

What is Basic about Basic Emotions? Lasting Lessons from Affective Neuroscience

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Abstract

A cross-species affective neuroscience strategy for understanding the primary-process (basic) emotions is defended. The need for analyzing the brain and mind in terms of evolutionary stratification of functions into at least primary (instinctual), secondary (learned), and tertiary (thought-related) processes is advanced. When viewed in this context, the contentious battles between basic-emotion theorists and dimensional-constructivist approaches can be seen to be largely nonsubstantial differences among investigators working at different levels of analysis.

Keywords

affective neuroscience, brain, emotions, evolution, primary processes

In addressing the following questions posed by Jim Russell, we found the first to be rather ambiguous from our neuroscience perspective. Our italicized insertions clarify how we approach such issues.

Question 1: How does a basic emotion evolutionarily built-in/“primary-process” emotions, in our preferred terms, which we will describe at the outset differ from simply a discrete-emotion episode which we envision as typically a higher order tertiary mind-brain process, as described below?

The brain is the only organ of the body where it is empirically evident—anatomically, histologically, and functionally—that the pressures of evolution left clear “historical” imprints on its organization. This history is evident in the layered stratifications where more ancient systems are situated medially and caudally, and the more recent systems were added laterally and rostrally. And as far as we know, what went before provided critical anchors, restraints, as well as opportunities for future developments. Accordingly, brain and mind have to be understood in hierarchical ways, preferably from the earliest archaic to the most recent MindBrain functions (we conflate “mind” and “brain,” and also use it in reverse—BrainMind—double capitalized, to reflect our monistic ontology, emphasizing that these are two sides of a coin¹). The various evolved as well

as developmentally emergent levels of control need to be conceptualized in terms of “nested hierarchies”—lower levels rerepresented within emergent higher levels—yielding two-way (circular) communications among all levels. However, only the most ancient layers of the mind can be deemed to be truly basic. Without a clear understanding of those foundational issues, overall understanding is compromised. A clear vision of basic emotion networks in the brain can prevent conflation of everything into an inextricable tangle.

Hierarchical controls are evident in brain regulation of emotionality. As a heuristic simplification, we prefer the following levels-of-analysis nomenclature: (a) *primary-process* core affects arise from ancient subcortical processes (Panksepp, 1982, 1998, 2005a), (b) *secondary-process* elaborations—namely emotional learning—arise from Pavlovian/classical conditioning and instrumental/operant learning principles, and (c) *tertiary-process* emotions—complex cognitive-affective amalgams, such as ruminations and affectively charged thoughts about ongoing emotional issues, which emerge via neocortical interactions with paralimbic and limbic structures. In the higher mind, these nested hierarchies interact with working-memory fields to plan alternative courses of action to cope with ongoing affective opportunities and challenges. Obviously, a variety of top-down and bottom-up controls exist within the BrainMind,

as highlighted recently by studies of human depression and translational animal models (Alcaro, Panksepp, Witzak, Hayes, & Northoff, 2010).

Such hierarchical evolutionary controls also relate to levels of consciousness (see Vandekerckhove & Panksepp, 2009). As Endel Tulving (2002, 2004) envisioned, consciousness, both affective and cognitive, can be considered in terms of (a) *anoetic consciousness*—experience without understanding, at the bottom, (b) *noetic consciousness*—knowing/learning facts about yourself and the world, and (c) *autonoetic consciousness*—being able to use episodic, personal memories to time travel forward and backward in MindBrain space so as to better anticipate the future. Both viewpoints, in parallel, recognize “nested hierarchies” in BrainMind organization. We believe a better appreciation of such levels of organization can diminish confusions and disputes among investigators working at different levels of MindBrain control.

In our estimation, emotion-affect research cannot proceed coherently unless investigators are clear about their level of analysis, and ready to deal with terminological confusions regarding emotion nomenclatures that do not recognize such issues. No doubt the top-down (cognition to affect) and bottom-up (affect to cognition) perspectives can be diced in various ways, but we believe the most coherent and neuroscientifically defensible evolutionary approach is to have clear bottom-up “primary-process” views; namely, some kind of neuroscientific “basic emotion” approach that simply cannot be clarified easily through human research. Animal neuroscience models are essential for envisioning such evolutionary processes clearly. Once that task is reasonably well developed, then one can have more coherent research programs on top-down “regulatory” (tertiary-process) approaches. If we have no vision of how affective experience emerged in MindBrain evolution, we can only have surface descriptions of complex wholes, mostly in correlational domains, where debate among alternative views may be interminable, since ideas cannot be falsified.

With the guidance of such evolutionary perspectives, we may eventually agree that *basic emotions* can only exist clearly at primary-process levels, namely before learning and higher order thoughts add rich developmental and cultural complexities. The general failure to recognize such “levels of control” continues to cause much mischief in modern emotion studies.

Question 2: What is your list of basic emotions? Are all emotions basic, or just some? If some, how do you distinguish basic from nonbasic emotions? What is the relation of nonbasic to basic emotions?

The cross-species primary-process (“basic”) emotions refer to “prototype emotional states”—namely, SEEKING, FEAR, RAGE, LUST, CARE, PANIC/GRIEF, and PLAY—that can be evoked by artificial activation of subcortical networks of the brain. We capitalize these terms to minimize mereological fallacies (part-whole confusions) that would hinder discourse if we simply used vernacular-emotional terms. This new terminology is also designed to help investigators not concerned with foundational-evolutionary issues, to help them understand the

various emotional tools for living that are a cross-mammalian heritage. Our affective-emotional taxonomy is based on robust cross-species evidence that distinct emotional states evoked by brain stimulations, especially in subneocortical “limbic” regions, readily serve as “rewards” and “punishments” in a variety of learning tasks (Panksepp, 1998, 2005a, 2005b). In short, there is something about emotionality that is neurogenetically foundational for BrainMind emergence, and primary-process emotional networks are among such functional specializations.

In contrast, comparable *genetically dictated* neocortical specializations are rare. Essentially none has yet been identified, despite the extensive postulation of diverse forms of cortical modularity (e.g., the “language instinct”). Even visual cortex achieves its functionality through life experiences rather than genetic dictates (Sur & Rubenstein, 2005), albeit that emergence does require genetically ingrained subcortical visual functions. The vast neocortical fields of columnar “chips” provide general-purpose processing analogous to “random-access memory”—allowing the developmental construction of vast affectively rich perceptual and cognitive representations, with the aid of primary-process emotional specializations. Dimensional and constructivist perspectives about our emotional lives are very effective in promoting research on human tertiary-process mind functions, but such strategies do not work well (yet) in the study of subcortical emotional specializations.

Within nested BrainMind hierarchies, primary levels of affective experience guide what happens at secondary and tertiary levels developmentally. Eventually higher mind functions rule decision making, even in animals (see Mendl, Burman, & Paul, 2010), but they collapse like a house of cards if the primary processes are severely damaged (Watt & Pincus, 2004). Parenthetically, we suspect cognitive scientists are currently discovering many “unconscious” decision-making functions, only because they ignore (do not monitor) subtle primary-process affective shifts in their subjects.

Emotional lives of mature individuals consist mostly of secondary- and tertiary-process emotional issues—“pure” primary-process emotions, unalloyed with complex cognitive attributions and appraisals, are relatively rare. But we should be clear that there is no evidence that the neocortex can generate emotional feelings on its own (without accompanying arousals of paralimbic and subcortical emotional effector systems). Indeed, to this day no rigorous evidence exists for the classic James-Langeian view that emotional feelings arise from bodily arousals being “read out” by higher conceptual neocortical regions. Neocortex engenders many emotion regulatory and conceptual functions, but to the best of our knowledge, no strong emotions on its own. Those are the facts as we currently understand them. Indeed, a recent meta-analysis provides strong support for the basic emotions of happiness, sadness, fear, anger, and “disgust” (Vytal & Hamann, 2010), yielding many subcortical arousals consistent with classic affective neuroscience views, along with distinct paleocortical arousals that we believe reflect activations of critical bridging structures between the subcortical emotional networks and the higher neocortical-cognitive processing of the emotional primes.

Subcortical, primary-process affective circuitries supply the major *unconditioned stimuli* and *responses*—what behaviorists always relied upon to generate the “rewards” and “punishments” leading to learned behaviors. Indeed, at such low levels of the brain, unconditioned emotional “response” systems appear to generate affective experiences. It is important to understand that artificial arousals (brain stimulations) of the primal emotional “response” circuits consistently serve as “rewards” and “punishments” in animals (gold standards for the loci of control for affective experiences in animals). Such brain arousals are accompanied by distinct emotional actions, and coordinated peripheral autonomic-visceral arousals. There is no evidence that these emotional states are not experienced. But abundant data highlight that they are deeply experienced in both animals (e.g., Panksepp, 1971, 1990, 2005a, 2005b) and humans (Heath, 1996; Mayberg, 2009; Schlaepfer et al., 2008).

Thus, from a neuroscience perspective, the concept of “basic emotions” only makes full sense at the primary-process level. However, this does not exclude the meaningful influence and detection of such processes at higher secondary- and tertiary-process levels. Affective manifestations at those levels remain related to the primary “flavors” of the emotional prototypes—for example, cognized irritation can be envisioned as derivative of primary RAGE circuitry, and feelings of rejection as derivative of PANIC/GRIEF separation-distress circuitry. The primary processes engender emotional-affective-autonomic-behavioral coherence evident in ethological analyses² (as first described by Darwin, 1872/1998), and we assume they are critically important for the diverse varieties of emotional valence, arousal, and power, which become affective forces evident cognitively at tertiary levels of mind. We note in passing that the neuroscience evidence for multiple arousal systems in the brain (Pfaff, 2006) allows for abundant diversity in the forms of arousal that accompany each primal emotion.

We suspect a credible brain-based basic-emotions typology allows for a heuristic functional integration of intrinsically related “families” of emotion interacting with each other, as opposed to a misleading “functional separateness” implied by traditional “discrete-emotion” approaches. From this point of view, anger provoking “irritation” becomes a low-level member of a RAGE/affective attack “family” of emotions, which can be further elaborated by cognitive/tertiary processes. Loneliness, sadness, shame, and guilt may all become cognitive/tertiary elaborations related to fundamental separation-distress (PANIC/GRIEF) issues. Humor may be a cognized form of rough-and-tumble PLAYfulness. And so on for the other primes. This heuristic approach suggests how various primary-process neurochemical manipulations modify abundant tertiary emotion “derivatives” (Panksepp & Harro, 2004). In this vein, oxytocin is hot right now, but there are many other possible manipulations (Panksepp, 2004, 2009), with numerous testable predictions—low-hanging fruit that are not being harvested. For example, consider that opioids, which robustly reduce separation distress in animal models, should inhibit feelings of guilt in humans, based on the hypothesis that feelings of guilt are cognized extensions of separation distress.

We suspect brain evidence will eventually show that the subneocortical substrates of emotional affects are critical building blocks for higher emotions such as guilt, hatred, loneliness; that is, emotions molded by cognitive attributions. However, using an analogy from chemistry, although the “atomic components” (primary processes) are absolutely essential for higher types of emotions, constructed into “compounds” by means not yet understood, we should expect to see that those MindBrain “compounds” exhibit new emergent properties, hard to predict from the constitutive atomic elements (just consider the diverse properties of H₂O as an analogy). But at this point in our intellectual history, to say that such higher cognized emotions are “emergent properties” is close to saying nothing new or empirically useful.

In sum, with development and maturation, the MindBrain gets ever more complex, but that complexity is best approached by first outlining the most fundamental principles. That has generally not happened in psychology. At the highest level, we conceptualize our emotional lives in thoughts and words, but do such superordinate levels of organization really vastly modify how primary emotions feel? We don’t know. But we do know these cognized tertiary emotional processes promote art, movies, music, poetry, rhetoric, theater, etcetera. So, from a mature, fully resolved, MindBrain perspective, all emotions are not basic. But those that are become critically important components for the higher order complexities that arise from the developmental landscapes of individual lives and cultures.

Question 3: Does the existence of a basic emotion depend on the existence of a central organizing mechanism (something like an “affect program”) or can a basic emotion be simply a patterned response?

Our reading of the brain evidence, largely culled from *causal* brain stimulation research on other animals, suggests that at the primary-process level, the key circuits are ones that integrate a host of organismic features—behavioral, autonomic/visceral, and affective—together into a coherent and complex emotional response. Although a “raw feeling tone” (varieties of valence and arousal) is part-and-parcel of the overall responses, is this complexity conceptualized well as an “affect program”? We think a dynamic operating-system or “command network” concept is a better descriptor of the primal emotional prototypes. We view these networks as ancestral tools for living, further refined by living in the world, which in ethological terminology can generate instinctual, but flexible “fixed action patterns,” and in behavioral terminology, constitutes *unconditioned responses* of great relevance for understanding emotional learning and the experienced qualities of human emotional life.

The higher ramifications of such primary brain processes remain barely mapped by neuroscience. The primary-process emotional systems do not just generate “patterned responses” but also the rudiments of core emotional experiences. This is empirically affirmed by the ability of localized stimulation of these systems to mediate “reward” and “punishment” functions in the brain. These brain systems form basic foundations for what higher brain mechanisms can achieve on the foundation of primary-process affective life.

Question 4: In everyday discourse, emotions cause certain behaviors (fear makes us flee, makes our heart race, makes us think irrationally, and so on). In your theory, does a basic emotion have such causal powers? Which powers?

We would emphasize that primary emotions derive their power from their pleiotropic motivational and learning effects, and of course their primary influence on autonomic and visceral/somatic states. Again, understanding the impact of emotion depends on what level of the MindBrain one is discussing. At the primary-process level, emotional networks engender “intentions-in-action,”—the raw emotional affects arise from emotion–action patterning circuits that control a host of objective, highly synchronized autonomic and somatic motor manifestations. When these “powers” are integrated with higher MindBrain functions (particularly complex executive functions), we develop capacities for “intentions-to-act” (Ciompi & Panksepp, 2005; Panksepp, 2003).³ How well these lower aspects of mind guide higher decision making remains open for empirical and philosophical debate. If we see levels of control as “nested hierarchies” with two-way (circular) routes of causality, there are many possibilities, hardly any of which have been empirically worked out. We know how powerful the primary-process levels of organization are simply because human brain stimulation provokes remarkably powerful affective feelings—psychological states that have never been aroused by stimulating higher neocortical brain zones that mediate tertiary emotional processes within the aforementioned hierarchy.

In sum, at the lowest coherent level of emotionality (i.e., subcortical command circuits), experienced affect emerges as part-and-parcel of the arousal of primary emotion-generating circuits. Perhaps the feeling is also “read out” by neocortical systems, but that is not a parsimonious view, nor is it consistent with any existing stream of causal evidence. At the intermediate (secondary) level, where classical and instrumental learning loom large, initially neutral stimuli (conditioned stimuli) that are consistently paired with the core affective states of the brain (the unconditioned stimuli and responses) begin to control conditioned affects and emotional reactions (conditioned responses). Tertiary processes arise from cortical maturation, yielding thoughts and cognitive awareness about our emotional lives. In this way, we can systematically envision the emergence of ever more complex hierarchical controls, all in the service of better anticipating key survival issues. In this fashion, the “power” of raw emotions is harnessed into ever larger networks of learned-deterministic and subsequently awareness-based conscious choices (granted there is enough “random access memory” [RAM] space [aka neocortex] to engender more deliberative schemes than are contained in the lower levels of the BrainMind).

There are reasons to believe that primary-process emotions figure heavily in the genesis of psychiatrically significant emotional imbalances, and provide endophenotypes for a future science of biological psychiatry (Panksepp, 2004, 2006), illustrated well by the genesis of depression as related to protracted separation distress (Panksepp & Watt, 2011; Watt & Panksepp, 2009a, 2009b). The existence of intrinsic (primary-process)

emotional “powers” in the brain is abundantly supported by evocation of coherent emotional actions and affects by applying electrical “garbage” with no information content (electrical stimulation of the brain (ESB) from a 60 Hz wall socket, current stepped down, of course) applied to specific brain sites (Olds, 1977; Panksepp, 1971, 1982). Any theory of emotions that does not address or cannot explain such highly replicable facts is simply not dealing with all the relevant evidence, especially the most robust, *causal* findings in emotions studies.

Question 5: In what sense are basic emotions basic? Specifically, please touch on the questions about what makes a basic emotion basic: must the emotion be evolutionarily shaped? Biologically prewired? Psychologically primitive? A building block of other emotions? All of the above?

Much of this has already been addressed. All these premises are well supported. Yes, the underlying circuits for primary-process emotions were evolutionarily programmed/prewired, albeit also epigenetically “shaped.” They are psychologically primitive and are “building blocks” for higher emotions. Basic emotions are tools for living that are inherited potentials of the brain (i.e., SEEKING, RAGE, FEAR, LUST, CARE, PANIC/GRIEF, and PLAY, although there may be more). Including primary-process sensory and homeostatic affects, such as DISGUST and HUNGER, as basic “emotions” is unwise (i.e., may be category errors). They belong in “sensory” and “homeostatic” affect categories (see Panksepp, 2007a).

Evolutionary prewiring does not mean these functions are not further refined by experiences (e.g., epigenetic expansions of dendritic trees, induction of various trophic factors, and other complex housekeeping functions within the neuronal networks that constitute such systems). Plasticity is pervasive in brain development. The prototype affective networks supply motivational templates and key control mechanisms for learning and the construction of “personality” and “temperament” (influences that may be monitored verbally; Davis, Panksepp, & Normansell, 2003).

Neuroscience evidence indicates that primary-process emotional systems engender “psychological primitives”—raw affects—that can serve as “building-blocks” and “fuel” for abundant higher MindBrain developments. This is truly remarkable! All of this entails experience-dependent neuroplasticity operating in widespread corticolimbic networks. We do not yet know how such higher integrations occur mechanistically, but we know that wherever brain stimulation evokes coherent emotional reactions, those stimulations serve as “rewards” and “punishments” in various learning tasks (Ikemoto, 2010; Panksepp, 1971, 1982, 1998, 2005a, 2005b), especially conditioned place avoidances and preferences (for full summary, see Tzschentke, 2007).

Primary-process emotions promote the emergence of socially constructed emotions (as noted in our discussion above of related “families” of emotion). Jealousy may coalesce and derive its nuanced affect from concatenations of mild FEARful, PANICKed, LUSTy feelings (Panksepp, 2010a). Jealousy may emerge when one begins to PANIC that they will no longer have

anyone to CARE for them (or share LUST with them), making them less happy/PLAYful, all of which promotes demanding SEEKING of reunion, commonly contaminated by RAGEful displays. Because of these affective cross-currents, one is often emotionally confused and ambivalent, with little fun left in life. Such working hypotheses can be empirically evaluated once we find ways to pharmacologically modulate emotional primes in human beings studied in complex real-life social situations (e.g., Depue & Morrone-Strupinsky, 2005). Currently intranasal oxytocin is one effective bridge to such cross-species studies (for critique, see Panksepp, 2009), with the most recent study at this writing being Mikolajczak et al. (2010).

Again, we emphasize, there are nonemotional basic affects such as DISGUST, a primary-process sensory affect, which may permit higher order feelings of social disgust (e.g., experiencing conditioned disgust in reaction to another's antisocial behavior). Although disgust does appear in other basic-emotion typologies, we suggest that, unlike the aforementioned basic emotions, primal disgust was not evolutionarily designed to structure complex adaptive responses, although the feeling, just like hunger, can be as strong as that evoked by primary-process emotions. DISGUST and HUNGER are in our judgment therefore simply not in the same class as "blue ribbon" prototype emotions such as FEAR, RAGE, LUST, etcetera.

Question 6: How are basic emotions differentiated one from another?

The various distinct primary emotions are differentiated in terms of different prototypical somatic and visceral action patterns and feelings. We can be sure that ESB can evoke distinct and coherent emotion-type behavioral responses from all mammals studied so far, accompanied by many distinct vocalizations. No one would confuse affective RAGE with FEARful freezing/flight, or eager environmentally directed SEEKING and a host of social behaviors (LUST, CARE, and PLAY). The fact that one can evoke these kinds of responses with ESB along distinct, widely distributed subcortical regions, suggests that one could construct fine-grained emotional coding schema, such as Ekman and Friesen's Facial Action Coding Scale (1978), by monitoring the successive muscular contractions, and especially the autonomic arousals, in animals that are induced to become emotionally aroused under strict "stimulus control" applied *within the brain*. One can also apply formal discrimination paradigms to stimulation of various emotional systems to see if animals distinguish the underlying affects, a difficult task successfully accomplished by Stutz, Rossi, Hastings, and Brunner (1974). More research like this is needed. However, there is abundant work indicating that many pharmacological manipulations that modulate emotionality in animals are easily distinguished in formal state-dependent drug discrimination studies (Overton, 1991).

Clearly, more work needs to be done, but an ethologist's eye has no problem in distinguishing a variety of emotion patterns across all mammalian species (Darwin, 1872/1998). Likewise, careful facial analysis of babies by Cal Izard, and adults by Paul Ekman, speak loudly for the prevalence of similar displays in humans, even though real-world complexities add abundant ambiguities and qualifications (Russell, 1995).

Question 7: If your list of basic emotions is a set of English terms, how do you respond to the claim that some languages lack equivalent terms for those emotions but include emotion terms that differ in meaning from English terms? What is the relation between your basic emotions and the everyday folk language people use to talk about their emotions?

At our primary-process level of analysis this is not a problem, for all labels used were designed to reflect the need for a new nomenclature at this level of analysis. For instance, primal rough-and-tumble play sequences are easily recognized from their characteristic behavior patterns, albeit there is a big problem in simply using "play" and various other linguistic-vernacular descriptors for the primary-process emotions. That is why we selected full capitalizations as the terminological convention for primary-process emotions (*vide supra*). Parenthetically, capitalizations were chosen also to attract attention, and coax people to think about primary-process issues, much ignored in psychology. The capitalization convention is intended to highlight that a specialized language is necessary for communicative clarity about primary-process issues: we realize this is a hard sell, but we are talking about universal systems of mammalian brains.

Our short list of *emotional* operating systems is not meant to suggest that there are no other primary emotions, but simply that all additions need to be based on the gold standard for inclusion, especially evocation of coherent emotional responses and affective "reward/punishment" states with localized brain stimulations. Surely there are other primary-process affects (e.g., sensory and homeostatic) which may also have abundant words and distinctions around the world, and some may choose to envision them as "emotional states" but that would conflate important neural and functional distinctions. For instance, the pleasures and displeasures of sensation are numerous, but they are not appropriately placed in the prototype emotion category, for they are not dependent on "moving out" dynamically to engage the environment in emotion-characteristic ways.

The relation between our "basic emotions and the everyday folk languages people use to talk about their emotions" is difficult to address since no one has yet conducted a brain-based study of primary-process emotions in humans. However, we suspect that the BrainMind dynamics we describe as primary emotions have substantive functional and affective correspondences in all human cultures. Of course, they may be hard to ferret out, since such studies would require abundant linguistics competence across multiple languages.

To that end, we provide brief sketches of these systems here. Extensive overviews of the neuroscientific details are available elsewhere (e.g., Panksepp, 1982, 1998, 2005a; Panksepp & Biven, 2011). Let us start with the most primitive, and hence the most intriguing, perhaps a "granddaddy" of the other systems, the SEEKING urge, followed by reptilian emotions, and ending with the various social systems (all of which may depend, substantially, on the SEEKING system):

SEEKING: A remarkable system that has emerged from brain research is that which mediates the appetitive desire to find and harvest all the fruits of the world, and which has an

uncanny and vitally adaptive capacity to match internal needs and environmental opportunities, and to sensitize the mind/brain to all manner of reward predictors/cues. This “desire” or SEEKING system (perhaps this is the major foundational substrate for Spinoza’s concept of *conatus*) has a distinct similarity to the “interest” concept that is proposed in some basic emotions theories (e.g., scholars such as Cal Izard and Robert Plutchik). Animals eagerly self-activate—self-stimulate—this system in addictive ways. SEEKING is a basic, positively valenced general motivational system that helps mediate our desires, our foraging and our positive expectancies about the world (Panksepp & Moskal, 2008). Although highly resolved cognitive information descends into this system, the output is much less resolved, coaxing the animal to behave in a handful of appetitively aroused, goal-directed ways. In any event, this system highlights the massive degree to which a basic state control system that mediates the primary-process phenomenology of appetitive urges can readily link up with cognitive systems that mediate secondary-process awareness and appraisals. This system operates in both positive and negative emotional situations (e.g., seeking safety when in danger), and helps maintain a coherence and fluidity in behavior as well as our cognitive apparatus (Alcaro, Huber, & Panksepp, 2007; Ikemoto & Panksepp, 1999). We believe that this system deserves to be considered a special class of one—when this system is severely damaged or profoundly dysfunctional, most other prototype states are compromised and difficult to activate with classic external elicitors.

FEAR: Our world has abundant dangers, many of which we need to learn about, and others which we intrinsically FEAR. Although the stimuli that provoke our intrinsic fearfulness may be different, the core structure of the aroused FEAR system may be very similar across all mammalian species. For instance, we humans do not enjoy either unprotected heights or strange dark places where our minds are captivated by fear. Rats, on the other hand, enjoy darkness more than light, but they become timid in the presence of just small samples of cat fur, which we can hardly detect, even though our lab-reared rats have never met a threatening cat in their lives. Neuroscientists have unraveled the details of the brain circuitry that mediate some of the fears, but they have tended to focus on information that enters the FEAR system via so-called “high-roads” (more cognitive-perceptual inputs), and via “low-roads” (the more primitive sensory inputs), while all too often ignoring the “royal road”—how these telencephalic structures project into the ancient core of the FEAR system itself (central amygdala, ventrolateral hypothalamus, and periaqueductal gray), which governs the instinctual action apparatus for freezing and flight that intrinsically helps animals avoid danger. There are probably several distinct anxiety-type affect systems in the brain (e.g., see PANIC/GRIEF below), but we are barely beginning to learn how to dissect one from another.

RAGE is often aroused by the competition for resources, with bigger, faster and stronger, animals often winning. This

system can also be aroused by restraint and frustration. If we do not get what we want, it is likely that there will be more activity in our RAGE system than there would be otherwise. Of course, adults can modulate their anger in ways that children and animals cannot (consistent with increasing top-down cortical inhibition of virtually every emotional system). Just like every subcortical emotional system, higher cortico-cognitive ones are able to provide inhibition, guidance, and other forms of emotional regulation. We presently have no medically accepted psychotropic drugs that can specifically control pathological anger, but the neuroscientific analysis of RAGE circuitry may eventually yield such tools, for instance substance P antagonists, which may assist in better self-regulation of anger (Panksepp & Zellner, 2004).

LUST: Where would we mammals be if we did not have brain systems to feel passionate toward each other? Male and female sexual systems are laid down early in development, while babies are still gestating, but they are not brought fully into action until puberty, when the maturing gonadal hormone systems begin to spawn male and female sexual desires. However, because of the way the brain and body get organized, female-type desires can exist in male brains, and male-type desires can exist in female brains. Of course, learning and culture persistently add layers of control and complexity that cannot yet be disentangled by neuroscience.

CARE: And where would we mammals be if we did not have brain systems to take CARE of each other? Extinct! The maternal instinct, so rich in every species of mammal (and bird too), allows us to propagate effectively down generations. To have left this to chance, or the vagaries of individual learning, would have assured the end of our line of ascent. These hormonally governed urges, still present in humans, have produced a sea change in the way we respond to newborn babies—those squiggly infant lives that carry our hopes and our recombined packages of genes into the future. The changing tides of peripheral estrogen, progesterone, prolactin, and brain oxytocin figure heavily in the transformation of a virgin female brain into a fully maternal state. Additionally, this system implies that there must be a primitive empathic capacity emerging in mammals (to detect and respond to distress signals in their infants), and also suggests that females may be *on average* more empathic and nurturant than males (see Watt, 2007a, 2007b, for review).

PANIC/GRIEF: When young children get lost and separated from their caretakers, they are thrown into a PANIC. They cry out for reunion, and their feelings of sudden aloneness and distress may reflect the ancestral neural codes upon which adult sadness and grief are built. A critical brain system is that which yields separation-distress calls (crying) in all mammalian species. Brain chemistries that exacerbate feelings of distress (e.g., corticotrophin releasing factor) and those that powerfully alleviate distress (e.g., brain opioids, oxytocin, and prolactin) are the ones that figure heavily in the genesis of social attachments and perhaps amelioration of depression also (Nelson & Panksepp, 1998). These are the

chemistries that can assist or defeat us in our desire to create intersubjective spaces with others, where we can learn the emotional ways of our kind. Many social-chemistries remain to be found, but when they are, we will eventually have new ways to help those whose social emotional “energies” are more or less than they desire (Panksepp, 2004; Watt & Panksepp, 2009a, 2009b). Precipitous arousal of this system may be essential for panic attacks. This knowledge may also link up with a better understanding of childhood disorders such as autism, since some children with this heterogeneous condition may be socially aloof if addicted to their own self-released opioids as opposed to those activated by significant others (Panksepp, Lensing, Leboyer, & Bouvard, 1991).

PLAY: Young animals play with each other in order to navigate social possibilities in joyous ways. The urge to play was also not left to chance by evolution, but is built into the instinctual action apparatus of mammalian brains. We know less about this emotional system than any other, partly because so few are willing to recognize that such gifts could be derived as much from Mother Nature as from our kindest nurture. It is even harder to conceive that such systems might even promote a joyous “laughter” in other species (Burgdorf & Panksepp, 2006; Panksepp, 2007b). This is a social “experience expectant” system that brings young animals to the perimeter of their social knowledge, to psychic places where one must pause to contemplate what one can or cannot do to others. Human children that are not allowed safe places to exercise their ludic energies may express playful urges in circumstances where such activities are not welcome, yielding perhaps, an overdiagnosis and overmedication of attention deficit hyperactivity disorder (ADHD). Perhaps a more useful and humanistic “treatment” would be to provide extra rations of free playtime every day (Panksepp, 2007c). It seems likely that this type of primary-process social activity, that progressively incorporates secondary and tertiary emotional processes into its “web,” does this, in part, by “programming” higher neocortical networks essential for well-modulated social abilities (Panksepp, 2001), partly by activating many genes that promote neocortical functions and maturation (Burgdorf, Kroes, Beinfeld, Panksepp, & Moskal, 2010).

Question 8: What are the minimal cognitive prerequisites for the occurrence of a basic emotion?

It all depends on how you define “cognitive,” especially in the current era where it seems to encompass everything the BrainMind does, including abundant unconscious cognitive processes. We define “cognitive” to be those information inputs into the brain, and subsequent processing that arises principally from our exteroceptive sensory apparatus, leading gradually to the refinement of higher brain executive functions. Those functions only provoke emotions via learning. For each of the primary-process emotions, there are only a few unconditioned stimuli that can evoke unconditioned emotional responses. For instance, in all mammals, pain can evoke FEAR, consistent with an assumption that at some point in evolution, fear

emerged from the affective mandate to avoid tissue damage (pain) as a forward-looking predictive-anticipatory function informing animals to cease and desist (if the danger was inanimate) or fight or flee (if animate). In rats, the simple smell of cats will evoke FEARfulness, probably by direct vomeronasal inputs to amygdala (Panksepp & Crepeau, 1990). The point is that primary-process emotions, before conditioning, are born largely “objectless.” Practically all object relations, including propositional attitudes, are learned.

Some secondary (learned, cognitive) levels of control can be systematically studied in animal models (e.g., LeDoux, 2000). In humans, tertiary processes such as thoughts clearly eventually come to both arouse and regulate emotions, but there are few good animal neuroscience models for those most interesting cognitive controls of emotionality, although possibilities have been discussed (Griffin, 2001). New dimensional models of animal emotion–cognition interactions may eventually fill that need (see Mendl et al., 2010; and commentary by Panksepp, 2010b). Cognitive processes get ever more influential in emotion regulation as one ascends from primary to tertiary levels of analysis, to the point where it is popular to conflate the two concepts even though there are many ways to distinguish each (e.g., Ciompi & Panksepp, 2005; Panksepp, 2003).

It would be good if all investigators situated their inquiries within the hierarchical organization of MindBrain processes. Much confusion in this arena of thought and its resulting debates are due to people working at different levels but arguing about issues as if they were working at the same levels. There are hardly any behavioral neuroscientists or psychologists on the Anglo American scene working at primary-process emotional levels. Many esteemed behavioral neuroscientists are working at secondary-process levels (e.g., fear conditioning, exemplified best by LeDoux’s work). Understandably, most psychologists are working at the tertiary-process level, even as they may identify themselves as primary-emotion theorists (because they understand that such brain functions must exist, even though their ability to pursue causal analysis of the underlying issues are meager, compared to animal research).

We believe a substantive foundation for all the other levels of analysis will emerge from a cross-species primary-process, *causal* understanding of subcortical, mammalian brain networks. Understandably, there is little neuroscientific work in humans progressing at this level of analysis. However, several sophisticated brain-imaging studies are consistent with the subcortical locus of control for human emotional affects, pretty much as specified by a cross-species affective neuroscience (e.g., Damasio et al., 2000; Denton, 2006; Mobbs et al., 2007; Northoff et al., 2009). Indeed, as already noted, a recent meta-analysis robustly supports a basic-emotional organization of the human brain (Vytal & Hamann, 2010). Although fMRI and PET work continues to generate abundant correlates for emotional states, we do not believe that these technologies by themselves can tease apart foundational causal issues toward which emotion research needs to aspire.

How might this be achieved? Surely the increasing use of deep brain stimulation as a therapeutic modality provides new

opportunities to seek psychological correspondences (e.g., Mayberg, 2009; Schlaepfer et al., 2008), and also connectivity maps that clarify “locus of control” issues in the brain (Schoene-Bake et al., 2010). However, the most robust causal connections may emerge if findings from affective preclinical work (Panksepp, 2004) can be translated into parallel causal manipulations in human research and medical practice. Oxytocin is one example that is moving forward robustly (Panksepp, 2009). Opioid relationships have already provided compelling correspondences with our preclinical work (Depue & Morrone-Strupinsky, 2005). Indeed, at this level, our views can be easily negated: for instance, if substance P antagonists do not reduce angry-irritability in humans, cross-species affective neuroscience findings will have failed to clarify corresponding processes in humans. There are now many such predictions (see Panksepp & Harro, 2004, for just a few).

In closing, we note, with regret, that experimental psychologists have little empirical access to the primary-process mechanisms of the human BrainMind without investing in the study of highly informative animal models. The subcortical loci of control for human emotions is much underestimated. Evolution built our higher minds on a solid foundation of primary-process neuroaffective mechanisms, shared *in kind*, albeit not in precise detail, by all mammals. If so, rigorous animal brain research approaches can clarify key principles of such brain functions in humans (Panksepp, 1998, 2005b).

Many still believe that basic emotions do not exist in human brains (see Barrett, 2006; Ortony & Turner, 1990). If our fellow animals have them, and we still have homologous neural circuits, then it is likely we still have basic emotions too. Evolution cannot discard foundational issues, for that is incompatible with survival. This does not mean that dimensional research approaches to emotion studies don't have utility. They do, even in animal research (see e.g., Mendl et al., 2010). Indeed, such approaches may capture something of critical importance about higher human brain functions, where conceptual structures rule the BrainMind landscape. Dimensional perspectives are a fine way to order the seeming chaos of affective life. For a full discussion of such issues, see the forthcoming book devoted to this debate (Zachar & Ellis, in press) and other calls for consilience (Panksepp, 2007d). Basic-emotion approaches currently have enough robust neuroscientific evidence (Panksepp, 1998; Vytal & Hamann, 2010) that it seems ungracious to claim otherwise. Investigators committed to dimensional-constructivist views of emotions may want to periodically ask “Whether situating human emotional feelings on theoretically generated maps of multi-dimensional affective space (arousal-valence) reflects biologically-dictated brain functions or simply research-promoting conceptual acts?” (Panksepp, 2010b, p. 2907).

The bottom line in good science is whether proposed scientific theories and concepts can be experimentally falsified. Cross-species primary-process affective neuroscience has that attribute front and center. It aspires to bring a data-based neuro-evolutionary vision to our understanding of the foundations of human emotions that can be falsified in multiple ways. Hopefully each investigator, whether basic or constructivist, will assume

the responsibility to phrase their emotion theories with reference to scientific standards by which all our ideas must be judged: namely, do they engender a rich set of falsifiable predictions *at all relevant levels of analysis*, from human phenomenological to causal cross-species neuroscientific work? Such interdisciplinary work remains in short supply. If we encouraged more such work, we may soon have a coherent answer to how emotional feelings are created in human and animal brains.

Notes

- 1 We use these terms interchangeably, understanding that some formulations bridge from mind language to brain language, while other formulations reverse this. However, we see little difference between which side of the border one starts bridging efforts. Without bridging efforts our understanding in this area will remain woefully incomplete.
- 2 “Coherence” means that the various neural components that contribute to each emotional operating system (a) work together like a symphony, and (b) at the behavioral level there exist characteristic emotional action patterns that can be ethologically recognized as distinct emotional entities—exploration, freezing-flight, precipitous attack, etcetera. The remarkable feature of these evoked behaviors is that the activating stimulus is noninformational energy (e.g., stepped-down sine-wave current directly from a wall socket), yielding a distinct and recognizable (i.e., “coherent”) response pattern.
- 3 This distinction was originally made by John Searle (1983), helping us highlight that at the primary-process level there is an evolutionary directedness to instinctual-emotional behaviors that serves a general adaptive function (i.e., coherent “intentions-in-action”), that becomes refined with rerepresentational processes of learning and thought, allowing organisms more deliberate actions, which at their highest forms are cognitively experienced as “intention-to-act.”

References

- Alcaro, A., Huber, R., & Panksepp, J. (2007). Behavioral functions of the mesolimbic dopaminergic system: An affective neuroethological perspective. *Brain Research Reviews*, *56*, 283–321.
- Alcaro, A., Panksepp, J., Wiczak, J., Hayes, D. J., & Northoff, G. (2010). Is subcortical-cortical midline activity in depression mediated by glutamate and GABA? A cross-species translational approach. *Neuroscience & Biobehavioral Reviews*, *34*, 592–605.
- Barrett, L. F. (2006). Are emotions natural kinds? *Perspectives on Psychological Science*, *1*, 28–58.
- Burgdorf, J., Kroes, R. A., Beinfeld, M. C., Panksepp, J., & Moskal, J. R. (2010). Uncovering the molecular basis of positive affect using rough-and-tumble play in rats: A role for insulin-like growth factor I. *Neuroscience*, *163*, 769–777.
- Burgdorf, J., & Panksepp, J. (2006). The neurobiology of positive emotions. *Neuroscience and Biobehavioral Reviews*, *30*, 173–187.
- Ciampi, L., & Panksepp, J. (2005). Energetic effects of emotions on cognitions: Complementary psychobiological and psychosocial finding. In R. Ellis & N. Newton (Eds.), *Consciousness & emotions* (Vol. 1, pp. 23–55). Amsterdam, the Netherlands: John Benjamins.
- Damasio, A. R., Grabowski, T. J., Bechara, A., Damasio, H., Ponto, L. L. B., Parvizi, J., & Hichwa, R. D. (2000). Subcortical and cortical brain activity during the feeling of self-generated emotions. *Nature Neuroscience*, *3*, 1049–1056.
- Darwin, C. (1998). *The expression of emotions in man and animals* (3rd ed.). New York, NY: Oxford University Press. (Original work published 1872)
- Davis, K. L., Panksepp, J., & Normansell, L. (2003). The affective neuroscience personality scales: Normative data and implications. *Neuro-Psychoanalysis*, *5*, 21–29.

- Denton, D. (2006). *The primordial emotions: The dawning of consciousness*. New York, NY: Oxford University Press.
- Depue, R. A., & Morrone-Strupinsky, J. V. (2005). A neurobehavioral model of affiliative bonding: Implications for conceptualizing a human trait of affiliation. *Behavioral and Brain Sciences*, 28, 313–395.
- Ekman, P., & Friesen, W. V. (1978). *Facial action coding system: A technique for the measurement of facial movement*. Palo Alto, CA: Consulting Psychologists Press.
- Griffin, D. R. (2001). *Animal minds: Beyond cognition to consciousness*. Chicago, IL: University of Chicago Press.
- Heath, R. G. (1996). *Exploring the mind–body relationship*. Baton Rouge, LA: Moran Printing.
- Ikemoto, S. (2010). Brain reward circuitry beyond the mesolimbic dopamine system: A neurobiological theory. *Neuroscience & Biobehavioral Reviews*, 35, 129–150.
- Ikemoto, S., & Panksepp, J. (1999). The role of nucleus accumbens dopamine in motivated behavior: A unifying interpretation with special reference to reward-seeking. *Brain Research Reviews*, 31, 6–41.
- LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience*, 23, 155–184.
- Mayberg, H. S. (2009). Targeted electrode-based modulation of neural circuits for depression. *Journal of Clinical Investigations*, 119, 717–725.
- Mendl, M., Burman, O. H. P., & Paul, E. S. (2010). An integrative and functional framework for the study of animal emotions and mood. *Proceedings of the Royal Society, B: Biological Sciences*, 277, 2895–2904.
- Mikolajczak, M., Gross, J. J., Lane, A., Corneille, O., de Timary, P., & Luminet, O. (2010). Oxytocin makes people trusting, not gullible. *Psychological Science*, 21, 1072–1074.
- Mobbs, D., Petrovic, P., Marchant, J. L., Hassabis, D., Weiskopf, N., Seymour, B., ... Frith, C. D. (2007). When fear is near: Threat imminence elicits prefrontal-periaqueductal gray shifts in humans. *Science*, 317, 1079–1083.
- Nelson, E. E., & Panksepp, J. (1998). Brain substrates of infant–mother attachment: Contributions of opioids, oxytocin, and norepinephrine. *Neuroscience & Biobehavioral Reviews*, 22, 437–452.
- Northoff, G., Schneider, F., Rotte, M., Matthiae, C., Tempelmann, C., Wiebking, C., ... Panksepp, J. (2009). Differential parametric modulation of self-relatedness and emotions in different brain regions. *Human Brain Mapping*, 30, 369–382.
- Olds, J. (1977). *Drives and reinforcements: Behavioral studies of hypothalamic function*. New York, NY: Raven Press.
- Ortony, A., & Turner, T. J. (1990). What's basic about basic emotions? *Psychological Review*, 97, 315–331.
- Overton, D. A. (1991). Historical context of state dependent learning and discriminative drug effects. *Behavioural Pharmacology*, 2, 253–264.
- Panksepp, J. (1971). Aggression elicited by electrical stimulation of the hypothalamus in albino rats. *Physiology & Behavior*, 6, 311–316.
- Panksepp, J. (1982). Toward a general psychobiological theory of emotions. *The Behavioral and Brain Sciences*, 5, 407–467.
- Panksepp, J. (1990). Can “mind” and behavior be understood without understanding the brain? A response to Bunge. *New Ideas in Psychology*, 8, 139–149.
- Panksepp, J. (1998). *Affective neuroscience: The foundations of human and animal emotions*. New York, NY: Oxford University Press.
- Panksepp, J. (2001). The long-term psychobiological consequences of infant emotions: Prescriptions for the 21st century. *Infant Mental Health Journal*, 22, 132–173.
- Panksepp, J. (2003). At the interface between the affective, behavioral and cognitive neurosciences: Decoding the emotional feelings of the brain. *Brain and Cognition*, 52, 4–14.
- Panksepp, J. (Ed.). (2004). *A textbook of biological psychiatry*. Hoboken, NJ: Wiley.
- Panksepp, J. (2005a). Affective consciousness: Core emotional feelings in animals and humans. *Consciousness and Cognition*, 14, 30–80.
- Panksepp, J. (2005b). On the embodied neural nature of the core emotional affects. *Journal of Consciousness Studies*, 5, 158–184.
- Panksepp, J. (2006). Emotional endophenotypes in evolutionary psychiatry. *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, 30, 774–784.
- Panksepp, J. (2007a). Criteria for basic emotions: Is DISGUST a primary “emotion”? *Cognition & Emotion*, 21, 1819–1828.
- Panksepp, J. (2007b). Neuroevolutionary sources of laughter and social joy: Modeling primal human laughter in laboratory rats. *Behavioral Brain Research*, 182, 231–244.
- Panksepp, J. (2007c). Can PLAY diminish ADHD and facilitate the construction of the social brain? *Journal of the Canadian Academy of Child and Adolescent Psychiatry*, 10, 57–66.
- Panksepp, J. (2007d). Neurologizing the psychology of affects: How appraisal-based constructivism and basic emotion theory can co-exist. *Perspectives in Psychological Sciences*, 2, 281–296.
- Panksepp, J. (2009). Primary-process affects and brain oxytocin. *Biological Psychiatry*, 65, 725–727.
- Panksepp, J. (2010a). The evolutionary sources of jealousy: Cross-species approaches to fundamental issues. In S. L. Hart & M. Lagerstee (Eds.), *Handbook of jealousy: Theories, principles, and multidisciplinary approaches* (pp. 101–120). New York, NY: Wiley-Blackwell.
- Panksepp, J. (2010b). Affective consciousness in animals: Perspectives on dimensional and primary-process emotion approaches (A commentary on Mendl, Burman & Paul, 2010). *Proceedings of the Royal Society, B: Biological Sciences*, 277, 2905–2907.
- Panksepp, J., & Biven, L. (2011). *The archaeology of mind: Neuroevolutionary origins of human emotions*. New York, NY: Norton.
- Panksepp, J., & Crepeau, L. (1990). Selective lesions of the dual olfactory system and cat smell-attenuated play fighting among juvenile rats. *Aggressive Behavior*, 16, 130–131.
- Panksepp, J., & Harro, J. (2004). The future of neuropeptides in biological psychiatry and emotional psychopharmacology: Goals and strategies. In J. Panksepp (Ed.), *Textbook of biological psychiatry* (pp. 627–660). New York, NY: Wiley.
- Panksepp, J., Lensing, P., Leboyer, M., & Bouvard, M. P. (1991). Naltrexone and other potential new pharmacological treatments of autism. *Brain Dysfunction*, 4, 281–300.
- Panksepp, J., & Moskal, J. (2008). Dopamine and SEEKING: Subcortical “reward” systems and appetitive urges. In A. Elliot (Ed.), *Handbook of approach and avoidance motivation* (pp. 67–87). New York, NY: Taylor & Francis Group.
- Panksepp, J., & Watt, J. (2011). Why does depression hurt? Ancestral primary-process separation-distress (PANIC) and diminished brain reward (SEEKING) processes in the genesis of depressive affect. *Psychiatry*, 74, 5–13.
- Panksepp, J., & Zellner, M. (2004). Towards a neurobiologically based unified theory of aggression. *Revue Internationale de Psychologie Sociale*, 17, 37–61.
- Pfaff, D. (2006). *Brain arousal and information theory*. Cambridge, MA: Harvard University Press.
- Russell, J. (1995). Facial expression of emotions: What lies beyond minimal universality? *Psychological Bulletin*, 118, 379–391.
- Schlaepfer, T. E., Cohen, M. X., Frick, C., Kosel, M., Brodesser, D., Axmacher, N., ... Sturm, V. (2008). Deep brain stimulation to reward circuitry alleviates anhedonia in refractory major depression. *Neuropsychopharmacology*, 33, 368–377.
- Schoene-Bake, J.-C., Parpaley, Y., Weber, B., Panksepp, J., Hurwitz, T. A., & Coenen, V. A. (2010). Tractographic analysis of historical lesion-surgery for depression. *Neuropsychopharmacology*, 35, 2553–2563.
- Searle, J. R. (1983). *Intentionality: An essay in the philosophy of mind*. New York, NY: Cambridge University Press.
- Stutz, R. M., Rossi, R. R., Hastings, L., & Brunner, R. L. (1974). Discriminability of intracranial stimuli: The role of anatomical connectedness. *Physiology & Behavior*, 12, 69–73.

- Sur, M., & Rubenstein, J. L. (2005). Patterning and plasticity of the cerebral cortex. *Science*, *310*, 805–810.
- Tulving, E. (2002). Chronesthesia: Awareness of subjective time. In D. T. Stuss & R. C. Knight (Eds.), *Principles of frontal lobe function* (pp. 311–325). New York, NY: Oxford University Press.
- Tulving, E. (2004). Episodic memory from mind to brain. *Review of Neurology*, *160*, 9–23.
- Tzschentke, T. M. (2007). Measuring reward with the conditioned place preference (CPP) paradigm: Update of the last decade. *Addiction Biology*, *12*, 227–462.
- Vandekerckhove, M., & Panksepp, J. (2009). The flow of anoetic to noetic and auto-noetic consciousness: A vision of unknowing (anoetic) and knowing (noetic) consciousness in the remembrance of things past and imagined futures. *Consciousness and Cognition*, *18*, 1018–1028.
- Vytal, K., & Hamann, S. (2010). Neuroimaging support for discrete neural correlates of basic emotions: A voxel-based meta-analysis. *Journal of Cognitive Neuroscience*, *22*, 2864–2885.
- Watt, D. (2007a). Toward a neuroscience of empathy: Integrating affective and cognitive perspectives. *Neuro-Psychoanalysis*, *9*, 119–172.
- Watt, D. F. (2007b). Affirmative-action for emotion in cognitive neuroscience in the study of empathy: response to commentaries. (Target Article: Towards a neuroscience of empathy: Integrating cognitive and affective perspectives). *Neuro-Psychoanalysis*, *9*, 161–172.
- Watt, D., & Panksepp, J. (2009a). Depression: An evolutionarily conserved mechanism to terminate separation distress? A review of aminergic, peptidergic, and neural network perspectives. *Neuro-Psychoanalysis*, *11*, 5–104.
- Watt, D. F., & Panksepp, J. (2009b). Response to commentaries (Target Article - Depression: an evolutionarily conserved mechanism to terminate protracted separation distress. A review of aminergic, peptidergic and neural network perspectives). *Neuro-Psychoanalysis*, *11*, 87–109.
- Watt, D. F., & Pincus, D. I. (2004). Neural substrates of consciousness: Implications for clinical psychiatry. In J. Panksepp (Ed.), *Textbook of biological psychiatry* (pp. 627–660). Hoboken, NJ: Wiley.
- Zachar, P., & Ellis, R. (in press). *Emotional theories of Jaak Panksepp and Jim Russell*. Amsterdam, the Netherlands: John Benjamins.