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On the Embodied Neural Nature of Core Emotional Affects

*Basic affects reflect the diversity of **satisfactions** (potential rewards/reinforcements) and **discomforts** (punishments) that are inherited tools for living from our ancestral past. Affects are neurobiologically-ingrained potentials of the nervous system, which are triggered, moulded and refined by life experiences. Cognitive, information-processing approaches and computational metaphors cannot penetrate foundational affective processes. Animal models allow us to empirically analyse the large-scale neural ensembles that generate emotional-action dynamics that are critically important for creating emotional feelings. Such approaches offer robust neuro-epistemological strategies to decode the fundamental nature of affects in all mammals, including humans, but they remain to be widely implemented. Here I summarize how we can develop a cross-species affective neuroscience that probes the neural nature of emotional affective states by studying the instinctual emotional apparatus of the mammalian body and brain. Affective feelings and emotional actions may reflect the dynamics of the primal viscerosomatic homunculus of SELF-representation.*

Overture: A Synopsis of the Affective Neuroscience Strategy

How can we ever understand how affective experience is created in the brain?

My premise is that affective experience is a deeply neurobiological process, and scholars who do not invest in the biological sciences, have little hope of shedding light on what affects really are. In my estimation, such intrinsic brain processes, shared in part by all mammals, need to be defined conjointly in terms of experiential and neural-systems characteristics. Obviously, one cannot study such psychobiological processes without fully considering the nature of human experience, but one cannot understand the neural mechanisms unless one has

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empirically compelling model systems for the brain work. Although the affective lives of the other animals can only be indirectly estimated from a study of their emotional behaviours, if we take a fully evolutionary approach, the knowledge we cull from them can be phenomenologically evaluated in our own species.

The essence of the affective neuroscience approach I have advocated is that we may comprehend the nature of affect by cross-species triangulation among three relevant lines of evidence: the behavioural, the psychological and the neuroscientific (Panksepp, 1998a). I believe the most behaviourally relevant line of evidence is the study of instinctual emotional behaviours, best done in animals who do not inhibit or regulate such behavioural outputs as much as humans. The complex cognitive aspects will continue to be best studied by human first-person self-reports, but animals' vocal signals and behavioural choices may remain essential for identifying the material substrates from which affective states first arose in brain evolution. If so, the brain mechanisms that generate affective experiences are best deciphered in animal models where the necessary physiological work can be done (Panksepp, 2005a).

My guiding premise is that there exist homologous neuro-evolutionary foundations for affective experience in all mammalian brains. Affective neuroscience seeks to reveal the causal foundations of basic human emotional feeling through a neuroscientific study of emotional operating systems in relevant animal models. The nature of such experiences in animals is an important, but secondary, issue. Establishing general principles shared by all mammals is the optimal strategy for laying a solid foundation for understanding the core affective states of humans. Thus, neuro-mechanistic insights derived from the animal work must be corroborated through human research, where first-person experiential changes can be documented (Panksepp, 1999) and clinical implications evaluated (Lane & Garfield, 2005; Panksepp, 2004).

Although the semantic and conceptual dilemmas in the field of affect science are abundant, through successive empirical iterations of this type of neuro-evolutionary strategy, lasting cross-species principles of how brain dynamics generate affect should emerge. Since this kind of approach remains to be widely implemented (Panksepp, 2005a), the aim of this essay is to highlight how progress might be facilitated. The biggest conceptual dilemma is how to *define* deep evolutionary functions of the brain, such as the affects,¹ which may be the 'ancestral voices of the genes' to use Ross Buck's felicitous phrase.

[1] The psychological definition of affect is largely based on the traditional Wundtian idea that all emotions have three major dimensions: i) various feelings of goodness and badness (valence), ii) levels of psychological activation (arousal) and iii) how much an emotion fills mental space (power or surgency). These are typically operationally measured with various pencil and paper self-report scales. Obviously, the ultimate definition of an emotional affect must be strongly linked to neural properties that can not be achieved before the scientific work is reasonably well advanced. However, the general characteristics of emotional systems have been defined in neural terms, and include the following six characteristics of emotional operating systems depicted in Figure 1. Affect, in this scheme, arises from the characteristic neurodynamics of these emotional operating systems, perhaps by interacting with other brain circuits for self-representation such as those that arise from

Historical and Conceptual Perspectives

Because of the paucity of relevant discussions in neuroscience, few explicit and testable theoretical proposals concerning the nature of affect have been placed on the intellectual table. An exception would be those general neuroanatomical hypotheses arising largely from recent human brain imaging, where the likelihood of many false negatives and affect-free cognitive neuro-echoes remains large. If one carves this intellectual territory into tripartite zones, it is clear how disparate and uncoordinated present paradigms remain: 1) The traditional *behavioural neuroscience* view (i.e., that emotions are learned via reinforcement principles; Gray, 1990) suggests that affect is not a relevant question in animal research, since such experiential processes emerge in humans through our unique cortico-cognitive linguistic abilities (Rolls, 1999). 2) The traditional *cognitive neuroscience* view suggests that affects reflect the ability of neocortical processes, whether those of dorsolateral frontal cortical working-memory fields (LeDoux, 1996) or somatosensory fields of the cortex (the somatic-marker hypothesis of Damasio, 1994, 2003), to 'read out' implicit subcortical emotional information into experiential states (Lane & Garfield, 2005). 3) In stark contrast, the *affective neuroscience* view holds that raw affects arise from the neurophysiologies of a variety of sub-neocortical emotional action systems that modulate the dynamics of our core selves (MacLean, 1990; Panksepp, 1982, 1998a,b). Because of such profound ontological disagreements, the study of affect is generally ignored in basic animal research (for overview, see Panksepp, 2005a), even though it is emerging as a major theme in animal welfare studies (McMillan, 2005).

Most everyone understands what it means to feel hungry, thirsty, cold, angry, fearful, sad, happy, disgusted, lusty, and intensely interested in pursuing the many resources of our environments. This 'understanding' is psychological, reflecting our basic experiences of living in the world. We can only obtain comparable evidence in other animals by careful studies of their natural emotional and motivated behaviours (Panksepp, 1998a, 2005a), especially their emotional vocalizations that may reflect their internal affective states (Knutson *et al.*, 2002; Panksepp *et al.*, 1988, 2002). The only measures neither animals nor very young children can provide are propositional linguistic reports which require neocortical tissues far removed from, and perhaps not well connected with, brain areas that mediate emotional feelings. Thus, with respect to every measure except one, intentional verbalized feedback, we are confronted by exactly the same epistemological difficulties in studying the internal emotional experiences

centromedial midbrain circuits (e.g., PAG) that are strongly interconnected with medial frontal structures (for a schematic depiction, see Affective Neuroscience, Fig 3.3 (Panksepp, 1998a)). In general, it may be easier to define and study core emotional affects than sensory ones, because of the clear and measurable behavioural-action indicators evident during instinctual-emotional arousal. In any event, affects reflect relatively invisible neurodynamics of ancient brain systems that are hard to measure directly. That may require development of novel techniques where many recording probes are situated properly in the relevant circuits rather deep within the brain (Panksepp, 2000), with an attempt to reconstruct the state spaces of each basic emotion.

of all mammals. In humans we have the further problem that the relevant brain systems are inaccessible in routine research practices. But brain affective processes remain neglected in animal neuroscience, even as psychology has reclaimed affect, cautiously, as a critical mind process (Barrett *et al.*, 2005; Davidson *et al.*, 2003; Russell, 2003).

The search for a scientific understanding of basic affective feelings in behavioural neuroscience was sluggish during the past century because of the prevailing positivistic belief that such subjective states of mind either did not exist or were unknowable, and hence outside the ken of scientific inquiry. Such biases became ingrained in the psychological sciences long before modern neuroscience revealed new empirical possibilities. Affects were scientifically unknowable as long as we did not understand how the brain worked in conjunction with the body, and how the brain-body duo engaged the world. Modern neuroscience has changed all that. Neuroscience now allows us to theoretically envision the neurophysiological causes of affective experience, with abundant predictions that can be disconfirmed through rigorous investigation (Panksepp, 1998a, 2005a). With molecular advances in our understanding of the brain, such perennial problems of human and animal existence can now be scientifically clarified. But to do that we must seek to envision how large-scale neural networks establish mentality through complex interactions both inwardly and outwardly directed.

Unfortunately we still have a socio-cultural problem in brain-mind science — most psychologists are ill-prepared (even resistant) to actualize the opportunities that basic animal neuroscience is providing for a causal understanding of human emotional feelings. Conversely, many neuroscientists remain hesitant to envision how psychological processes emerge from neural dynamics, especially in other animals. To the best of our knowledge, *basic* affective feelings supervene on homologous brain systems shared by all mammals, especially the many ancient subcortical systems that remain poorly illuminated by existing brain imaging technologies (for critiques, see Panksepp, 2004a,b; Schulman & Rothman, 2004). Just as most telescopes can't see far into space, most imaging procedures focus on large, recently evolved, highly active cognitive regions of the brain rather than anatomically smaller, metabolically dimmer subcortical circuits. Only a few have used imaging technologies optimally focused on subcortical systems that animal experiments have long implicated in the genesis of emotional feelings (e.g., Damasio *et al.*, 2000) and sensory affects such as orgasms (Holstege *et al.*, 2003). In any event, neural correlates revealed by imaging only direct us to brain regions where other techniques need to be applied to ferret out causal factors. To develop comparative neuro-phenomenological perspectives and to reveal general principles of mammalian emotional systems, we do need to consider the nature of primary-process affective consciousness in other animals (Panksepp, 2003).

Abundant evidence currently affirms that other animals experience the raw biological values of existence — primary-process affective states — although they may neither cognitively dwell nor reflect on those states as we humans can.

Their experiences can be indexed by the evaluative choices they make, such as conditioned place preferences and aversions, indicating that they distinguish life-supportive and life-detracting events (Bardo & Bevins, 2000), providing a foundational understanding of human feelings (Panksepp, 1998a, 2005a).

Toward an Understanding of Affective States Within the Brain

How could spooky, hard-to-define processes such as affects (see note 1) have ever emerged in brain-mind evolution? Perhaps such internal coding of life-supporting values dramatically enhanced survival. Affects probably emerged in brain evolution to help animals anticipate various survival needs and thus prepare for them in advance. In other words, affects reflect ancestral memories — neuromental heuristics that enhance life-sustaining decision-making. Indeed, it is possible that the kinds of ‘reinforcement’ processes that mediate individual learning are fundamentally affective, and that there are many basic affects, not just singular forms of positive and negative valence.

In my view, emotional feelings represent only one category of affects that brains experience. Emotional affects appear to be closely linked to certain prototypical types of action readiness (e.g., rage, fear, desire, lust, distress, nurturance, playfulness) that may derive their characteristic experiential feels from brain operating systems that orchestrate such instinctual responses. Other affects, constituting the pleasures and displeasures of sensations (e.g., enticing and disgusting stimuli) and bodily homeostatic and background feelings (e.g., hunger and exhilaration), reflect how life-supportive and life-detracting stimuli create neuro-phenomenological changes that help index neuro-metabolic states of well-being. Just consider feelings of profound tiredness after vigorous physical exertions. Animals show all possible indicators of such states, except saying, ‘I’m exhausted.’ Fatigue arises from poorly understood brain and bodily changes, but reduction of brain dopamine activity is surely one key aspect. Since time immemorial, coca leaves have been used to alleviate fatigue in traditional cultures, and pharmacological elevation of brain dopamine increases work output in animals (Panksepp & Moskal, 2005).

Affective mentalities may be clarified by decoding the ways in which our brains were constructed through eons of evolutionary selection. For instance, brain dopamine energizes the seeking of all types of resources. Such appetitive desires are manifested in subjective feelings of exhilaration that can border on euphoria (Volkow *et al.*, 2002), but initially such states exist without propositional contents. Early in development, the brain does not know what it is seeking—such knowledge requires experience in the world. Some say it is hard to imagine how affects could have emerged in brain dynamics as a function of evolutionary selection, but this is not so hard to conceptualize. Presumably all affects ultimately reflect various distinct neurodynamics that simultaneously code for the intrinsic behavioural and psychobiological values essential for survival.

Newborn animals must have some intrinsic capacity to anticipate life-supporting and life-detracting events, and affects serve those functions. Learning extends and resolves them even further. Thus, hunger is a useful way to anticipate energy needs well before body resources are dangerously depleted. Fear can keep animals out of harm's way. Separation distress can diminish the probability of becoming lost. Of course, the animal work can only illuminate basic human affects if sufficient neuro-evolutionary continuities exist to allow credible cross-species translations. While fish may have little to teach us about jealousy, mammals that show strong social attachments surely can. Each system has to be worked out on a case-by-case basis, not only with respect to individual species but also individual brain neurochemistries. With dopamine, we no longer have much doubt that circuits such as mesolimbic pathways facilitate foraging and euphoric psychic energization in all mammals. If excessively sustained, such changes degenerate into the paranoid ideation of schizophrenia and eventually depression upon drug withdrawal as organisms 'collapse' from psychic exhaustion.

If the basic emotional affects are closely associated with the instinctual emotional-action dynamics that all mammals exhibit spontaneously in various life-challenging situations, we have a workable strategy to understand the neuro-evolutionary sources of the kinds of feelings (primal neuro-emotional *endophenotypes*) that figure so heavily in everyday affects as well as the excesses of psychiatric disorders (Panksepp, 2004a). Cross-species neuro-ethological research may clarify how such foundational aspects of consciousness arise from the organic complexities of brains and bodies. If such foundational neurodynamics are closely related to the generation of primal experiential states, we may finally have a workable paradigm for studying the *causal* foundations of affective consciousness in animals as opposed to just the neural *correlates* of cognitive consciousness in humans. Such a *dual-aspect monism*² strategy provides a most coherent epistemological way to proceed.

Since adult human behaviour is remarkably well regulated by higher cognitive processes, the activities of emotional action tendencies are not as easily monitored in our own species as in fellow animals. Contrary to William James's

[2] Dual-aspect monism is the view that the complexities of nature cannot be understood from a single perspective. Thus in affect science, each emotional state has several facets that go together as reflective of the same process. For instance, complex emotional instinctual behaviours, such as rough-and-tumble play, are considered to have an affective facet that might be called social joy (Panksepp & Burgdorf, 2003). This reduces the need to dwell on a variety of dualistic dilemmas that could immobilize research into the brain substrates of affective processes in animals. In brain science, this 'dual-aspect theory' was first fully developed by George Henry Lewes in Chapter III of his *The Physical Basis of Mind* (1877), the third volume of his *Problems of Life and Mind*. It is more productive than general mind-brain identify theories which can easily envision mentality to be epiphenomenal. If anything, we can be certain the experiential states are thoroughly neurobiological processes. Dual-aspect monism offers a clear strategy to link basic dynamic features of brain and mind, such as emotional instinctive expressions and the corresponding affective states, in empirically productive ways. If this view yielded no new predictions, it would simply be another metaphysical view. However, this strategy allows clear predictions from basic behavioural research in animals to predictions concerning brain functions that control emotional feelings in humans (Panksepp, 1999). Hence it is falsifiable.

famous conjecture (i.e., the famous James-Lange peripheral read-out theory of emotion), my premise is that it is not the peripheral bodily changes that are the main sources of our emotional feelings, but rather the central neural circuit dynamics that generate instinctual emotional actions and associated autonomic changes that support those actions. In other words, the primal emotional action networks, neural systems that James knew nothing about, may be the proximal sources of raw emotional feelings. They may directly generate affective states that are excellent brain heuristics for guiding additional learning.

Humans still have those instinctual dynamics in their brains, but adults often actively inhibit their expressions. We are adept at repressing instinctual actions — from striking out in anger to showing our grief — through higher cerebral inhibition. Just consider how well eliminative urges are regulated in humans — leading to escalating distress in various social situations. And even if inhibition of emotionality were not such an enormous problem, our experimental access to the relevant neuro-causal processes in humans remains meagre.

Despite spectacular advances in non-invasive brain imaging of higher cerebral processes, and our capacity to stimulate neocortical areas with transcranial magnetic stimulation (Nahas *et al.*, 2004; Schutter *et al.*, 2004),³ the disentangling of brain processes that are essential for the generation of emotional feelings does require direct manipulation of subcortical causal mechanisms in ways that are ethically inconceivable in human research (and debatable in animal research). If substantive progress on such human questions could be advanced through the study of the natural emotional circuits of other mammals, it would be short sighted not to invest in models where critical evidence can be harvested. Let's remember that much of what we know about the mechanisms of memory was derived from the study of sluggish sea creatures (e.g., especially as studied by Eric Kandel and colleagues, now emulated and extended by many others).

Animal research programs seeking to understand human emotional feelings can choose to pursue neuroethological studies of natural emotional behaviours (e.g., Panksepp, 1982, 1998a), or to focus on emotional learning (e.g., LeDoux, 1996). Obviously both are important, but I favour the former since affectively rich, natural emotional behaviour patterns can be evoked by localized electrical brain stimulation (ESB). Electrical 'garbage' — brain stimulations that have no 'informational' content — applied to homologous subcortical regions yields coherent emotional behaviour patterns in all mammals. Such manipulations yield the corresponding emotional feelings in humans (Heath, 1996; Panksepp, 1985). Because this pattern of '*electrical garbage in, behavioural coherence out*' is evident across species, we can be confident that the brain stimulation is evoking natural, evolved functions of the brain. Such sub-neocortically evoked instinctual actions are also accompanied by internal states that animals find desirable or undesirable, as indicated by their behavioural choices (Panksepp,

[3] The author has undergone stimulation of essentially all regions of his neocortical mantle with TMS, with no elicitation of acute emotional experiences, affirming that such cerebral structures may not be critical for raw affective experiences, especially since localized stimulation of subcortical sites often yield intense affective experiences (Heath, 1996; Panksepp, 1985).

1998, 2005a). Thus, from a dual-aspect monism perspective, it seems likely that the study of the neural underpinnings of unconditioned emotional behaviours in animals is a compelling way to understand the nature of emotional affects in all mammals.

Such findings fit nicely with a naturalistic views of emotions that are resonant with more humanistic cognitive perspectives (Robinson, 2005). We humans do not learn to experience affects, but we *learn* when and how to experience them and what to do about them. The classic cognitive view that emotions always need propositional objects, must deal with the dilemma that it would be counterproductive to have ancestral memories (e.g., emotional tools for living) pre-coded for propositional contents. Why waste genetic effort on things that need to be learned, but for exceptional cases such as the smell of predators. Propositional contents must come from living in actual worlds. Raw affective feelings need not. Indeed, ancestral affective ‘memories’ are fine general-purpose tools for guiding subsequent learning. Since evolved emotional tools were designed to interact with cognitive structures, it is no surprise that our primitive affects come to be modulated by higher brain structures (Ochsner *et al.*, 2004).

Basic affects are cross-species gifts of nature. Since the earliest neuroscience work on such topics, it has seemed highly likely that certain core emotional feelings are ‘instinctual’ tools of nature rather than constructions of nurture (Panksepp, 1998). Emerging evidence continues to highlight how much our affects are dependent on our animalian emotional circuits. Just recently it has been revealed that ESB applied to nucleus accumbens can generate smiling and mirth (Okun *et al.*, 2004), and in essentially the same brain regions, we can evoke joyous playful chirping-‘laughter’ in rats, not unlike that seen in human children at play (Burgdorf *et al.*, 2001; Panksepp & Burgdorf, 2003). These brain areas also light-up when one is anticipating rewards with feeling of positive affect (Knutson *et al.*, 2001), just as the animal data predicted (Ikemoto and Panksepp, 1999). Although such instinctual systems are intimately related to learning processes, they were created, in raw form, by our ancestral heritage pre-dating the appearance of *H. Sapiens* on the face of the Earth.

To make progress on elucidating the nature of affective states, emotional and otherwise, one needs to consider psychological perspectives that can be linked to neuroanatomical, neurochemical and neurophysiological levels of analysis. Robust linkages to human concerns will emerge if critical underlying brain and body functions are homologous in other mammals where neural mechanisms can be studied in sufficient detail. The resulting neurochemical principles may be evaluated in human models, where one can obtain self-reported internal experiences (Panksepp, 1999; 2004b). However, before proceeding, let me pointedly highlight the continuing anti-affect sentiments in modern behavioural neuroscience.

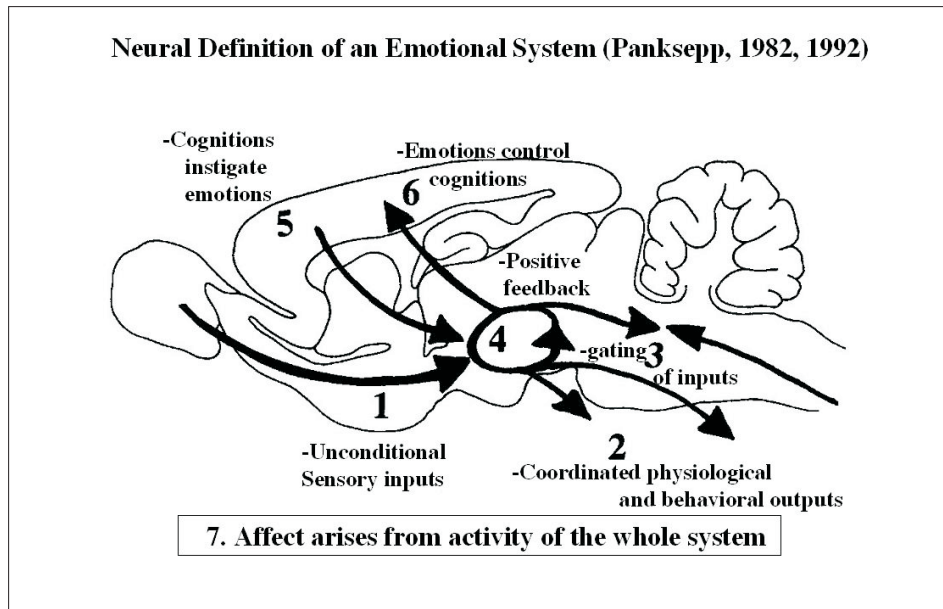


Figure 1. Neural definition of an emotional system (Panksepp, 1982, 1992).

The various neural interactions that are characteristics of all major emotional systems of the brain. (1) Various sensory stimuli can unconditionally access emotional systems; (2) emotional systems can generate instinctual motor outputs, as well as (3) modulate sensory inputs. (4) Emotional systems have positive-feedback components that can sustain emotional arousal after precipitating events have passed; also (5) these systems can be modulated by cognitive inputs and (6) can modify and channel cognitive activities. In addition, the important criterion that emotional systems create affective states is not included, but (7) it is postulated that arousal of the executive circuit for each emotion is essential for elaborating emotional feelings within the brain, perhaps by interacting with other brain circuits for self-representation such as those that exist in extended centromedial midbrain circuits (e.g. PAG) that interact with anterior cingulate and frontal cortical systems. [Adapted from Fig. 3.3 in *Affective Neuroscience* (Panksepp, 1998a), with permission from Oxford University Press.]

The Neglect of Affect and Emotions in Behavioral Neuroscience

Historically, it is easy to understand why affects and other subjective experiences were neglected in behavioural neuroscience. There are no unambiguous ways to define the evolved 'emotional' functions of the brain-mind before the relevant scientific inquiries. Good definitions of intrinsic brain functions can only follow incisive neuroscientific inquiries, but provisional definitions can be generated by the circuit properties shared by all basic emotional systems (Figure 1; see also note 1). Without intentional verbal reports of mental experiences (obviously only possible in organisms that have language), one can only proceed if one advances theoretical frameworks that lead to clear hypotheses with explicit behavioural predictions. Only after abundant research can one judiciously weigh the evidence from psychological perspectives (Knutson *et al.*, 2002; Panksepp, 2005a). Unfortunately, such theorizing has long been dismissed in behavioural neuroscience as mere speculation, and hence relevant data

collection has been inordinately slow. Many have long shared profound doubts as to whether animals have any emotional experiences at all.⁴

According to our *dual-aspect monism* strategy, basic affective experience emerges from the dynamics of emotional operating systems that remain conserved among all mammalian species, leading to clear predictions about the nature of raw emotional feelings in humans. My research has aspired to provide a coherent theory of the neuro-evolutionary underpinnings of raw emotional feelings, while most of my colleagues have insisted that this topic cannot be scientifically addressed. Historically, it is understandable why modern neuro-behaviorists have little interest in understanding how animals feel, but they may be ignoring wide swaths of what is truly transpiring in brains of the animals they study. Indeed, if it were to turn out that ‘reinforcement’ processes were actually dependent on the affective systems of animal brains (*vide infra*), we may not fully understand the mechanisms of learning without probing the nature of neuro-affective processes.

In any event, modern behavioural neuroscience is out of step with other informed views on animal feelings (e.g., Bekoff, 2002; Grandin, 2005; MacMillan, 2005), and serious engagement on this topic is difficult unless one is willing to consider the implications of *all* the available evidence (also see Panksepp, 1998a, 2002a,b, 2005a). Thus, it is becoming increasingly important for brain researchers to discuss whether internally experienced agonies and joys, pleasures and displeasures, exist in the minds of the animals they study. If such feelings do exist and do guide their behavioural choices, we cannot understand their brains or our own, without discussing and probing such processes openly. Such subtle issues can be resolved with substantial assurance by evaluating whether conditioned place preference and place-avoidance tendencies emerge in animals experiencing apparent emotional states. If animals had no affective experiences, there would be no obvious reason for them to exhibit learned behavioral preferences. Considering the robust evidence for such affective states

[4] For didactic purposes, let me consider the position of a most illustrious animal emotional-memory researcher, Joseph LeDoux, who has sought to understand fear-learning while attempting to ‘escape from the shackles of subjectivity’ (2000, p. 156). In the past, he has been consistently explicit about i) the likelihood that animals do not experience emotions, and hence ii) the supposed irrelevance of affective experience for understanding emotions in animals. Recently he changed his mind on the first aspect of this issue, while continuing to claim that such states of mind in other animals are scientifically unfathomable: In the January 4th 2005 issue of the *New York Times*, in an article entitled ‘God (or Not), Physics and, of Course, Love: Scientists Take a Leap’ fourteen culturally prominent thinkers were asked: ‘What do you believe is true even though you cannot prove it?’ LeDoux responded: ‘For me, this is an easy question. I believe that animals have feelings and other states of consciousness, but neither I nor anyone else has been able to prove it. We can’t even prove that other people are conscious, much less other animals. In the case of other people, though, we at least can have a little confidence since all people have brains with the same basic configurations. But as soon as we turn to other species and start asking questions about feelings and consciousness in general we are in risky territory because the hardware is different. Because I have reason to think that their feelings might be different than ours, I prefer to study emotional behaviour in rats rather than emotional feelings.’ And what are those *reasons*? Animal sub-cortical ‘limbic’ emotional zones are organized largely the same as ours, albeit they typically have relatively less neo-cortical mass to reflect on their feelings. If affect emerges from those higher reflections, LeDoux is correct. If affects emerge from the homologous sub-neocortical limbic regions, then he is wrong.

(Panksepp, 1998a; 2005a) and the resulting novel causal predictions for human feelings (Panksepp & Harro, 2004), the century-long resistance to integrating such ideas into mainstream neuro-behavioural thinking should gradually fade. However, at present most remain true-believers of the catechisms of early 20th century behaviourism that was inspired by 19th century bio-physics and reinforced by 20th century positivism (Greenspan & Baars, 2005). It continues to be reinforced by an implicit, but rather widespread, anthropocentric neuro-dualism — the view that experiential states are only a property of massively expanded human-type neocortices.

Do Animal Have Emotional Experiences?

Perhaps it is idle anthropomorphism to conclude that other animals do have emotional feelings? Perhaps our human emotional feature detectors (cortical mirror neurons?) only coax us to envision such potential fantasy processes in the minds of other animals. But maybe affects are also essential parts of their brain realities. As every farm boy and dangerous animal trainer knows, it is important to recognize various basic emotions in other animals from their behavioural acts (Darwin, 1872) and emotional vocalizations (Leinonen *et al.*, 2001). Such information is awfully important for staying out of harms way (Hebb, 1946).

Although it may turn out that sub-neocortical emotional neurodynamics need to be re-represented in the neocortex before affective experiences emerge (Lane & Garfield, 2005), the postulation that high-level neocortical readouts, unique to human brain expansions, are essential for core affective feelings may be as naive as the long-discarded geocentric view of the universe (Panksepp, 2005b). Does one need much better evidence for affective experience in animals than the demonstration that arthritic distress in rats increases their consumption of opioid pain-killers (Colpaert *et al.*, 1980)? Abundant data indicate that sub-neocortical processes are critical for such effects (Ikemoto *et al.*, 2003; Panksepp, 2005a). Opioid induced reward is elaborated low in the brain. Place preferences are obtained by putting morphine into primitive brain regions such as the Periaqueductal Gray (PAG) and the Ventral Tegmental Area (VTA), but not ten other higher brain regions that also have abundant opiate receptors (Olmstead & Franklin, 1997). The most vigorous ESB rewards and aversions are obtained from nearby subcortical regions with no robust effects from neo-cortical sites (see note 3). Self-administration of various addictive substances is achieved largely from deep medial subcortical loci (Ikemoto & Wise, 2004). The same goes for neurochemical modulation of a host of other emotional action processes such as anger-type aggression (Siegel, 2005), fearfulness (Panksepp, 1990a), sexuality (Pfaff, 1999), and maternal nurturance (Numan & Insel, 2003), even though the affective properties of such manipulations have been less consistently evaluated.

The existence of various experientially rich emotional systems in sub-neocortical regions of mammalian brains seems definitive (Panksepp, 1998a). Their precise nature is not. That will require more neuroscientists to probe the

fine details of these complex systems with conceptually open-minded and methodologically hard-headed devotion. In my estimation, the best place to start is with the thorough analysis of the affects that accompany instinctual emotional behaviors, and then the re-representations of these brain functions in other brain areas, followed by a study of the more subtle affects. To my knowledge, there is little data that emotional instinctual processes are affectively vacuous, and abundant data that they are accompanied by feelings, perhaps as an integral aspect of the underlying neurodynamics (Panksepp, 2005a)

The Animalian-Emotional Sources of Basic Human Values: Toward A Taxonomy of Basic Affective Feelings

The varieties of affective feelings are enormous, and many humans are skilled in talking about the meaning of such feelings in their lives. However, at their core, raw affective experiences appear to be pre-propositional gifts of nature—cognitively impenetrable tools for living that inform us about the states of our body, the sensory aspects of the world that support or detract from our survival, and various distinct types of emotional arousal that can inundate our minds. Affects reflect the heuristic value codes that magnificently assist survival, and give ‘value’ to life. My *working* premise is that emotional affects reflect certain types of neurodynamics, whose hard-to-describe subjective aspects resemble the recursive-dynamic ‘attractor-envelopes’ of instinctual emotional actions (i.e., the large-scale neurodynamics of the respective emotional operating systems summarized below). In other words, the outward instinctual-behavioural dynamics of various emotional arousals may have class resemblances to the brain dynamics that concurrently create the experiential feelings. Just imagine the pounding feeling of anger. An empirically workable dual-aspect monism strategy may allow us to monitor affects rather directly through the large-scale network characteristics of the underlying brain systems (Panksepp, 2000). However, there are other kinds of affects beside emotional ones (see note 1).

It seems reasonable to taxonomize affective experiences into at least three major varieties: 1) the homeostatic states of our body signaled by interoceptors as well as other chemical states of the body (hard to observe via external signs), 2) the great variety of exteroceptively driven affects such as taste (slightly easier to observe), and 3) the emotional affects, so evident in instinctual action dynamics. The emotional affects may be easiest to study if there are, in fact, solid predictive relationships between the brain mechanisms of emotional action dynamics and the respective feelings. It is also possible that consummatory and other bodily actions accompanying sensory affects, may provide direct read-out of the other kinds of affective processes (Berridge, 2000). In any event the dual-aspect monism strategy currently provides a robust cross-species empirical predictions for how raw emotional feelings may be created in humans (Panksepp & Harro, 2004).

There is insufficient space here for anything more than thumbnail descriptions, but the outward emotional action dynamics evident in all mammals include seven primal emotional processes: (1) SEEKING is characterized by a persistent positively-valenced exploratory inquisitiveness, with energetic forward locomotion — approach and engagement with the world—consisting of probing into the nooks and crannies of interesting objects and events (this system is critical also for most other basic emotional responses, such as the seeking of safety when threatened); (2) FEAR is characterized by bodily tenseness and a shivery negatively valenced immobility, which can burst forth into a dynamic flight pattern with chaotic-projectile movements to get out of harm's way (which may reflect recruitment of dopamine energized SEEKING urges); (3) RAGE is characterized by a vigorous casting of the body at offending objects with biting and pounding of the extremities; it is a mixture of positive and negative valence; (4) LUST is characterized by an urgent and rhythmic thrusting of the body toward receptive others, and in their absence, a craving tension with both positive and negative affective features; (5) CARE is characterized by a gentle, caressing, enveloping body dynamic accompanied by relaxed positively valenced states of the body; (6) PANIC (separation distress) is characterized by aversive crying actions, with urgent attempts at reunion, followed by weakness and a despairing body carriage as grief sets in if reunion fails; (7) PLAY is expressed in a bounding lightness of movement that has an affectively engaging dynamic poking and rhythmic quality, at times bordering on aggression. In my estimation, 'dominance' reflects the epigenetic consequence of several emotional systems, especially PLAY, in action (and should not be deemed a primary emotional system). There are many cognitive emotions that probably rely on these 'primes' for their arousal. For instance, jealousy may arise from mixed feelings of anger, separation-distress and desire, etc.

Hopefully these verbal images help us to envision the dynamic pre-propositional feelings of the various basic emotions. Perhaps a careful topographic analysis of such complex instinctual actions could eventually yield mathematical algorithms for the field-dynamics that characterize affective states. If the feelings of the basic emotions have a class similarity to the outwardly evident behavioural-instinctual action dynamics (imagine again the surging pounding feelings and behaviours of anger), then we may have an objective scientific paradigm for concurrently studying the nature of the emotional primes not only behaviourally but also as affective processes of the brain (Panksepp, 1998a). It would also provide a way to envision how the classic explanatory gap between subjective experience and objective brain events could be bridged. If this dual-aspect monism approach should prove to be misguided in specific instances, we will still have acquired important knowledge concerning the underlying brain substrates of emotional actions in other mammals, and thereby guidance for understanding comparable actions in our own species. It is a win-win research proposition, since it focuses on the spontaneous behaviours of organisms.

Emotional Action Dynamics

Only a few have attempted to objectively measure the ‘force fields’ of bodily emotional *dynamics* (Clynes, 1978). It is increasingly recognized that voluntary simulation of instinctual emotional action dynamics can evoke emotional feelings in humans (for a review, see Niedenthal *et al.*, 2005). One can even generate feelings by simulating emotional action dynamics mentally, without outward actions (Panksepp & Gordon, 2003), providing a methodology for imaging human emotional-action/affective states in novel ways. This also helps explain why neurologically ‘locked-in’ patients, with damage to ventral motor outputs of the brainstem, can still experience emotions — they retain the requisite brain emotional systems, no longer expressed on the body surface. Distinct affective dynamics are also evident in emotional vocalizations (Fichtel *et al.*, 2001), which may be artistically rendered to enhance the emotional qualities of music (Clynes, 1978; Panksepp & Bernatzky, 2002).

Accumulating evidence suggests human emotional feelings are closely linked to action tendencies that are subcortically generated in both animals and humans. It is easy to communicate these bodily dynamics with selected body parts such as expressive movements of the hands (recognition of basic emotional actions is remarkably high (Panksepp, 2003, unpublished data)). Such movement dynamics can help arouse emotional feelings (Clynes, 1978). Of course, in addition to the solid foundation provided by emotional action dynamics, the full quality of each emotional feeling must also include (i) the somatic sensory-feedbacks that accompany such actions, (ii) the changes in the dynamics of neo-cortical fields, as well as (iii) the aroused autonomic and hormonal processes (Fig. 1).

An Overview of Neuroanatomical Locus of Control for Emotional Affects

A striking aspect of emotional-instinctual behaviours in animals is how they survive neo-decortication, especially if the damage is inflicted early in development. Are the animals now simply proverbial ‘reflexive robots’ or do they still have basic affective experiences? Most behavioural neuroscientists still subscribe to the former view, largely because they cannot envision how psychological/subjective processes have any explanatory value in their neuro-mechanistic schemes. This reflects a failure to consider the dual aspect monism view that all basic psychological processes are completely neurobiological (although typically environmentally triggered). When one takes a dual-aspect view to emotional operating systems, neither the neural nor the psychological perspectives are mechanistically privileged. They are reflections of the self-same complex network functions of the brain.

Consider the case of play — one of the biggest sources of social joy. The outward character of playfulness remains largely intact following neo-decortication, and the accompanying affective experiences seem to be sustained (Panksepp *et al.*, 1994). Such animals readily acquire various instrumental behaviours to obtain rewards (Kolb & Tees, 1990), albeit evaluations of

conditioned place preferences in such animals remain regrettably scarce. As all animals mature, they become increasingly dependent on epigenetically derived functions elaborated in higher brain regions, and hence decortication is less well tolerated in older mammals. However, the critical issue here is whether the experienced dynamics of basic emotional feelings exist in such organisms, and the weight of relevant evidence suggests that affective mental contents survive radical neo-decortication.

First, emotional-instinctual behaviours can be instigated by ESB of extended neural circuits below the neocortex. As already noted, the rewarding and punishing properties of such ESB and comparable chemical stimulation of the brain derive their affective punch from subcortical systems (Heath, 1996; Panksepp, 1985). Animals self-stimulate even after surgical damage to higher neocortical regions (Huston & Borbely, 1973; 1974). Parenthetically, such findings affirm classic distinctions between brain emotional/affective and cognitive/rational processes (see next section).

Second, one could note that adult humans who lose most of their neocortical functions fall into persistent vegetative states (PVS), where the remaining expressive gestures (e.g., apparent anger) are deemed affectively vacuous (e.g., 'sham rage'). Obviously, such neurologically impaired humans cannot report on their potential affective states, but we should at least consider the possibility that they sustain some level of affective experience, especially since minimally conscious patients exhibit a great deal of brain activity that would not have been expected from their severe behavioural-communicative deficits (Schiff *et al.*, 2005).

Just as young animals sustain coherent emotional responses following decortication, human children with brain damage that would produce unmistakable PVS symptoms in adults, exhibit emotionally rich responses as long as they are reared in loving environments (Shewmon *et al.*, 1999). They exhibit preferences for supportive people, enjoy music and exhibit clear signs of other basic affects. Are these behaviours simply reflexive, or indicative of experiential states? This dilemma is comparable to what we routinely encounter in interpreting animal behaviour. However, to the extent that their behaviours provide critical evidence, such children do have mental lives.

As I write this essay, the neurological case of Terry Schiavo, who died several weeks after her feeding tubes were removed, should be raising the issue of whether she still had any raw affective feelings in her cognitively unconscious mind. Have her feelings been as completely erased as her cognitive abilities or have they regressed to the level of children with such brain damage (e.g., Shewmon *et al.*, 1999)? Did she die with excruciating feelings of thirst accompanying her final passage?

If vegetative individuals like her still have any remnant of psychic distress, then death by dehydration is 'culturally' condoned cruelty, and it would be more humane for family and medical decision makers to have the option of gentle opioid euthanasia. Although such individuals are clearly cognitively unconscious, they may still have nonreflective affective feelings. Thus, we should

evaluate whether such patients are capable of showing some simple conditioning and preferences for certain rewards and punishments using simple response measures such as eye movements. Although in such PVS cases surface EEGs reflect no measurable cognitive activity, might deeper brain imaging and affective conditioning studies reveal some level of felt experience even though they no longer have the wherewithal to communicate with the outside world (Schiff *et al.*, 2005)? In the absence of additional data, it remains plausible that such pre-propositional individuals, at least those who exhibit some instinctual emotional behaviours, may have some residual emotional feelings. Their preferences, using the simplest response measures, need to be evaluated, as they have in decerebrate cats (Schlaer & Myers, 1972).

The evidence for a sub-neocortical locus of control for affect makes bottom-up approaches to raw affective experience essential to eventually understand the top-down cognitive controls related more to emotional awareness (Lane and Garfield, 2005; Panksepp, 2005b). The bottom-up views of emotional experience help clarify pre-propositional affective psychodynamics that emerge from sub-neocortical regions of the brain. In contrast, top-down views can highlight the rich cognitive tapestry of emotional experiences, where individual differences, art and creativity prevail (Barrett, *et al.*, 2005; Robinson, 2005). While our animalian emotional circuits provide an essential infrastructure for our basic, pre-propositional affective states, higher cognitions help regulate and parse those feelings further, allowing our feelings to interpenetrate with perceptual representations of world events in a seemingly infinite number of ways. I would again emphasize that the problem of clarifying the cognitive contents of animal minds is much harder, perhaps next to impossible (Lewontin, 1998), as compared to the basic emotional contents.

Distinctions Between Cognitive and Affective Processes

There are powerful modern trends in cognitive psychology to conceptualize cognitive and emotional processes as so intertwined that there is no meaningful way to separate them (e.g., Barrett *et al.*, 2005; Lane & Garfield, 2005). However, I suspect such confluences arise from our failure to fully consider the neuro-evolutionary evidence from other animals. From the subjective 'mind's eye' perspective, our feelings and thoughts are indeed remarkably interpenetrating, but they can be distinguished in many areas of the brain. In terms of brain evolution they probably have many distinct genetic and neural controls, as highlighted by how various sub-neocortical emotional operating systems remain remarkably intact in animals neo-decorticated during infancy (Panksepp *et al.*, 1994). Such distinctions are also evident following various kinds of neurological damage in human where the cognitive and affective responses to the same external stimuli, such as music, can be clearly dissociated (e.g., Griffiths *et al.*, 2004).

We can distinguish affective from cognitive processes on many other dimensions: Affects have a sub-neocortical locus of control; they arise from

broad-scale *state control* functions⁵ — large-scale neural ensembles in action; they are analog, less computational, and generate *intentions-in action* that guide *action-to-perception* processes, with many distinct neuropeptidergic codes. In contrast, cognitions have a neocortical locus of control; they arise from more discrete informational *channel functions*. Thus, cognitions are more digital, more computational, can generate *perception-to-action* processes that can lead to *intentions-to-act*, and are profoundly dependent on rapidly acting amino-acid transmitters. Emotional states are fundamentally evolved ‘energetic’ conditions of the brain-body continuum, while cognitions parse the many differences in exteroceptive space and time (see Ciompi & Panksepp, 2005; Panksepp, 2003).

This is not to suggest that our ancient emotional operating systems were not intimately linked to emerging cognitive processes in brain evolution. They surely were. Indeed, our cognitive apparatus may have been evolutionarily constructed on the solid platform of affective principles. However, raw affects do not arise *directly* from the intricacies of our higher cognitive abilities (Liotti & Panksepp, 2004), even though those abilities become decisive in our capacity to effectively and affectively navigate the world — to find ‘comfort zones’ where we wish to live. Much of our cognitive activity emerges in the service of maximizing our satisfactions and diminishing various discomforts. The states of the nervous system that ‘reinforce’ learning may be fundamentally affective.

Now that investigators have finally attempted to see which brain areas are involved in emotionally ‘hot’ cognitions and non-emotional ‘cold’ cognitions, it is clear that more ancient medial ‘limbic’ regions of the telencephalon are devoted to affectively rich emotional reasoning while the more recently evolved fronto-lateral areas of the brain are more involved in ‘cold’ types of rational deliberations (e.g., Goel & Dolan, 2004; Northoff *et al.*, 2004). It is the emotionally based reasoning that is more concerned with egocentric affective issues, while cognitions are devoted more to allocentric concerns. It is probably the case that our feeling of ‘livingness’ is linked more to our affective than our rational nature. Even though emotional affects can easily be repressed by cognitions as we mature, cognitive abilities do not survive after extensive damage to the brainstem substrates of attentional and emotional arousals (Parvizi & Damasio, 2001; 2003; Watt & Pincus, 2004).

The neuroscience of animal cognitions is confronted by more variety than the neuroscience of their affects. Platypuses may think with the cerebral representations of their bills (Pettigrew, *et al.*, 1998) and star-nosed moles through their nasal tentacles (Catania & Kaas, 1997), in ways we can barely envision. But even here scientific progress can be made, especially if we recognize that most other mammals probably cogitate with perceptual images (Grandin, 2005) and that

[5] *State* and *channel* functions refer to the fact that all of what transpires in the brain is not information-processing. Global *states* are created by a variety of neurochemistries, from biogenic amines to peptides, that control vast regions of the brain simultaneously. Affects are presumably regulated by such neurodynamics, which can push the organism into globally distinct psychobehavioural states that are not meaningfully computable digitally; they are nonlinear large-scale analog dynamics. *Channel* functions refer to more discrete information-processing patterns where classical computational metaphors may be more effectively implemented.

much of their higher mental apparatus is devoted to finding and constructing affective comfort zones in physical and social environments (McMillan, 2005). Thus, it is understandable that in maternal behaviour, the basic emotional urge to provide care exists in lower parts of the brain (Nelson & Panksepp, 1998), while the social bonds that allow animals to selectively care for their own offspring are elaborated by higher brain functions (Keller, Meurisse & Levy, 2004). The pleasure of taste is elaborated in lower regions of the brain (Berridge, 2000) than our ability to emotionally over or under respond to qualitative shifts in taste (i.e., contrast effects: when rewards are shifted from higher to lower quality incentives).

In sum, although evolutionary divergences at higher cognitive levels are vast among species, cognitive decision-making remains tethered to affective foundations (Damasio, 1994). In this vein, a critically important neuroscientific question is how the intrinsic affective values of the nervous system help create learning.

Education of the Affects: Emotions, Learning and ‘The Law of Effect’

Just as humans, other animals seek positive affect and avoid negative affect (McMillan, 2005). For most positive emotions (seeking, lust, care, play. . . and perhaps anger in certain situations) as well as for various positive environmental incentives (food, water, etc) animals must actively seek engagement with objects in the world. Thus, they need a general-purpose SEEKING system that pre-propositionally engages the world. Only through experiences with the world do such foraging ‘energies’ gradually get directed by learning and accruing knowledge about the world (Ikemoto & Panksepp, 1999). Animals need to avoid the major negative emotions (fear, separation distress, and anger in various situations) as well as negative sensory incentives (e.g., seek safety and avoid aversive and disgusting stimuli). They need to seek stimuli that can alleviate the distress of homeostatic imbalances (hunger, thirst, cold, etc) and the interdigitating gratifications of various social contacts (sex, nurturance, play).

Animals track optimal levels of positive affect by being ‘magnetized’ by positive affect supportive environmental stimuli (Cabanac, 1992). How learning is linked to these affective states-of-being has never been satisfactorily resolved, partly because of a conceptual morass concerning the scientifically unknowable nature of felt experience during the early part of the 20th century. In behavioral science, the process that supposedly mediates between the seemingly unfathomable affective nature of animals and their (our!) ability to learn is ‘reinforcement,’ based on Thorndike’s celebrated ‘law of effect.’ This idea, as it was transformed from an affective to a non-affective concept, gradually led to the demise of affective thinking in all of psychology.

As initially phrased by Edward Thorndike (1874-1949), the ‘law of effect’ asserted that: ‘Of several responses made to the same situation, those which are accompanied or closely followed by *satisfaction* to the animal will, other things being equal, be more firmly connected to the situation, so that, when it recurs, they will be more likely to recur; those which are accompanied or closely

y followed by *discomfort* [annoyance] to the animal will, other things being equal, have their connections to that situation weakened, so that, when it recurs, they will be less likely to occur. The greater the *satisfaction* or *discomfort*, the greater the strengthening or weakening of this bond.' (Thorndike, 1911, p. 244, my italics).

Of course, it was hard to envision, without an in-depth knowledge of the brain, how ephemeral subjective states such as '*satisfaction*' and '*discomfort*' linked up to concrete observable behavioural changes so evident in learning. Accordingly, Hull (1884–1952), Skinner (1904–1990), and other behaviorists changed the key terms in the 'law of effect' — namely *satisfaction* and *discomfort* — into *positive* and *negative reinforcements* and *punishments*. . . which are even more theoretical concepts, but which, because of their inherent psychological ambiguity (they refer not to mental contents but what we do to animals) seemed to allow an 'escape from the shackles of subjectivity' (LeDoux, 2000, p. 156). Of course, if subjective states of the nervous system exist, and those neurodynamics are critical for understanding what animals do and how they learn, we must talk openly about such body/brain/mind entities.

As *reinforcement* concepts were taken to be real brain processes, behaviourism discarded any connection with the great diversity of affective concepts that scholars from Aristotle to Darwin had deemed essential for any coherent understanding of human and animal behaviour. However, aside from the role of excitatory amino acids, such as glutamate, that participate in all brain processes, to this day no one has given us a clear conception of what *reinforcement* really means in terms of neural functions. Still, the power of the concept has been so pervasive in psychological science that entire theories of emotion have been based on it. For instance, Jeffrey Gray (1990) framed emotion theory in terms of emotional states being created by positive and negative reinforcements. I challenged that idea by suggesting, in line with Thorndike's original view, that reinforcement is fundamentally affective — that various affective/emotional states help create behavioural change that we attribute to concepts such as reinforcement (Panksepp, 1990b). More recently Rolls (1999) has created another sophisticated reinforcement-based theory of how emotions are constructed by learning, while ignoring vast amounts of neuro-ethological evidence concerning the affective nature of the animal mind. This vast historical rift between traditional affective views of mental life and behaviouristic views of learning (with no acknowledgement of mentality) can only be healed by modern scholars considering *all* the relevant evidence, as opposed to their own favourite set of terms and findings. We need to consider how behaviour is controlled conjointly by neural and psychological causes. They reflect the same biophysical processes, but the psychological terms may be especially relevant for discussing the actions of large-scale neural networks.

When one does this, while accepting that central tenet of materialism that all aspects of mind are thoroughly biological, interesting new syntheses are possible. Lets consider brain dopamine circuits that have long been implicated in brain 'reward' processes. In fact, the ethological data suggests that this system helps energize a coherent evolutionary tool for learning, namely the

foraging/SEEKING urge (Panksepp, 1981, 1986; 1992, 1998), which links up with higher associative mechanisms (Ikemoto & Panksepp, 1999). Such integrative evolutionary concepts have been consistently ignored by neuro-behaviourists, who have recently rediscovered a more limited version of the concept within a reward ‘wanting’ framework. This psychological construct remains carefully encased in scare quotes to alert behaviouristic readers that it is not intended to convey any experiential meaning (Berridge & Robinson, 2003; see critique in footnote #3, pp. 37–38 in Panksepp, 2005a) while concurrently allowing such mentalistic concepts to entice psychologically-oriented scholars.

However, the most puzzling behaviouristic *meme* in this field is the brain dopamine ‘reward prediction error’ concept, advanced on the basis of enhanced dopamine nerve cell firing in animals seeking rewards (Schulz, 1998; 2000; 2002). This concept has been applied to the study of animal behavior with inadequate consideration that arousal of brain dopamine systems contribute to natural emotive behaviour patterns and psychologically experienced states. Meanwhile, it has long been known that human drug addictions, desires and cravings ride upon the arousal of this system (Volkow *et al.*, 2002; Panksepp *et al.*, 2002). Can we really understand what dopamine does in the brain without any explicit concern for how this system helps create psychological processes that lie at the heart of our strivings to obtain rewards? Perhaps not (see Panksepp & Moskal, 2005).

It is long past time to return affective constructs back to the discussion of what ‘rewards,’ ‘reinforcement’ and ‘punishers’ really are. This will help fill the current void between external stimulus contingencies that lead to cognitions, and the neuro-affective functions of all mammals (Ikemoto & Panksepp, 1999). Indeed, the libidinal dopamine energized SEEKING urge may provide an essential generalized platform for the expression of many of the other basic emotional processes. For instance, it is hard to imagine predatory intent, maternal CARE and sexual LUST without SEEKING influences. It is the one system that helps animals anticipate all types of rewards.

Emotional Awareness is not the same as Emotional Affects.

Clearly, emotional systems are constituted of multi-layered hierarchical processes (Fig. 1). Animal models can clarify the pre-propositional affective mentalities of the lower substrates, while the human work is better suited to delve into the diverse cognitive-conceptual capacities of higher brain regions. The lower substrates, because of evolutionary conservation of functions, are more likely to be homologous across species, and hence more capable of empirical clarification. The many cognitive aspects of emotionality, individuated by many situational contingencies — attributions, judgments, beliefs or construals — remain the main focus of interest for most psychologists. To scientifically envision such higher emotional experiences, we must invest in new, subtle and open-ended scientific tools such as the Levels of Emotional Awareness scales (e.g., Lane & Garfield, 2005). But we also must develop new psychological paradigms — perhaps a new neuro-psychoanalysis — that aspires to link the flow of

our higher mental apparatus to the ancestral emotional organic dynamics revealed by animal brain research (Panksepp, 1999; Solms & Turnbull, 2002).

Complex phenomenological theories, ungrounded by brain functions, have reigned for too long in traditional psychoanalytic and psychological theory. A new brain-mind science needs to be grounded in comparative psycho-neuro-phenomenological perspectives that can be linked to behavioral and biological variables, especially the neurochemistries for emotions clarified by neuroscience (Panksepp, 1998a; 2005a). Without a full synthesis of animal and human research, we cannot fathom the foundations of our mental apparatus.

Neuronal SELF-representations and the Neurodynamics of the Affects.

So how do organisms experience affective-emotional states within their brains? This critical question remains largely unaddressed. It must first be theoretically confronted if we are going to generate testable theories of how emotional feelings are actually generated in the brain/body. The traditional answer has been that one does not have any mental experiences until certain kinds of information interact with — are ‘read out’ by — higher neo-cortical mechanisms that elaborate our awareness of the world. Many still believe that affects are not experienced in the lower reaches of the brain — that all brain functions below the neocortex are experientially implicit and unconscious. Within such anthropocentric world-views, emotional feelings cannot be understood until we figure out how the higher regions of the brain generate awareness of the world.

My own evidence-based vision of how affect emerges from the brain is rather different. To penetrate this epistemological ‘brick wall’ — namely what it actually means, in psycho-neurological terms, to have raw affective feelings — I think that we must entertain neuro-psychological conceptions of human and animal ‘souls’ through concepts such as the — ‘core self’ (Damasio, 1999; Gallagher & Sheard, 1999; Panksepp, 1998a). I suspect our mental lives are critically linked to primal viscerosomatic representations of the body situated in paramedian regions of the brain, and connected to associated higher limbic areas that can elaborate a variety of basic action dynamics that help constitute the organic feeling states of the basic emotions (i.e., the full activity of genetically ingrained emotional systems, as highlighted in Fig. 1). In other words, there exists a subcortical viscerosomatic homunculus, laid out in motor-action coordinates, that creates a primal representation of the body (core SELF) that can be modulated by global brain emotional networks that establish affective intentions in action, which are projected into and onto the world as prototypical affective values, helping guide cognitive intentionality (Panksepp, 1998b).

Core emotional feelings may be part and parcel of these global neurodynamics of the SELF (an acronym which can be translated as the Simple Ego-type Life Form), which finds its most coherent instantiation in brainstem regions such as the PAG and closely intermeshed paramedian diencephalic zones just above (e.g., ventral tegmental area at the hypothalamic-midbrain juncture) and just below (e.g., parabrachial regions of the brains stem). This extensive action

network of the brain, extending up to medial frontal cortical regions, is modulated by a host of body variables, both autonomic, somatic and hormonal, as well as a variety of higher brain functions that can bring this large and coherent neural field into those action dynamics that we recognize as distinct emotional systems. The neurodynamics of such global psycho-behavioural attractors have not yet been measured objectively; at minimum, that would require accurate placement of many recording probes in carefully selected trajectories of the various emotional systems (Panksepp, 2002b).

It is within the rich neural connectivities to higher paramedian brain regions and lateral limbic cortices (e.g., insula) that higher forms of ‘the self’ will be found. Indeed, modern brain imaging has revealed that when we dwell self-referentially, as opposed to simply informationally, on any aspect of the world, such paramedian regions of the brain (the higher limbic zones from medial frontal, anterior cingulate regions to retrosplenial cortices toward the back of the brain) become selectively aroused; cognitive dwelling on the same stimuli leads to more lateral cortical arousal (Northoff *et al.*, 2005). It is probably within these medial brain regions that we become aware of our emotional feelings — where emotional feelings and emotional cognitions are blended. These classic limbic brain regions (MacLean, 1990) are essential for us to deliberate on the deeper aspects of our emotional nature. These higher emotional regions of the brain exist in reciprocal relations to the more cognitive working memory regions that are essential for our rationality (Goel & Dolan, 2004; Liotti & Panksepp, 2004; Northoff *et al.*, 2004).

Mental life *is* constructed from many global neurodynamics, and meaningful distinctions between emotional and cognitive processes within the brain should not be minimized. The lower paramedian trajectories of the basic emotional systems — which converge on the more ancient periaqueductal, central gray regions of the midbrain — are essential for ancestral affective memories (Panksepp, 1998b). Those core feeling dynamics cannot cognitively reflect on themselves, but they may be experienced as cognitively unadulterated forms of pure affective livingness that may be an essential foundation for all higher mental functions. There are no principled logical or good empirical reasons to believe that experiences of affect cannot exist without cognitive mediation. In their basic form, affects may be cognitively blind while still being a primordial sort of mentality — neurobiologically ingrained ancestral memories that are intimately intertwined with the genetically prescribed biological values of our bodily existence.

Perhaps many individuals lose touch with the importance and nature of such emotional values as they cognitively mature into the complex socio-cultural contexts that mould our cognitive lives. Thereby, affects may become part of our dynamic subconscious. Still, those ancient aspects of mental life probably continue to influence our emotional experiences from birth to death. Without those gifts of nature — those basic neural tools for living — we would be scarecrows in the material world, moving as the environmental winds blow (as behaviourism once envisioned), as opposed to being the deeply feeling, enactive creatures that we (and other mammals) truly are.

The failure to recognize how evolution constructed the foundational aspects of mental existence remains a continuing intellectual tragedy of 20th century behavioural science (Panksepp, 2005a). The resulting anthropocentrism and neuro-dualisms continue to haunt us to the present day. Those cold materialistic visions still offer images of an affectively ungrounded existence, beings as intrinsically valueless as inanimate nature. But that is not a conclusion supported by functional brain research. Affective biological values — the ancestral voices of the genes — exist at the foundation of our higher cognitive apparatus. It is through the interweaving of such intrinsic value structures with cognitive processes, and our eventual capacity to reflect on them, that many special human mental capacities and behavioural abilities emerge that cannot be studied in other animals.

Recapitulation

To understand emotional feelings, where large-scale brain-mind processes are not as visible as we wish they were, theoretical perspectives that lead to concrete predictions are essential (Panksepp, 1998a). There is now abundant evidence that emotional feelings may arise substantially from the same large-scale neurodynamics that generate the various emotional-instinctual actions that all mammals, including young humans, explicitly exhibit. The emotional instincts are not affectively vacuous. Regrettably, the instinctual emotional expressions were *arbitrarily* relegated into the category of unconscious/implicit/reflexive behavioural processes long before we had neuroscientific and behavioural tools to begin to probe their neural and psychological nature. Accordingly, in behavioural neuroscience, traditional non-experiential concepts prevail to this day, even though abundant data now indicate that affective experiences are decisive for much of what animals actually do, and they may even construct those brain processes that are so important for promoting learning via that exquisitely clear *procedure*, but spooky *process*, called *reinforcement*.

Of course, all existing levels of analysis, even those that deny any mentality to animals, can contribute to a comprehensive understanding of emotionality. At present, core affective processes are best illuminated, scientifically, by studying the intrinsic emotional action-generating dynamics of animal brains. If higher cognitive emotional feelings of humans do substantially arise from instinctual action systems that are homologous in all mammals, then we may finally understand some of the more subtle aspects of human affective consciousness by studying the more primitive emotional systems of other animals. Obviously, there will be many species differences to be documented. However, granted the evolutionary continuity of the mental apparatus in all mammals (Darwin, 1872), animal neuro-ethological research can engender substantive empirical progress on such questions of ultimate human concern.

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