive structures in order to generate the psychological impact of raw feelings. However, without a substantive neuroscientific understanding of the id, the rest of FREUD's theory of psychology could not be adequately evaluated. Our recent understanding of basic emotional systems permits a potentially fruitful rapprochement between psychoanalytic and neuroscientific approaches to mind (KANDEL 1998; PANKSEPP 1999).

FREUD, no doubt, would be very favorably disposed to such views. As FREUD highlighted in his "Project" (1981a) when he discussed the pleasure and unpleasure of sexual release: "…a suspicion forces itself on us that… the endogenous stimuli consist of *chemical products,* of which there may be a considerable number." (p321). Although he neglected such issues for most of his career, toward the end of his life FREUD still asserted that "The future may teach us to exercise a direct influence, by means of particular chemical substances, on the amounts of energy and their distribution in the mental apparatus." (FREUD 1981c, p182). It would be an understatement to say that many such agents have now emerged, and there are many other possibilities in the wings. Indeed, at the heart of many of the brain's affect programs of the mammalian brain, "there are a variety of chemical codes (largely neuropeptidergic) that may eventually permit precise new modes of psychiatric intervention, and new ways to evaluate how feelings are constructed in the human brain" (PANKSEPP 1999, p44).

From this vantage, it would be important for us to be able to directly study the human mental processes on line—not just with direct brain measures such as EEG and fMRI but also psychoanalytically (i.e., free associative narratives in "normal" individuals induced to experience distinct moods). Although brain imaging techniques have given us remarkable snapshots of emotions—from psychostimulant craving (CHILDRESS et al. 1999) to sadness (GEORGE et al. 1996)—they have not yet added much to our understanding of how the dynamics of mind change during these states. Could the technique of free-association be utilized experimentally to reveal the affective dynamics of the human mind (DAHL 1998)? I suspect that a new field of inquiry, such as *psychoethology,* which would seek to characterize the normal affective-cognitive topography of the human mind under the sway of different emotions could help us scientifically characterize many basic psychological processes. But more on that later.

II. The Generation of Associative "Valence-Tagging"

I doubt if many investigators today would claim that human emotions are totally socially constructed. At the same time few would claim that social-construction of emotionality is either modest or negligible. Obviously, the genetically provided emotional systems of the brain, many of which become fully operative soon after birth in all mammalian species (Table 1), are continuously molded by organismic responses to new environmental objects and events. Brains can imbue initially neutral environmental events with values. This is commonly called valence-tagging or secondary/conditioned reinforcement—the ability of previously neutral events to assume the intrinsic values evoked by emotionally salient events (i.e., unconditional stimuli) through associative learning. Even though this may transpire by a variety of distinct mechanisms operating at several hierarchical levels within the brain/mind, leading to a complex developmental landscape, the simplest and most widely studied form is that arising from classical conditioning. This reflects one of the simplest forms of cognitive-emotional interaction that exists within the brain. To put it in everyday words—even though individuals at an instinctive level may know what they like and what they do not like (through unconditional pleasure-unpleasure responses), at a cognitive level they do not. However, through classical conditioning, cognitive systems learn quickly.

Let me also put this in more traditional psychological terms: The systematic pairing of neutral cues or conditional stimuli (CSs) with biologically important events or unconditional stimuli (UCSs) which spontaneously evoke instinctual behavioral and physiological changes, also known as unconditional responses (UCRs) can rapidly produce learning, or conditioned responses (CRs). The ability of the temporal pairing of CSs with UCSs to produce CRs, has been a staple of behavioral psychology since Pavlov systematized such knowledge. Now, there is widespread recognition that most emotional responses can be conditioned in this way. That has led to a cottage industry of behavioral researchers working to reveal the details of how fear responses condition in the amygdala (e.g., how tones and light paired with shock evoke conditioned withdrawal or or autonomic arousal responses). Generally, such investigators believe that the understanding of emotions is best achieved through the implementation of simple learning approaches that focus on associative learning issues as opposed to the intrinsic evolutionarily dictated nature of brain emotional systems. The techniques are very effective in both animals (LEDOUX 1996) and humans (ÖHMAN 1993), and they are well within the tradition of 20th century behavioral science.

Unfortunately, such work only tells us a great deal about how emotional responses can be molded by learning, but comparatively little about the intrinsic nature of the evolved emotional processes of the brain. The widespread use of such classical conditioning techniques has led to the recognition that much of emotional learning occurs at unconscious levels. That conclusion is generally accepted since many classically conditioned fear responses occur so rapidly that no subjectively experienced cognitive or affective processes is likely to have intervened between the presentation of a CS and the emission of the CR that is measured. However, it is rarely acknowledged that the long-term affective responses generated by such conditioning may also be influential in regulating the behavioral tendencies of animals. Indeed, the comparative neglect of long-term emotional responses within such research programs may now be promoting a misleading picture of the organization of emotions in the brain/mind, and the study of projectile classically conditioned responses needs to be supplemented by the recognition that affective feeling states are concurrently conditioned to the CSs, and that those states may have causal efficacy in the *sustained* regulation of subsequent behaviors.

For instance CSs that have been paired with painful stimuli, can subsequently intensify other fear responses commonly evaluated in the potentiated startle paradigm, and also promote longer term behavioral changes such as freezing. A study of this background fear is getting somewhat closer to the underlying affective process. It is now certain, as has been suspected for 30 years, that a hot-bed for such associative learning is in the local circuits of the lateral and central amygdala (LEDOUX 1996), but it is gradually being realized that anxiety conditioning can occur in many other brain areas (DAVIS/SHI 1999; MAREN 1999). The key synaptic chemistry which seems to promote both the conditioning and deconditioning of such associative responses are changes in glutamatergic transmission (FALLS/MISERENDINO/DAVIS 1992). Indeed, it is likely that conditioning, or at least long-term sensitization (ADAMEC 1997), can occur along the whole length of emotional command systems (see previous section), so an enormous amount of work remains to be done before we truly understand how pervasive is the plasticity of this system along the neuroaxis.

Only modest headway has been made in implementing such strategies for the study of most other, especially positive, emotional processes. An exception is the recent work on the role of brain "reward" and dopamine systems in the conditioning of appetitive eagerness (for a recent reviews, see IKEMOTO/PANKSEPP 1999; SCHULTZ 1998). To highlight how effectively such processes can be used to study other subtle positive responses such as social "joy" or animal "laughter," Figure 1 summarizes a classical conditioning experiment with tickle-induced 50-KHz chirping in young laboratory rats (PANKSEPP/BURGDORF 1999). Of the four groups depicted (see legend), only the group with contiguous CS-UCS pairings exhibited a systematically incrementing pattern of learned behavior. In other words, the young rats chirped in anticipation of being tickled. We presently have no empirical knowledge of where such conditioning occurs, but the cingulate and orbitofrontal cortices, as well as nucleus accumbens, septal nuclei and bed nuclei of the stria terminalis (BNST) are likely places to look.

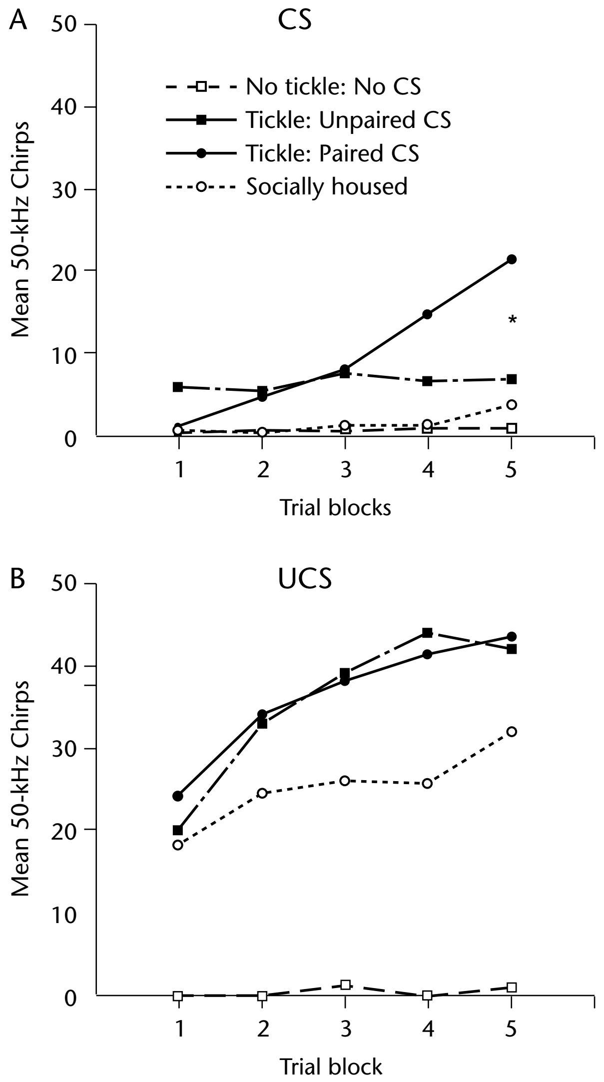

Figure 1. Mean (±SEM) levels of 50 KHz "laughter" type chirping during the first five trials of conditioning: "Tickle: Paired CS" animals were exposed to the conditioned stimulus—passive exposure to the the tickle hand—right before a 15 second period of tickling (data not shown, but rates of chirping were about 38 per 15 sec). The group of animals that received the CS followed immediately by tickling, exhibited significantly higher chirping rates than the other two control groups (data according to PANKSEPP/BURGDORF 1999).

Although the classical conditioning procedures tell us a great deal about how emotional values can be linked to neutral stimuli, we must also recognize that such approaches tell us practically nothing about the intrinsic nature of the emotional values that are mediated by the emotional command systems or UCR pathways (Table 1). To my way of thinking, that can only be achieved by the types of approaches highlighted in the previous section, as well as through various place-preference and place-avoidance conditioning procedures (for summary, see SCHECHTER/CALCAGNETTI 1993), as well as relevant operant learning tasks, with stringent schedules of reinforcement, to evaluate motivational strength. Animals seek out places where they have had positive affective experiences, and they avoid places where they have had negative ones.

Although many would like to believe that affective experiences occur within fairly high areas of the brain, such as neocortical zones that mediate working memory (LEDOUX 1996), the evidence so far seems to be that the affective content of experience can be elaborated quite low in the neuroaxis (e.g., OLMSTEAD/FRANKLIN 1997; PANKSEPP 1998a). Some may be tempted to suggest that such "affects" reflect unconscious processes, perhaps the "dynamic unconscious" postulated by FREUD, but I would rather view them as the essential foundations of consciousness. Consciousness must not only be conceptualized phylogenetically (CABANAC 1999; PANKSEPP 1990a), but also as ontogenetic processes of neuronal/psychological development. From this vantage, it is noteworthy that PET studies of infant brains have found much higher levels of metabolic activity in those primitive emotional areas of midbrain and diencephalon than in most cortical areas. However, with development, intense patterns of cortical activation gradually emerge (CHUGANI 1996). Are infants then unconscious, or are they simply operating primarily with primitive forms of affective consciousness? Pain studies of human infants tend to bear out the second alternative (ANAND 1997). The gradual development of working memory, with the ability to treat subcortical processes as tokens of information, presumably provides high-order regulation over emotional processes rather than constructing affect out of those inputs.

III. Emotions and Higher Order Psychological Processes

It is a straightforward tenet of folk-psychology that our emotions have robust effects on the way we think and what we think about. Because of such interactions, there is a regrettable tendency to conflate emotional and cognitive processes by people who do not work on the deep structures of the brain. Since so much of current work in experimental psychology is concentrating on higher cognition-emotion interactions in humans, and since animal work has comparatively little to say about those issues (i.e., thought processes are even harder than emotional ones to observe in animals—see HAUSER 2000), I will briefly cover one historical antecedent—the ideas of Alexander SHAND—that may help highlight reasonable ways to proceed at the human level. Then I will focus on one major conceptual issue—the nature of emotional *projections,* which may help us better understand how affective feelings interact with cognitive processes in very global ways. These lines of thought may help us establish some lawful relationship between emotions and cognitions.

First, let me indicate that three general laws of emotions that could be linked to a biological analysis were put forward by Charles DARWIN (1998). He suggested that each basic emotional system of the brain (i.e., his principle of *action, due to the constitution of the nervous system*), interacts with other systems (his principle of *antithesis*) and is also accompanied by the vast baggage of accumulated learning (his principle of *serviceable associated habits*). Contrary to modern investigators of emotions in animals, DARWIN was not hesitant to acknowledge that most probably a key feature of their emotional responses is a feeling tone.

Since then, there have been several attempts to codify the laws of emotions, as they operate at the psychological level (FRIDJA 1986) as well as how they operate at a deeper affective-logic level that has been related to psychiatric disorders (CIOMPI 1997). Unfortunately the empirical work has lagged far behind the general conceptualizations. To generate some simple straightforward experiments, it may be instructive for us to once more consider the systematization attempts of our predecessors, and I have been impressed by some of the ideas advanced by SHAND.

The "laws" of Shand

In 1920, Alexander SHAND published his monumental "*The foundations of character: Being a study of the tendencies of the emotions and sentiments*" which, in the midst of an impressive narrative, put forward 150+ laws that he believed accurately characterized human emotional feelings, their attending cognitions, and their various interactions. These "laws" were derived from everyday observations and personal insights rather than any systematic empirical analysis, but we should not dismiss them because of that. They still provide a source of many intriguing, empirically testable, hypotheses. I will only provide a sampling of his thought. His first few fundamental laws were those that he believed were the foundation for all other laws of character:

1) *"Mental activity tends, at first unconsciously, afterwards consciously, to produce and to sustain system and organization."* (p21)

2) *"Every primary impulse, whether it is independent or belongs to a primary emotion, is innately connected with the systems of fear, anger, joy, and sorrow, in such a way that, when opposed, it tends to arouse anger; when satisfied, joy; when frustrated, sorrow; and when it anticipates frustration, fear; these systems being similarly connected together."* (p38)

6) *"All intellectual and voluntary processes are elicited by the system of some impulse, emotion, or sentiment, and subordinated to its end."* (p67).

Although many of SHAND's laws seem straightforward, even self-evident, and hence perhaps not worthy of empirical analysis, there are good reasons they should be deployed for experimental studies. An empirically verified fact is worth a thousand reasonable assumption. Indeed, I am tempted to suggest that a new discipline, such as experimental philosophy, might be quite useful in this arena since experimental psychologists often seem not be temperamentally ready to tackle such issues. In any event, it they could be empirically substantiated, each of the following assertions could broaden and deepen our scientific understanding of basic emotional matters.

15) *"The joyful temper, in proportion as it is stronger than the ordinary disposition to joy, weakens sensibility to the opposite emotions of repugnance and sorrow, and by strengthening hope and confidence in the future, weakens the opposite emotions of despondency and despair."* (p153).

17) *"The joyful temper lowers the threshold of sensibility for joy, hope, and confidence, but raises it for sorrow, despondency, and despair."* (p.154).

20) *"The sorrowful temper lowers the threshold of sensibility for sorrow, despondency, and despair, but raises it for joy, hope and confidence."* (p154).

33) *"The universal end of Fear is merely to prevent the occurrence of some threatening event whether the danger be 'real' or 'imaginary.' "* (p215)

37) *"All varieties of anger tend to accomplish their ends by some kind of aggressive behavior."* (p250).

38) *"Fear and anger tend always to exclude one another, where both are referred to the same objects."* (p254).

69) *"Sorrow tends to be diminished by the knowledge that another sorrows with us."* (p341).

70) *"Sorrow tends to be increased by the knowledge that another rejoices at our suffering."* (p341).

Perhaps one reason such reasonable assertions never received much attention was because they utilized a host of affective concepts which were axiomatically accepted as emotional givens, with no replicable empirical evidence provided for their existence. Now that we are beginning recognize the neural circuits from which such feelings arise (PANKSEPP 1998a), we may finally be able to implement new research programs that try to highlight the types of intrinsic affective-cognitive regularities that are evident from an everyday folk-psychological perspective. One of the most workable general concepts is that of *projection*—the tendency of people to cast their feelings onto the world as if the world were the cause of their feelings.

Emotional projections into cognitive activities

It is now generally accepted that emotional and cognitive processes massively interact (GRAY 1990; PANKSEPP 1988, 1990b; PARROT/SCHULKIN 1993), and incisive empirical work on those topics is increasing (CHRISTIANSON 1992). Rather than detail those trends here, let me simply highlight one issue that may be empirically very workable—the ability of emotions to be projected onto objects and subjects in the world. Although the concept of "projection" was a mainstay of FREUDIAN theory that has been empirically neglected, its pervasiveness in human affairs should be receiving more prominent attention in the empirical analysis of how emotions and cognitions interact within the brain. It still has enormous psychiatric implications.

Although one could envision that "projection" would be largely a matter of how "valence tagging" between perceptions and cognitive impressions transpires (*vide supra*), it may be a more pervasive and dynamic a brain response than that. It may reflect direct actions of emotions on brain areas that mediate cognitive and perceptual processes. Since cognitive processes are designed to deal with moment by moment events in the external world, while affective feelings reflect evolutionarily provided value codes, it may be that the projection of feelings onto environmental events and objects was one of the simplest ways for evolution to persistently guide the perceptual priorities of the cognitive apparatus.

It is easy to imagine that this type of interaction operates through some type of global neurodynamic/neurochemical process in the brain, whereby basins and peaks of attractors mold the psychological landscape. It may reflect how emotions are "embodied" or broadcast widely in neural tissues rather than being informationally encapsulated linear programs such as those that operate in digital computers. Various widely acting neurochemical "spritzers" (e.g., norepinephrine and serotonin) as well as widely dispersed peptide system could be the substrates for these widespread effects in the brain.

If we correctly comprehend how the corresponding psychological processes are aroused neurobiologically, we should be able to develop major new ways to modify how people view the events of their lives and hence open up new avenues of psychotherapeutics. For instance, from the animal data, we could envision that sexual jealousy is aroused substantially by activation of brain vasopressin systems (WINSLOW et al. 1993). Many comparable psychobiological hypotheses concerning human mental dynamics could be generated from recent neuropeptide research in animals, (PANKSEPP 1993a, 1998a), which should eventually provide opportunities to modify specific emotions in fairly discrete ways, and to determine, mechanistically, how affects, and hence value priorities, are "projected" into the world. Some of the most dramatic forms of such projection will be found in disorders such phobias and post-traumatic stress disorders (VAN DER KOLK et al. 1996), and there are new ideas (e.g., "limbic permeability") how such processes emerge psychobiologically (ADAMEC 1997).

It is possible that many cognitive problems could be ameliorated simply by adjusting the underlying emotional feelings. Recent evidence for this comes from the widespread use of SSRIs (Serotonin Specific Reuptake Inhibitors) which dramatically reduces the tendency of people to experience negative emotions toward other people (KNUTSON et al. 1998). Indeed, marriages that have been on the verge of falling apart because of the negative feelings that spouses commonly project on each other have been saved by the ability of these agents spontaneously alleviate negative feelings, with no need for any further cognitive adjustments (KRAEMER 1993). In other words, affective states of consciousness may have such insistent effects on cognitive flow that direct interventions on the affective processes may, quite simply, be among the most robust and effective ways to rechannel cognitive resources. However, since cognitive attributions can re-evoke emotions once pharmaceuticals have worn off, the role of other therapeutic interventions in establishing long-term ways to solidify new levels of emotional homeostasis need to be implemented. Even strange new technologies such as vagal pacemakers and modulation of cortical activity through rTMS (GEORGE/BELMAKER 2000), not to mention traditional interventions such as exercise, dance and music, may help achieve such ends.

IV. Emotions and Affective States of Consciousness

Our scientific understanding of how emotions and cognitions interact will depend substantially on our ability to decode how consciousness is elaborated by neural tissues. We are finally in an intellectual era where the discussion of such issues is again encouraged, but we remain remote from any consensus on how such processes are instantiated within brains. I favor the view that several types of consciousness exist—with an essential distinction to be made between affective-feeling and cognitive-propositional forms of consciousness as well as the simple perceptual awareness of events in the world (PANKSEPP 1990, 2000a). The former may be integrally linked to global organic processes constructed partly from slowly firing neuropeptide networks of subcortical origin, while the latter may be more "digital" and based on rapid-fire, informationally restricted excitatory amino acid transmission.

Although the foundations of consciousness are, no doubt, constructed from unconscious neural processes, I believe that cognitive forms of consciousness (thoughts about the world) were evolutionarily premised on the prior evolution of affective forms of consciousness, which inform organisms what it might be worth thinking about. That form of mental activity, as described by Marian DAWKINS (1998, p97), may be essentially "a matter of attending to internal images or representations of objects and events… that an animal has some sort of inner representation of the external situation confronting it or that it has memories or anticipations of future situations. Thinking may lead to comparisons between two or more representations and to choices and decision about what to do next based on some sort of assessment of likely outcomes." The same may be said for affective consciousness, except the so-called "representations" may be evolutionarily provided action states that arise intrinsically from emotional systems of the brain. In their role of regulating behavioral output, these states may be much more similar across mammalian species than the the specific thoughts and behaviors animals exhibit.

The emergence of higher forms of consciousness in brain evolution may have been premised upon the preexisting action-readiness and affective dynamics of emotional systems. As I suggested a few decades ago: "I assume that the most primitive function of consciousness is to facilitate adaptive response selection from alternative courses of action: It allows organisms to cope with complex environmental situations in which several behavioral alternatives are competing, with comparable urgency, for a common output channel in the brain. Such a crisis of choice (if one can imagine a crisis on an evolutionary time scale) may have become most urgent to species that possessed executive brain mechanisms that could concurrently promote several adaptive behavior patterns to a single type of environmental challenge. As I have discussed more fully elsewhere… emotive command circuits may have such a characteristic. This flexibility could promote adaptive response-molding, perhaps by a 'reinforcement' mechanisms linked to fluctuating activities in the underlying executive circuits." (PANKSEPP 1982, p451).

The number of proposals on what it means in neural terms to have had emotional feelings are rather scarce. Some believe that feelings are nothing more than some type of information in comparatively recently evolved neocortical working memory systems (e.g., LEDOUX 1996), while others have preferred a JAMES-LANGE type of bodily feedback approach (DAMASIO 1994). The only reasonably well-developed alternative to that view is the possibility that emotional command systems can establish various distinct types of resonances in the neurosymbolic representation of a primordial body (the "SELF"), situated largely, at least in early neonatal development, within deep and ancient mesencephalic areas such as the PAG and surrounding tectal and tegmental systems (PANKSEPP 1998b). Parenthetically, DAMASIO (1999) has more recently moved toward this point of view, with his idea of core-consciousness which is very similar to the concept of the SELF (Simple Ego-type Life Form). The SELF is capitalized to highlight that this is a postulate concerning some type of primordial organization of the brain—a coherent neurosymbolic-homuncular schema of the organism, a virtual body heavily weighted toward the representation of basic motor-orientational and visceral processes. Within consciousness studies, this most central zone of the midbrain has often been neglected in preference to the adjacent Extended Reticular Thalamic Activating System (ERTAS) which is especially important in gating somatic-sensory information to the thalamus (NEWMAN 1997; STERIADE 1996; STERIADE/JONES/MCCORMICK 1997). However, for the "consciousness community," WATT (1998, 1999a, 1999b) has been aspiring to make the necessary adjustments.

This view, contrary to cortico-centric views of consciousness, situates the emergence of global emotional integrative abilities rather more medially in the neuroaxis than the ERTAS, but still situated in a way that can modulate the arousability of the ERTAS structures (i.e., an amalgam of cholinergic, catecholaminergic, GABAergic and glutamatergic systems). With a massive concentration of the affective SELF in mesencephalic levels as well as slightly higher reticular tissues such as hypothalamic and other basal forebrain zones as well as among intralaminar and other reticular tissues of the thalamus, we have an image of affective consciousness which is experimentally testable. Further, the possibility of such brain functions are reiterated in yet higher interconnected tissues, especially frontal cingulate and insular cortical areas, the type of global, organically "embodied" influence that emotions can have on the brain is finally being more widely considered in the literature (see DAMASIO 1999; PANKSEPP 1998b; as well as the recent e-mail seminar organized by WATT, with a target paper by SCHIFF/PLUM 1999 providing a focus for discussion).

Obviously, affective consciousness, just like all other forms of consciousness, do not rely on single nuclear groups but rather the patterned interactions of may brain areas that are all refined by experience. Thus, the seat of the "SELF" is presumably reiterated during brain/psychic maturation, so that affective processes (and hence primal values) continue to inundate the rest of the emerging neural apparatus, especially of frontal cortical zones that elaborate long-term intentions and plans. This would help explain why modern brain imaging procedures tend to largely highlight correlates of telencephalic arousal during emotional states, while the more causal animals studies that tend to manipulate systems directly, are highlighting the importance of subcortical circuits that are rarely visualized with the PET and fMRI imaging procedures. Clearly, those techniques are generating many false negatives, for neurological studies indicate that the subcortical areas are of decisive importance in both the generation of affect and primary-process consciousness (SCHIFF/PLUM 1999). Recent work with new brain-imaging approaches is affirming such conclusions (DAMASIO et al. 2000).

In sum, according to the present view, affective feelings arise from various neurodynamics, which are concentrated but not restricted to specific centromedial areas of the brainstem. This general view could easily have been empirically refined during the middle and later parts of the last century. However, the emergence of digital computers, the cognitive revolution with its informationally encapsulated-modular views of information processing, as well as the rapid decline of psychodynamic perspectives, led several generations of scholars to neglect such integrative concepts for understanding the nature of consciousness. From the long-term vantage, this neglect may have some hidden benefits: Now it allows investigators, steeped in modern neuroscience methodologies, to construct more precise neural image of such foundational issues than could ever have been done before. Such a revolution in our thinking is already fostering new disciplines such as Neuro-Psychoanalysis (see SOLMS/NERSESSIAN 1999).

In any event, the above view of emotional feelings could help explain why so many emotions are so readily projected into the world of sensory-perceptual affairs, and how minimal stimuli in the environment (e.g., the way someone glances at you, or the intonation in one's voice) can captivate the brain/mind in emotional turmoil. Within the deepest mesencephalic areas (e.g., in PAG-ERTAS interactions), we can easily envision how basic emotional and motivational processes control the attentional and information-processing capacities of the somatic-exteroceptive (i.e., sensory thalamic-neocortical) nervous systems. The neurodynamics of emotions can easily inundate the neurodynamics of perceptual systems. Unfortunately, the empirical evaluation of such issues remains rudimentary.

V. Affective Consciousness and the Evolution of Free Will

One of the ultimate issues of consciousness studies is how "free will" could ever emerge from mechanistic activities of the brain. To have true voluntary choice seems incomprehensible within practically all materialistic physiological or computational notions of how cognitive processes of the brain–mind might operate. Unless one is willing to entertain that psychological processes operate at the quantum level (e.g., BECK/ECCLES 1992) there is simply no place for an immaterial mind to intervene in the material processes of the brain. Perhaps the present view of emotions can provide a conceptual handle to how that remarkable a feat may be achieved within a complex materialistic framework which does not aspire to deny that basic biological values do exist within the nervous system. It requires us first to appreciate that consciousness is not only *caused by* but also *realized in* specific types brain systems that mediate "intentions in action" (to again deploy SEARLE's discriminating perspective on this troublesome issue). There is no immaterial mind. A reasonably satisfactory understanding of the issues can be had if we appreciate how the higher forms of cognitive consciousness (e.g., "intention to act"), reflecting some capacity for freedom of choice, are based fundamentally upon the more ancient forms of affective consciousness where such choice was minimally possible. Still, affect programs in the absence of any sophisticated cognitive abilities, can presumably permit simple choices by being able to coherently reflect values that may be only partially represented in the environment. In any event, the basic emotional circuits, without the addition of cognitive potentials, are mechanistically rather closed systems—they are relatively blind to opportunities for adaptive behaviors that may exist in complex environments. Only additional layers of brain evolution opened up opportunities for the type of flexible response selection that we traditionally conceptualize as free will or volitional action (also see, LIBET/FREEMAN/SUTHERLAND 1999).

This view could also help bring some resolution to other major philosophical problems in consciousness studies: The dilemma of how the unified experience of consciousness get "bound" within the brain could be solved if we conceptualize that the very foundation of an affective mind, namely the virtual body or SELF, was first established in evolution upon stable motor coordinates, capable of being modulated by basic emotional systems that generate various forms of action readiness, upon which additional complex perceptual and cognitive processes could be built (PANKSEPP 1998b).

To reiterate, the type of "solution" to the free will problem that I and others (e.g., DAMASIO 1999) favor is based firmly on an evolutionary view of consciousness which makes a distinction between having basic emotional feelings (a brain function that all mammals share) and having the ability to have thoughts about those feelings (which is much more highly resolved in humans than most other mammals). The probability that consciousness emerged rapidly in brain evolution is, of course, remote. It probably went through many stages of emergence (PANKSEPP 1990a), and to understand it, we must first understand the foundational stages.

If affective consciousness emerged fairly early in brain evolution, and it is fundamentally reflective of instinctual emotional action systems interacting with a primitive neural representation of the SELF and ancient bodily (i.e., evolutionary) memories, then, with higher brain evolution, those pieces of information could serve as symbolic token within the deliberative capacities of more recently evolved neural substrates of more cognitive (i.e., exteroceptively tethered) forms of consciousness. Animals that only have affective consciousness presumably do not have the neural complexity to exhibit free (i.e., self-directed) choice. On the other hand, when a receptive neurosymbolic field evolved where affective forms of consciousness could be used as tokens of information in higher levels of deliberation, the doors to "free will" were opened in brain evolution. If the brain substrates for "the SELF" bifurcated, to be well represented in cognitive networks, as they already had within affective networks, then it is possible to envision that decisions could be made several steps removed from the immediacy of one's basic urges. Hence, rather than simply having "intentions in action," to again use SEARLE terminology (1983), the capacity to have "intention to act" gradually emerged.

The capacity of the higher self-structures to entertain several conflicting emotional and motivational alternatives concurrently is, to my way of thinking, the essential foundation for those brain processes that we presently subsume under the concept of "free will." As others, I would seek such higher abilities within neural systems closely affiliated with frontal cortical working memory systems as well as more posterior parietal systems that elaborate multi-modal representations of the world (SPENCE/FRITH 1999).

Although this provides only a glimmer of the complexity that needs to be empirically unraveled, I do not find it problematic to believe that "free will" is fundamentally, the ability of higher brains systems to deliberate more fully on the affective issues confronting an organism than they would be capable of if they did not have the higher symbolic capacities of the cortico-cognitive apparatus. Although all of our choices may seem quite limited, especially when the affective urges are intense, the cognitive symbolization of such affective processes under calmer states of mind, would provide the opportunity for flexible characterological development in well-reared children and hence the widening of meaningful life choices they can eventually make.

Those who are especially committed to becoming masters of that cognitive terrain, can even make choices incompatible with survival. Although most would have little desire to entertain such options, they are potentially there to be entertained by all. Within such a view of complexity, I see no problem for a highly evolved brain like ours, to "freely" pursue options completely of their own making. Of course, we should anticipate that the level of unconscious materialistic control within such control systems will always remain more substantial than any civilized human would wish to admit, and it might be deemed wiser, as a matter of personal philosophy, to not voluntarily enslave oneself to those organic tethers (e.g., as advocated by UUS 1999 in his existential "Libertarian Imperative" option).

In sum, we have to be willing to see our nature from several, often contradictory, perspectives, and it may be worth considering once more what William JAMES (1961, p305) had to say about the diversities of consciousness that can co-exist within our minds: "[O]ur normal waking consciousness, rational consciousness as we call it, is but one special type of consciousness, whilst about, parted from it by the flimsiest of screens, there lie potential forms of consciousness entirely different. We may go through life without suspecting their existence: but apply the requisite stimulus, and at a touch they are there in all their completeness, definite types of mentality which probably somewhere have their field of application and adaptation. No account of the universe in its totality can be final which leaves these other forms of consciousness quite disregarded."

VI. Implications for Psychotherapeutics

The implications of such a vision of the emotional brain should have profound consequences for how we eventually envision certain psychiatric disorders. The existing diagnostic systems, such as DSM IV and ICD-10, are excessively weighted to lists of symptoms, with a rather striking neglect of the underlying neural and psychodynamic issues (JENSEN/HOAGWOOD 1997). The present views may encourage investigators to bring brain emotional aspects into prominence once more (for one potential scheme, see Table 2). If we do this well, we should be able to create more effective and more humane therapeutic approaches, where well-informed patients are full collaborators in the therapeutic enterprise, including the selection of medications based on what they would desire for their lives.

Psychological and somatic therapies would also have increasingly prominent interactive roles in treatment strategies. In addition to harnessing the medium of language and cognitive insights, clients

Basic Emotional System (see Panksepp 1998a)	Emergent Emotions	Emotional Disorders
SEEKING (+ & –)	Interest Frustration Craving	Obsessive Compulsive Paranoid Schizophrenia Addictive Personalities
RAGE (– & +)	Anger Irritability Contempt Hatred	Aggression Psychopathic tendencies Personality Disorders
FEAR (–)	Simple anxiety Worry Psychic trauma	Generalized Anxiety Disorders Phobias PTSD variants
PANIC (–)	Separation distress Sadness Guilt/Shame Shyness Embarrassment	Panic Attacks Pathological Grief Depression Agoraphobia Social Phobias
PLAY (+)	Joy and glee Happy playfulness	Mania ADHD
LUST (+ & –)	Erotic feelings Jealousy	Fetishes Sexual Addictions
CARE (+)	Nurturance Love Attraction	Dependency Disorders Autistic aloofness Attachment Disorders
The SELF—a substrate for Core Consciousness (see Panksepp 1998b).	A mechanism for all Emotional Feelings	Multiple Personality Disorders?

Table 2. Postulated relationships between basic emotional systems, common emotional processes, and major psychiatric disorders. The last two columns only provide best estimates of the major relationships. Obviously, multiple emotional influences contribute to each of the emergent emotions (e.g., jealousy is also tinged by separation distress and anger), and all the emotional disorders have multiple determinants. Plus and minus signs after each indicate major types of affective valence that each system can presumably generate. Capitalization is used to designate the various emotional systems to highlight the fact that these are instantiated as distinct neural entities rather than simply psychological concepts. The essential neural components constitute command influences that coordinate the basic behavioral, physiological and psychological aspects of each emotional response.

would also be increasingly guided to supplement the more standard treatments with musical interventions, dance, exercise, meditation and the various untapped powers of various placebo effects. Psychopharmaceuticals and direct brain stimulation (as with rapid Transcranial Magnetic Stimulation—see Pasqual-Leone et al. 1998; George/Belmaker 2000) might be used more rationally, with continuous structured client feedback about the quality of their lives. In such multi-modal approaches, psychopharmaceuticals might be more commonly used in lower doses, perhaps less frequently (more on demand when clients desire certain kinds of emotional support), and the re-structuring and balancing of emotional energies would be pursued in a much richer therapeutic structures of understanding than they have been for too much of this past century.

Although such re-structuring of mental-health programs may sound utopian, we can anticipate that there will soon be a new age of psychopharmaceuticals, especially as we develop specific modulators of peptide based emotional systems (Panksepp 1993a), where psychological effects of drugs may be highly dependent on the quality of the social–emotional environments in which people live. We have already encountered some of this in our attempts to perfect naltrexone in the treatment of autism: The efficacy of that medication may be dependent on the social sensitivity of care-providers (Panksepp et al. 1991). The notion that medications may be uniquely efficacious in certain emotional environments is an idea whose time will come.

I do hope a day will eventually emerge when the analysis of the human psyche, perhaps again on the proverbial Freudian couch can be implemented in scientifically meaningful ways—perhaps through some type of approach such as "psychoethology.". In part, new variants of psychoanalysis should be guided by our understanding of the basic emotional processes that we share with the other animals. Indeed, for maximal progress, it would be advantageous if institutes are developed where convergent human and animal studies can be conducted under the same physical (and intellectual) roof. At present that remains a rare scientific model. The blending of approaches will require a level of consilience that was never achieved during the past century. It should be one of our foremost goals for the next. Such a synthesis would require us to respect not only the enormous fixed gifts of heredity that we carry within us but the remarkable plasticity of the brain–mind as it interacts with different environments.

VII. The Plasticity of Emotional Systems and Temperament

The plasticity of the nervous system—its ability to be molded in diverse ways by environmental inputs—is increasingly being recognized and acknowledged. Unfortunately, in certain segments of the intellectual community, this is still all too often done with a neglect of the equally important proposition that the plasticity operates within certain genetically dictated limits. The developmental implications of such processes are especially noteworthy (PANKSEPP 2001). Since the available literature in the field is so vast, let me simply summarize three of my favorite recent discoveries from animal brain research that have implications for understanding how stress may affect long-term psychological adjustments.

It is now known that the long-term stress responsiveness of an organism is strongly related to maternal bonding/separation issues (SCHMIDT/SCHULKIN 1999), but the details are rather surprising. For instance, although rodents exhibit a very modest pituitary-adrenal (P-A) stress response during the early neonatal period (3–4 days of life), animals that had been stressed at those early ages exhibit an exaggerated stress response when they grow older. On the other hand, older neonates (11–12 days of age), who already show a vigorous P-A stress response, exhibit comparatively less stress at an older age (VAN OERS/DE KLOET/LEVINE 1998). Thus, the long-term developmental consequences of neonatal stress can be diametrically different depending on exactly when the stress occurred (HEIM et al. 1997). It is to be expected that such long-term changes in stress-reponsivity may have effects on how emotions and cognitions interact later in life (i.e., early trauma that is not remembered may have long-lasting effects on adult personality), but little evidence is presently available on such issues.

A second impressive recent study related to the long term consequences of stress, as induced by a major social event—a single instance of social defeat—found remarkably long lasting effect in rats (RUIS et al. 1999). Socially housed male rats were given one robust experience with defeat by being forced to intrude into the territory of another male. The behavioral and physiological consequences were followed for three weeks. An informative aspect of this study was that following that horrendous defeat, half the animal were returned to live with their normal social groups while half were forced to live individually. The animals that had friendly social companionship following the stressor fared much better. They lost less body weight, were behaviorally less fearful, and exhibited smaller P-A stress responses to new stressful situations. At the end of the three week experiment, the socially-housed animals had larger sex glands and smaller adrenal glands (indicating they had experienced less chronic stress). This effect is rather similar to what we might expect from SHAND's 69th law, and it would suggest that simple social comfort is enough to ameliorate the effects of devastating emotional episodes. Active cognitive support may not be needed. In sum, friendly social companionship protected even "lowly" rats from the deleterious effects of social stress. One can only imagine how long such stressors might last in humans that had little social support—years no doubt.

Finally, in the same vein, BRUIJNZEEL et al. (1999) recently evaluated the cerebral consequences of one prior stress as evaluated by the *number of neurons* that respond to a different stress. The experimental animals in this study were exposed to one experience with mild foot shock, while the controls received no shock. Two weeks later, a shock-probe (very different from the previous shock device) was placed into each animal's cage. In investigating this novel object, animals usually received one or two shocks, and after half an hour their brains were removed and processed for cFos immunoreactivity, highlighting how many cells had been aroused by this stressful experience. The animals that had had the single prior experience with shock, exhibited twice the overall brain reactivity as animals that had not been previously stressed. Thus, the neural consequences of one stress experience could be clearly detected two week later within a remarkably large number of brain areas. Using such techniques, we are coming to better appreciate the widespread consequences of emotional arousal within the brain, even throughout most of the cortex (BECK/FIBIGER 1995; KOLLACK-WALKER/WATSON/AKIL 1997).

In short, we are finally in a position to empirically determine how emotional experiences can modify the temperamental tendencies of animals. More basic studies along these lines are bound to appear, and they will allow us to think clearly about the way similar emotional processes operate within human brains. How emotional habits may emerge in one of our most important, but least recognized emotional systems—the appetitive motivational SEEKING system—is extensively discussed in IKEMOTO/PANKSEPP (1999). Similar scenarios can be constructed for all the other basic emotional systems of the mammalian brain.

Conclusions and evolutionary/computational perspectives

Andy CLARK (1997) has provided a compelling argument for viewing cognitive processes as much more than digital information flow, and has insisted on including the analog processes of the body and environment as essential components of mind. Such perspectives are equally germane for emotions. We need thoroughly organic concepts of emotions in order to come to terms with what the brain really does. The cognitive revolution, modeled upon the type of information that flows most easily in digital computers is insufficient to really get at the roots of those organic dynamics that create affective consciousness. Although "affective computing" is beginning to flourish (PICARD 1997), there are many reasons to suspect that the neural foundation of consciousness is so fundamentally analog and organic that present computational–functional approaches will fail in giving us a realistic image of the foundations of mind. However, computational approaches do provide excellent ways to envision how the "scaffolding" for many higher informational-knowledge processes are created in higher regions of the brain.

At this point in the development (and failure) of cognitive science, it is becoming ever more evident that we need alternatives to traditional digital algorithms of consciousness. As Walter FREEMAN (1995, 1999) has advised us, we may need to fathom the "shape" of mind through images of multiple chaotic attractors derived from real-life analyses of spatially resolved neurodynamics. But still, such computations may only provide surface images of brain functions that constitute psychological processes in action. Then again, maybe that is precisely what mind is—a global, spatio-temporally resolved neurodynamic envelope arising from cascades of local perturbations within multitudes of neuronal assemblies. Perhaps the external form is a fine representation of the inner content. In any event, such dynamic metaphors provide images we desperately need to envision the true complexity of brain–mind. However, to fathom the ancient emotional and motivational systems upon which our higher mental abilities are build, we may need to understand the synaptic tides that course through the fabric of our lower brain through the auspices of many interacting neurochemical systems. Understanding the computational chatterings of digital on–off switches in computer simulations will never provide the powerful knowledge afforded by a study of the underlying organic processes.

In any event, to make substantive progress on such issues we need to have more pluralistic points of view. In addition to progressing further and further upward in computational–representational space, we also need to develop downward views whereby mind is rooted in, and perhaps fundamentally situated within embodied brain processes. Even though we may be able to eventually monitor the fluctuating shapes of primordial aspects of mind in non-linear dynamics (LEWIS/GRANIC 2000), to really understand what is going on, I suspect we shall also have to conceptualize psychological processes in organic terms: Not only does the brain resonate with the abilities of the physical body and the dynamics of the world, as outlined by CLARK (1997), the mind is instantiated in neural nets which do not simply transmit information, but which create dynamic fields of action that proved useful in the evolutionary history of each species. I suspect that such fields of action are the key dimensions of mind which are currently missing in modern mind science, and which can be most readily implanted into our ways of thinking through a variety of primary-process emotional concepts which recognize that affectively tinged action readiness is a fundamental substrate of mind. Basic psychological processes reflect the ways in which the evolutionarily provided brain tools of an organism to reach out into the environment. I especially like William POWERS's (1973, 1998) *Perceptual Control Theory of Action*, which is quite compatible with such views.

The fundamental cleavage lines of the primordial mind will have to be fathomed through some type of evolutionary psychology that we presently do not have. The "massive modularity" of the TOOBY/COSMIDES (2000) tradition has yet to handle the foundational issues well. It has not yet provided an intellectual structure that offers clear predictions about the brain. All too commonly, modern evolutionary psychology is expending its intellectual resources on potential fantasies (see SAMUELS 1998)—evolutionary stories which may interface nicely with the digital-cognitive revolution, but which do not jibe well with what we already know about the ancient regions of the brain where emotional urges are truly elaborated.

Too much of current evolutionary psychology is convincing too many young scholars who have not been steeped in substantive neuroscience and behavior genetics traditions a bill of goods that may lead to another "century of misunderstanding" comparable to that foisted upon us by the behaviorist and cognitive revolutions—branches of which rapidly transformed into "dustbowl" varieties where facts were collected with inadequate guiding concepts (which Kant warned us against—see epigraph). No comprehensive brain–mind science has yet emerged that has given us the type of realistic general image of mind that psychoanalytic thought sought to advance during the 20th century. Of course, the psychoanalytic tradition, following FREUD's (1981a) abandonment of his neuro-theoretical *Project for a Scientific Psychology* also did not have the heart to immerse itself in substantive brain matters, a bias that is only gradually being coaxed to change (see the new journal *Neuro-Psycholanalysis*—SOLMS/NERSESSIAN 1999). In any event, recent efforts like DAMASIO's (1999) are welcome harbingers of a new age of reason.

My personal advocacy of the subcortical view is premised on the conviction that at that level of neural evolution, we will find the genetically ingrained "powers" that have guided all subsequent layers of brain–mind emergence. Accordingly, I remain suspicious of an evolutionary psychology that would aspire to find special-purpose "modules" in higher regions of the human brain (e.g., TOOBY/COSMIDES 2000) when the absolutely essential lower modules we share with the other animals are being ignored. There are many reasons to believe that higher heteromodal regions of the human cortex are more akin, at least at birth, to general-purpose computational devices rather than special-purpose cognitive tools. Perhaps we could here extend Andy CLARK's (1997) remarkable image of language evolution as something that was adapted to existing brain function, rather than the brain being adapted to language. Let us take that line of reasoning a step further back: Perhaps the neocortex, a general purpose information processor resembling a massive ensemble of digital computers is adapted to the exigencies of core subcortical functions—the basic genetically-ingrained survival issues—which took so much longer to construct during brain evolution than did the cortex. We should remember that the human neocortex expanded remarkably rapidly during the past 3 million years, resembling the swift pace at which the speed and memory size of our man-made digital computers has increased during the past half century. A general purpose knowledge machine, with evolutionarily refined perceptual and motor abilities, is much more useful for guiding adaptive behaviors than special purpose cognitive modules. In this context, we should remember that most of the basic emotional and motivational survivial modules had been "perfected" by evolution long before proto-humans strode the face of this earth.

The human neocortex may be better conceptualized not as the fundamental source of consciousness but as a remarkable general-purpose skill-box that is adapted to the types of subcortical functions that had existed for a much longer time. Obviously, it is also designed to perceive the world in specific ways, but I doubt if it could perceive anything if separated from the subcortical functions to which it is largely subservient. In the final accounting, it may only be a tool of a more primary form of consciousness, and quite incapable of sustaining any type of consciousness on its own. And even though it is a most magnificent tool (with vast perceptual and cognitive abilities), it remains, I suspect, a handmaiden for more primary forms of consciousness (DAMASIO 1999; PANKSEPP 1998a, b). Core-consciousness—a global brain dynamic built upon biological survival values—was constructed out of organic materials in brain evolution, and it may still be tethered to those analog processes in some very fundamental ways.

I know of no evidence that is inconsistent with such a view, and if it were more generally considered, we might be encouraged to start looking for the big answers to our big questions subcortically where the cognitive light is dim but the affective light is bright. Obviously the subcortex is incredibly SELF-centric and "myopic" and the remarkable brightening and focussing of perceptual images achieved by the recently emerged cortical abilities is just short of miraculous. However, the real miracle of mind—the seat of the SELF—resides within medially situated subcortical areas as neurological evidence has long affirmed (SCHIFF/PLUM 1999). "Only" the glittering raiments of the mind—the autobiographical self and its many attendants—are stitched together by cortico-cognitive computations (DAMASIO 1999).

In sum, there are presently compelling reason to believe that the foundation of mind is realized in organic processes that can only be superficially modeled (i.e., like a toy-airplane) using computational approaches. Such pursuits may run into a massive wall—the true complexity of life—which may never be simulated except in the most pedestrian of ways. And our most effective simulations may require some type of attempt to mimic the evolutionary and epigenetic processes that help create the real developmental landscapes within living organisms. Molecular biology is now confronting such a walls in its desire to genetically engineer away disease. The interactive complexity of genetic controls remains mind-boggling and will continue to baffle us long after the human genome has been sequenced.

However, our technological endeavors are bound to yield many remarkable products, and computationalists are bound to eventually claim success on the consciousness issue. Accordingly, we now need another Turing Test to provide a compelling screen to evaluate the presence of "real" emotional and motivational processes—mental life in its various affective forms. May I suggest a few? Might not a combination of the following suffice: i) responses on a visually based RORSCHACH-type test designed to simulate our own free-associative tendencies, ii) an auditory-aesthetic prosody/musical appreciation test, and iii) a somatosensory and sexual test to evaluate the pleasure of touch and the friction of skin between consenting beings. We might add gustatory tests to distinguish wonderful culinary delights from more mundane edibles and potables, and tests to evaluate the presence of true hungers, passions, desires as well as cognitive responses to such basic conditions of the flesh.

In any event, it is a pity that many of these issues in humans remain to be empirically characterized. To achieve that, we will need a generation of mind scientists willing to pursue such mysteries of the human mind—evaluating the parametric psychological and brain responses of humans to a large range of affective stimuli, through some type of integrative psychobiology that does not yet exist. Because of the current stranglehold of fine-grained neuroscience and computational cognitivism on available resources, such integrative approaches to the brain–mind have barely begun. In short, it will be as important to understand why colo-rectal distention arouses so much affective turmoil in our brain–minds (TRAUB et al. 1996) as why we aspire to have lofty thoughts.

We will never have a satisfactory understanding of the human mind until we have a reasonable grasp of the "emotional brain" that all mammals share. In other words, there may be something to the embodied nature of living existence at the subcortical level that will require young scholars, devoted to the pursuit of artificial mentality, to get immersed in brain research. Perhaps we should encourage all students interested in mind to return once more, with refreshed evolutionary perspectives, to the animal brain research laboratory as part of their obligatory apprenticeship. Brain emotion theory can guide insightful new observations concerning animal behavior and predictions concerning the feelings that exist in human minds. Without such perspectives, the present tsunami of affect-free, cognitive research, that reveals little about our deeply human/animalian condition, can only increase, and we will continue to have an inadequate appreciation of our deeply embedded place of mind in the living order.

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Note

1 Previously published in 2000 as "The neuro-evolutionary cusp between emotions and cognitions: implications for understanding consciousness and the emergence of a unified mind science", Consiousness and Emotion 1:15–54. Copyright John Benjamins Publishing Company. Reprinted with their permission. Since we did not have the opportunity to work from the final copy-edited manuscript published in Emotions & Consciousness, the present version is based on the penultimate version of the author's manuscript. Except for precise wording and a few paragraphs that were not included in the previously published paper, this is essentially the same paper.

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