An Evolutionary Framework to Understand Foraging, Wanting, and Desire: The Neuropsychology of the SEEKING System

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The SEEKING system of mammalian brains needs to be understood from multiple scientific and clinical perspectives. SEEKING theory provides new neuropsychoanalytic perspectives for understanding the human mind and its behavioral and emotional disorders and considers dimensions of experience that have traditionally been subsumed under concepts such as "drives" and "motivations." Historically these concepts became problematic because experimentalists and clinicians didn't quite know what they were speaking about, at least within the evolved dynamics of the mammalian BrainMind. Here, we briefly summarize the history of the field and build a framework to help us understand a variety of human experiences, with the hope of understanding and treating common human psychological problems—from a vast number of addictive urges to depressive despair. Our goal is to promote an understanding of a key form of human experience that resides in the nomothetic primary-process domain, which provides a fundamental substrate for the idiographic growth of individual minds toward both psychological disturbances and mental health. Concurrently, by considering the impact of the SEEKING system in psychological, psychiatric, neuroscientific, and psychoanalytic domains, we have sought to provide a clear vision of one key entry point for linking our animalian foundations to a better understanding of the higher aspects of human minds and the brain.

Keywords: SEEKING; desire; drive; motivation; consciousness; wanting; craving; depression; addiction; neuropsychoanalysis

A problem that continues to impede productive psychoneurological research is the lack of generally accepted conceptual frameworks through which both psychological and modern neuroscientific perspectives can be integrated, studied, and understood in a common language. In this article we combine theory, experimental findings, and hypotheses to provide a synthesis of neuroscientific evidence and human subjective experience in order to understand the eager "desire" that characterizes so much of human and animal mental life. A primal neural system devoted to the "energetic" seeking of resources across mammalian species is foundational for this. This primary-process SEEKING system will be discussed, dissected, and synthesized as a foundational psychobehavioral phenomenon that has historically gone under many names, from "drive" in the psychoanalytic literature to "incentive salience" in modern behavioral neuroscience. It is the major brain source for the classical concept of global "motivation," but because this system mediates a remarkably energized form of intracranial self-stimulation reward, for six decades it has been misleadingly called "The Brain Reward System." This article highlights how a SEEKING view provides a more coherent understanding of how this emotional urge generates *joie de vivre* as well as many psychiatrically relevant vicissitudes of excessive motivational "drive."

The generic "reward" terminology for self-stimulation reward is psychologically ambiguous. It is currently increasingly understood that this "rewarding system" does not generate sensory pleasure but, rather, a psychomotor eagerness to obtain resources that can engender pleasure and also help avoid various forms of distress. A neuropsychoanalytic approach offers an alternative and hopefully more accurate vision of how a primal SEEKING urge to engage with the world

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in affective ways allows all mammals (and probably other vertebrates) to forage for and anticipate diverse rewards and also to cope with various "punishing" states of the world. As we clarify here, the capitalization of this large neural network is intended to provide a general nomenclature for "primary-process" brain systems laid down in the brain as instinctual, ancestral "memories" that all mammals need in order to survive (Panksepp, 1998, 2011a, 2011b).

Such a conceptual shift can also facilitate new understanding of how basic emotional systems promote simple learning (secondary-process) as well as cognitively sophisticated agendas (tertiary-process) that reflect how the "mind's eye" can travel both backward and forward, along past and future life-lines, in order to concoct new aspirations, hopes, and plans for the future, as well as to dream and learn. Ultimately the function of all primal affective processes is to better anticipate and cope with the future, each being molded through evolution to reflect the needs and best coping strategies of nature. But the SEEKING system stands out from the others because of its vast purview—its participation in practically all goal-directed mental and bodily activities.

Here the SEEKING system is discussed from both psychological and neurological perspectives. Well-known and widely used traditional concepts such as "drives" and "motivation"—often used in diverse ways in different disciplines—will be integrated with the SEEKING system perspective. However, the way in which this system is analyzed is also a question of perspective. The majority of behavioral neuroscientists take a "horizontal approach"—that is, systems are analyzed as sensory inputs being integrated with behavioral action, which of course they are. The neural systems are then analyzed sequentially, as a function of an organism's behavior over time, and are interpreted with little or no regard for the evolutionary organization of the brain. Our view is that this horizontal approach adds value, but also that the "vertical" perspective of primary–secondary–tertiary processing that takes an evolutionary perspective is also necessary to understand what, epistemologically, a specific experiment is studying. This is particularly important when studying emotional systems in nonhuman animals since, without such a "vertical" perspective, it is difficult to know what aspects of the neural systems and resulting experiences/behaviors are translatable to the human mind as well as what aspects of the human mind can be studied in other animals.

Without a coherent evolutionary perspective, results of animal research might therefore either be wrongly ignored or overinterpreted, leading to needless controversies. Our goal in this article is to integrate the horizontal and vertical perspectives. We break down the extended SEEKING system itself into its three horizontal component-functions—namely, (1) *generating* (generation of naked anticipation/excitement), (2) *coupling* (linking urges spatiotemporally to the objects and opportunities of the world and to specific drives in the brain), and (3) *enacting* (e.g., where SEEKING transitions from appetitive to consummatory, or at higher levels is accompanied by various thoughts or cognitive perspectives). These horizontal component-functions are simultaneously viewed through an evolutionary vertical perspective—of primary, secondary, and tertiary processes, reflecting instinctual, learned, and cognitive levels of analysis (for further discussion of such levels, see Panksepp's review of Damasio's *Self Comes to Mind* in the last issue of this journal; Panksepp, 2011d). Such a framework intends to shrink the gap between psychological and neurological research and thought and hopefully allows better integration of diverse points of view in this area (Panksepp & Moskal, 2008). A brief review of depression and addiction, as each relates to the SEEKING system, is also offered, along with theoretical implications for future research and clinical practice. Thus, this article ranges from concrete neurobiological evidence to both practical and philosophical perspectives/speculations.

Historical and philosophical perspectives

In his overview work, *An Outline of Psycho-Analysis,* Freud (1940) frames the abyss between psychological and neuroscientific understanding:

> We know two kinds of things about what we call our psyche (or mental life): firstly, its bodily organ and scene of action, the brain (or nervous system) and, on the other hand, our acts of consciousness, which are immediate data and cannot be further explained by any sort of description. Everything that lies between is unknown to us, and the data do not include any direct relation between these two terminal points of our knowledge. If it existed, it would at the most afford an exact location of the processes of consciousness and would give us no help towards understanding them. [pp. 144–145]

The last point raised is one that may exist forever, at least to some degree. Despite how close we come to understanding different aspects of the brain, even when tied empirically to psychological processes, this does not automatically illuminate the mechanisms by which consciousness arises within the brain. Some have sought to shrink this abyss. Karl Pribram (1971), for example, postulates that electromagnetic interference patterns, arising from underlying neural processes, create psychological experience—patterns that, in his view, take on features analogous to holograms. Such a view is certainly an empirically testable proposition but is not without problems. It may shrink the gap between the biology of neural activity and the emergent psychological experiences, but since electromagnetic distributions and interference patterns still rely on underlying neural biological processes, they alone do not explain what psychological experience is and how it relates to the brain. In other words, a certain philosophical aesthetic (i.e., proof) may forever remain outside the reach of science, even as we formulate ever more specific and testable predictions. It is therefore important for BrainMind science to frame discrete goals that can reconcile the neurological and psychological aspects of mental activities. A pragmatic "dual-aspect monism" framework, based on empirical psychoneurological confirmations and disconfirmations, is currently a better epistemological strategy (Panksepp, 2005; Solms & Turnbull, 2002). Moreover, a nonlinear dynamic system approach to subcortical network dynamics might one day help us understand the constitution of primal consciousness (Panksepp, 2000, 2001).

Because of neuroscientific advances, we are now able to exploit the insights and knowledge gained through concurrent psychological and neuroscientific inquiries to better treat psychiatric illness and promote better mental functioning. It is through such practical applications that new insights are bound to arise. Though all bridging efforts in the BrainMind sciences are bound to be theoretical approximations, their yield of concrete falsifiable predictions is our most productive way toward substantive understanding.

What, then, is the best perspective to take when approaching the question of the BrainMind in the larger sense? (Instead of the monistic BrainMind term, we will also simply use "mind" to denote that aspect of brain function that is experienced—namely, phenomenal consciousness.) At its foundational level, the mind must be understood in terms of evolution, and evolution must be understood in the context of the physical forces of nature and the distribution of resources in the world. An understanding of both needs to be rooted in working reality—namely, the scientific *weight of evidence*, based on experimental analysis of causes and effects, which are ultimately grounded in physics but with emergent properties that cannot yet be understood in terms of either physics or chemistry. Indeed, it is possible that Freud's restriction of drives down to the two predominant ones—sexuality and aggression (for recent clinical and psychoanalytic perspectives, see Kernberg, 2012)—was an expression of his understanding of this same root, though he also taught that many other drives existed, an idea from which we will extrapolate to brain organization later in this article. Although physics (forces of nature, and patterns seen therein) may one day provide an important route for understanding the mind (just as understanding the mind might lead to insights about the nature of reality and the forces governing it), we do believe that there are levels of control in nature, and mind becomes neuroscientifically interesting when we see it as an emergent property of complex network functions of the brain. In neuroscience, ruthless reductionism is not sufficient to understand the nature of mind.

At the present time, it is likely that large-scale network-level analysis, such as the natural evolved circuits discussed here, and still larger network properties of the brain are critical for the emergence of both lower and higher levels of consciousness (Panksepp, 2000). However, because of intellectual traditions, the reductionist level of analysis seems somehow more compelling to many and hence perhaps more commonly respected among basic neuroscientists than "emergentist" approaches. We feel that reductionism misses an essential ingredient, the emergent properties of nature. Consider the free flow of water, which can be transformed into a gas or a solid, with diverse and wonderful properties that could not have been predicted from the properties of hydrogen and oxygen, or even from a single molecule of H_2O.

However, we will not delve here into concepts such as quantum consciousness, nor what some would call "ultimate reality"—a topic for metaphysics. For us, the most probable route toward a practical scientific understanding of the subjectively experienced mind will lie within the working reality of the brain. The most fundamental issue then is how *mind* emerged in neural evolution. Our provisional answer is that it emerged from affective network processes, and the SEEKING urge was among the earliest "big-ticket items" and remains among the most important global foundations for higher mental processes and concepts such as intentionality and will. Furthermore, as the mind itself evolved as an operator of time, forming a continuity of experience, it seems plausible that the so-called dualistic abyss between the brain and mind can be studied scientifically, in the realms of measurable and dissectible causes and effects, often operating in two-way circular fashions in the whole organism.

Introduction to neural systems: bridging the gap between psychology and neuroscience

Substantive progress has been made during the past 50 years toward bridging the gap between psychological phenomena and the functioning of neural networks/systems of the brain (e.g., Panksepp & Biven, 2012; Solms & Turnbull, 2002). Advances in behavioral and cognitive neuroscience, and more recently systems and affective neuroscience have finally provided a foundation for conceptualizing diverse large-scale, psychologically relevant systems of interfunctioning neuronal nets that act together to generate coherent behavioral responses and primal psychological experiences.

The first such neuropsychological–behavioral system was discovered in the 1930s by Walter Hess (see his 1957 book, which highlighted coherent aggression systems in the brain, though he did not evaluate the affective properties of what we now call the RAGE system). The next system, which was thought to clarify "reward"/"reinforcement," was found in the 1950s when Olds and Milner discovered that rats would repeatedly press a lever to receive mild electrical stimulation to certain parts of the brain (Olds & Milner, 1954). Concurrently, a "punishment" system was discovered by Delgado, Roberts, and Miller (1954). Perhaps because of this context of discovery (during the behavioral era where external "rewards" and "punishments" were used to mold behavior), the Olds & Milner system came to be known as "The Reward System" of the brain. In support of this hypothesis it has been found that besides drugs of abuse, food and liquid rewards increase activity in midbrain dopamine neurons, which to this day are most commonly conceptualized as key parts of the reward circuitry (for extensive reviews see Haber & Knutson, 2010; Schultz, 2005), even though the long-held pleasure–hedonia hypothesis has been largely abandoned. Indeed, many brain functions that have little to do with rewards (and pleasure) as traditionally conceptualized also arouse this system, including exploration, enthusiasm, and euphoria—brain functions that better describe what this "reward circuitry" of the brain actually promotes. Thus, the simple "brain reward" scenario has repeatedly been complicated by many factors including the ever-present evidence that brain dopamine is involved in rather general motivational and diverse emotional processes (for reviews, see Panksepp, 1998; Wise, 2004). The theoretical reward-circuitry framework yielded substantial initial gains in understanding the brain and behavior but eventually led to many empirical problems and conceptual confusions.

Many other systems have since been discovered and studied, including the reconceptualization and expansion of "the brain reward system" as a general-purpose SEEKING/expectancy/wanting system (Alcaro, Huber, & Panksepp, 2007; Panksepp, 1981, 1982a, 1982b). Others include, but are not limited to, six additional primary-process emotional-behavior and affect-generating neural systems: PANIC/GRIEF, PLAY, RAGE, FEAR, LUST, and CARE (for intensive reviews, see Panksepp, 1998, 2005; Panksepp & Biven, 2012). The focus of this article is on the further development of SEEKING theory to promote a psychoneurological framework that allows diverse drives and motivations to be readily understood in terms of the operation of a general-purpose SEEKING system in ways that may promote understanding of key human experiences along with clinical implications—specifically, for understanding depression and various addictions (for related recent discussions see Alcaro & Panksepp, 2011; Panksepp & Watt, 2011; Watt & Panksepp, 2009; Zellner, Watt, Solms, & Panksepp, 2011).

Part of our psychological analysis arises from the perspective that the way in which something is conceptualized is not arbitrary or merely a manner of semantics, but is essential in guiding future research and the interpretation of past data. Such a framework also addresses utilitarian concerns such as how to better implement therapeutic interventions. The classical conception of the mesocortical limbic dopamine pathway as the "reward circuitry" of the brain has been the topic of much debate and refinement (Berridge, Robinson, & Aldridge, 2009; Panksepp & Moskal, 2008), and our perspective is that this brain system is still best understood by the psychobiological concept of SEEKING, since this concept is able to make sense of the largest number of facts. The SEEKING conception does not deny that activity within this system is rewarding in the behavioral sense that behaviors that engender increased activity in the SEEKING system will clearly increase in probability of repetition; yet, arousal of other neural systems can also be rewarding in this sense, with the medial septal area being best studied (Wauquier & Rolls, 1976). The positive affect generated by SEEKING is more akin to the human concept of internal euphoria rather than any specific sensory pleasure, while septal stimulation not only has different behavioral characteristics, but in humans also yields feelings of impending orgasmic pleasure (Heath, 1963). Since the brain can generate many distinct primary-process rewards, it is critical to conceptually and neuroscientifically parse them, a point also emphasized by Berridge and Robinson (2003). Thus, the

SEEKING view is consistent with the likelihood that the circuitry generates some kind of hedonic changes (i.e., positive valence), but this view aspires to provide a theoretical vision that will more readily interface with many other positively "exciting" behavioral activities and psychological feelings outside the realm that is normally thought of as rewarding in a primal "pleasure" sense.

The best complementary approach, albeit sufficiently different to provoke some interesting debate, is one proposed by Kent Berridge and colleagues (for thorough coverage, see Berridge, Robinson, & Aldridge, 2009; Peciña & Berridge, 2005). They parsed the concept of "reward" into the dual processes of "wanting" and "liking," with a key intermediary attribute called "incentive salience" (which is almost synonymous with "secondary reinforcement" in the original behavioristic terminology of appetitive learning). Their framework, which first appeared in 1993, partly pursuant to the views espoused by Panksepp (1981, 1982a, 1982b, and onward), offers conceptual refinements that are useful for those working within classical reward learning paradigms, and the wide appeal of their terminology may partly reflect the selection of common vernacular terms that are easily understood within the secondary and tertiary levels of BrainMind processing where most psychologists do their research. Their view is a major advance over the classical "brain reward system" concept, but in our estimation, is still too heavily based on a sensory-centric view of the underlying motivational system, which does not adequately capture the deep instinctual action components that the SEEKING system coordinates. Thus, it is not as broad and inclusive nor developmentally dynamic as the SEEKING system focus we elaborate here. In our estimation, it also does not generate as broad a theoretical integration that focuses on "organismic coherence," which yields diverse sets of predictions, especially to human psychological and clinical concerns, as suggested by the multi-tiered evolutionarily informed SEEKING theory—a methodological point we have already emphasized as key for long-term progress. More recently, steps toward dynamic systems frameworks have also been taken, which help conceptualize global networks beyond simple reward processing (Bromberg-Martin, Matsumoto, & Hikosaka, 2010; Hikosaka, Bromberg-Martin, Hong, & Matsumoto, 2008; Lewis, 2005; Panksepp, 2000), but there is insufficient space to integrate such progressive elaborations into our present coverage.

Our view is premised on the robust discovery that, to our knowledge, all mammals tested (including humans) show increased interaction with and exploration of the environment when the SEEKING system is chemically or electrically aroused, and the psychological urge evoked is one of positive euphoria accompanied by increased engagement with all of the life-supporting "affordances" of the world. People have reported increased planning, sexual arousal, energy, agitation, curiosity, increased general motivation, a pressure to act, and euphoric states when this system is stimulated (Coenen, Schlaepfer, Maedler, & Panksepp, 2011; Panksepp, 1985). The overall trajectory of this system is summarized in Figure 1 (which is the first visualization of the system in any mammal and is currently being well described in humans, using diffusion tensor imaging; Coenen et al., 2011). The heart of the system works in a coordinated way, receiving information from many brain areas and controlling a wide array of other BrainMind functions in diverse brain regions as it distributes a global urge to engage with the world (Figure 2).

Neurological and behavioral evidence for a SEEKING system

The underlying neuronal networks for SEEKING (the most important being collectively called the medial forebrain bundle, MFB, although there are other components) create a general psychobehavioral urge (or motive force) to act in a certain enthusiastic way that can be implemented into and coordinated with numerous emotions and drives and tied to diverse objects in the environment. Such a system allows an adaptive variety of possible behaviors to emerge from a generalized forward-directed, approach-type, appetitive engagement with the world. Functionally, besides the creation of this expansive, affectively saturated behavioral urge, the SEEKING system also plays an important role in one of the key overall functions of the mind—the spontaneous ability to anticipate future events and often to do so with robust mental enthusiasm. Indeed, all basic affects have some kind of intrinsic anticipatory function (e.g., FEAR anticipates and protects against destruction), but many are comparatively static (e.g., the sensory and homeostatic affects).

The anticipatory eagerness aroused by SEEKING is more future-*opportunity* oriented than the sensory affects. It is ready to capitalize on all the environmental resources needed for survival. In that general role, it was "designed" through evolution to be the most general-purpose emotional system of the brain. It integrates much of what organisms must do in order to

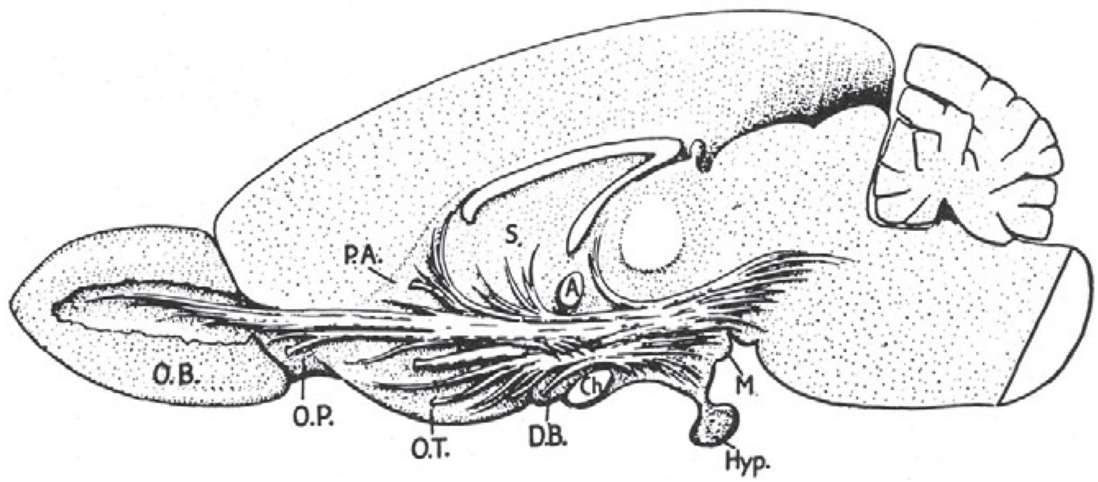

Figure 1. A drawing of the medial forebrain bundle, which illustrates the main trajectory of the SEEKING system (classically referred to as "the brain reward system"). It runs up from the midbrain, through the lateral hypothalamus (LH), into more rostral neural regions. Other neural regions pictured: optic chiasm (Ch), olfactory bulbs (O.B.), olfactory peduncle (O.P.), paraolfactory area (P.A.), olfactory tract (O.T.), diagonal band of Broca (D.B.), anterior commissure (A), pituitary gland/the hypophysis (Hyp.), septum (S.), and mammillary bodies (M). (Figure from Le Gros Clark, 1938.)

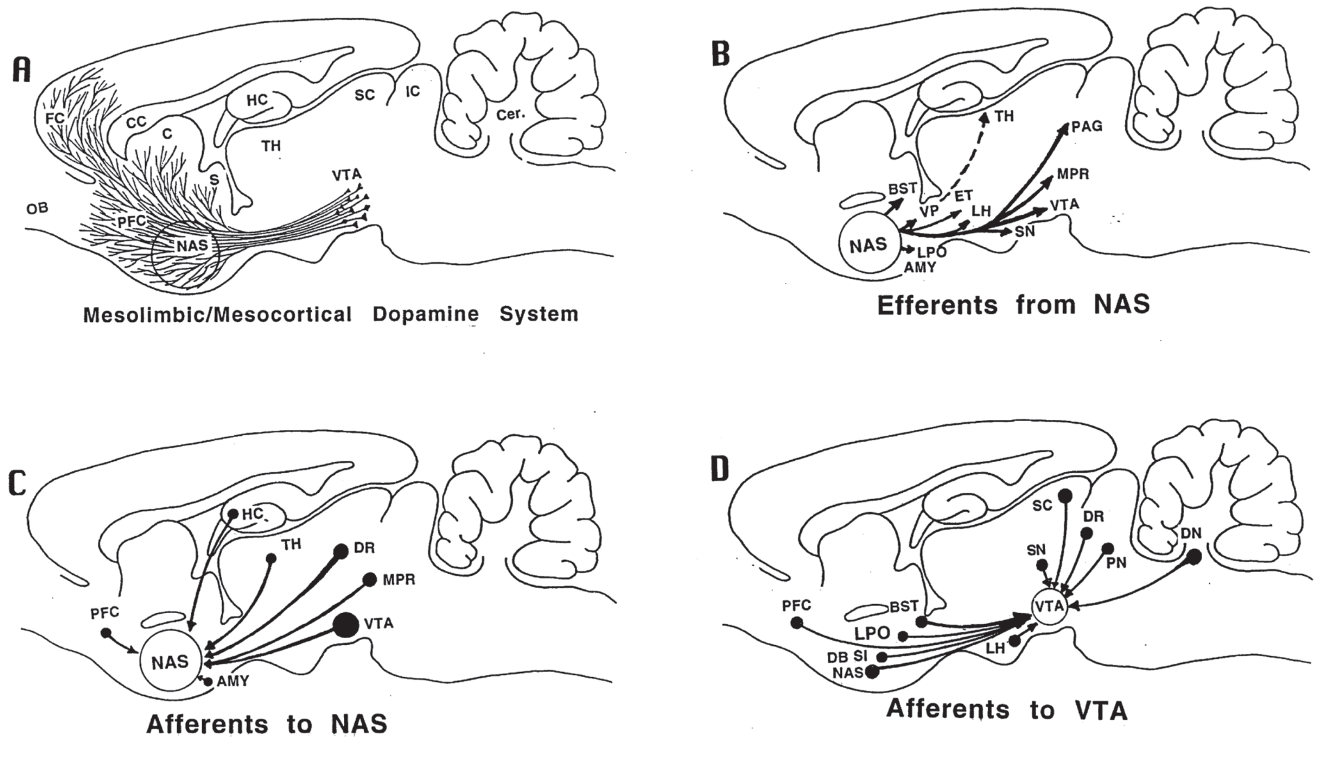

Figure 2. Diagrams showing different aspects of the SEEKING system in the rat brain. **A.** Ascending projections from the midbrain ventral tegmental area (VTA) a10 dopamine neurons that innervate the nucleus accumbens (NAS) and prefrontal cortex (PFC) among other regions. **B.** Efferents (descending) of the nucleus accumbens, mostly GABAergic. **C.** The major afferent projections to the NAS. **D.** Afferent projections to the VTA. Other abbreviations: amygdala (AMY), bed nucleus of stria terminalis (BST), caudate-putamen (C), corpus callosum (CC), diagonal band of Broca (DB), dentate nucleus (DN), dorsal raphe (DR), entopeduncular nucleus (ET), frontal cortex (FC), hippocampus (HC), inferior colliculus (IC), lateral hypothalamus (LH), lateral preoptic area (LPO), mesopontine reticular nuclei (MPR), olfactory bulb (OB), periaqueductal gray (PAG), prefrontal cortex (PFC), parabrachial nucleus (PN), superior colliculus (SC), substantia innominate (SI), substantia nigra (SN), thalamus (TH), ventral pallidum (VP). (Figure from Ikemoto & Panksepp, 1999.)

survive. Thereby, it also helps set up brain appetitive learning processes, establishing secondary reinforcements (or "incentive salience") that provide even longer term solutions to survival (Figure 3). Thus, one can imagine the system to be critically involved in anticipating what must be done, for the survival of the entire organism, when any of the basic bodily needs arise, from reducing hunger and thirst to promoting RAGE and even diminishing FEAR through activation of flight strategies. It can also generate a euphoric subjective "fortitude" that corresponds to the aroused foraging-appetitive behavioral urges, helping assure that organisms are up to the task of survival. As we will see, these psychological and behavioral resources are markedly diminished in clinical depression.

Anatomically, the SEEKING system runs upward from the midbrain VTA up through the lateral hypothalamus into the nucleus accumbens, toward the olfactory bulbs, and also includes many parts of the medial frontal cortical regions, though it is not limited to these ascending anatomical areas, as well as many regions farther down the brainstem to subcortical cerebellar regions. In terms of overall neurochemical modulation, the SEEKING system has been most closely associated with dopamine release—the VTA sends massive dopaminergic projections to the nucleus accumbens, but there are equally massive contributions from descending GABA systems. As discussed next, the whole MFB is enriched in other ascending catecholamine systems (norepinephrine and serotonin), as well as a host of neuropeptides, with ones like orexin finding their source neurons situated midway in the system at the lateral-hypothalamic level.

In sum, many brain regions (Figure 2) and neurochemical systems are interconnected with the SEEKING system, forming a complex web among coordinated neural networks, facilitating integration of homeostatic, sensory, autonomic, and learning processes to yield a coordinated affective presence that in classical behaviorist terminology has been called an approach motivation system (Alcaro & Panksepp, 2011; Ikemoto, 2010). The prefrontal cortex, hippocampus, and basolateral amygdala send learning-relevant glutamatergic projections to the nucleus accumbens, allowing the SEEKING system to integrate emotional-, spatial-, cognitive-, and environmental-cue-related information. The VTA and the hypothalamus also receive glutamatergic input from other rostral brain regions (the amygdala and hippocampus: for detailed review, see Haber & Knutson, 2010) as well as from below (Lavoie, Côté, & Parent, 1995). The lateral hypothalamus sends peptidergic projections, such as neurons releasing orexin, to both the nucleus accumbens and the VTA (whose activity is regulated by no less than a dozen other neuropeptide systems, each perhaps able to code somewhat different adaptive trajectories through the use of the SEEKING urge). From caudal regions of the brain, the locus coeruleus sends norepinephrine projections to the VTA—important for attentional filtering of extraneous information and cueing-in on novel experiences, as related to concurrent innervation of the hippocampus, amygdala, and neocortex. Likewise, the raphe nuclei send serotonin projections

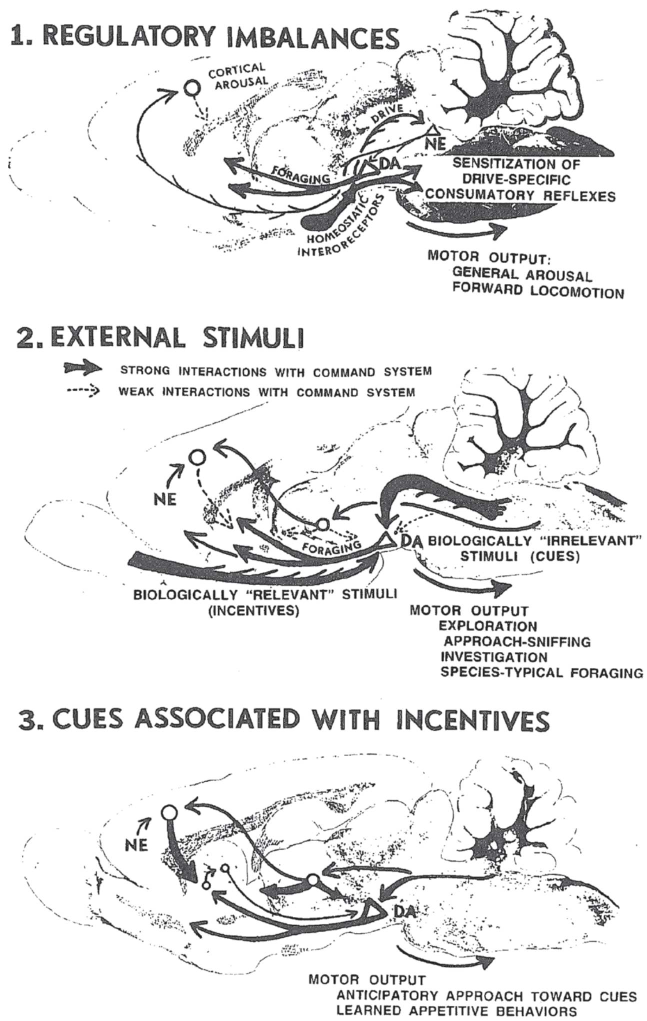

Figure 3. Schematic illustrating different factors that influence the SEEKING system. Panel 1 illustrates how changes in the homeostatic (primary) drives feed into the SEEKING system, which in turn leads to motor-coordinated forward-directed foraging behavior. Panel 2 illustrates how biologically relevant external stimuli (instinctual incentives) feed into the SEEKING system and can converge with biologically irrelevant stimuli (cues) to set the stage for learning. Panel 3: Cues become paired with incentives (secondary-process), leading to anticipatory behavior when the previously irrelevant cue is presented. (From Panksepp, 1998, Fig. 8.1, with permission of Oxford University Press.)

to these same brain regions, in order to stabilize the global brain dynamic we call SEEKING. In short, there is a highly integrated longitudinal brain system that supports practically all intrinsic life-supporting organismic actions, interfacing with appetitive learning (secondary-process) mechanisms and higher cognitive (tertiary-process) brain functions.

Behavioral evidence for a generalized primary-process SEEKING urge

One key set of experiments that clarify the divergence between "the brain reward system" and SEEKING system conceptualizations was performed in the 1970s (Mendelson, 1972; Valenstein, Cox, & Kakolewski, 1970). Rats implanted with electrodes in the lateral hypothalamus were placed in a testing arena half filled with miscellaneous objects such as sticks, corks, bottle caps, and food pellets. In Mendelson's work, the arena was divided into two halves, and animals received electrical stimulation only when situated on the side containing lots of "stuff." Animals collected items on the stimulation side and dropped them on the nonstimulation side—the end result being an apparent hoarding of objects on the nonstimulation side of the arena. Such behavior patterns are difficult to reconcile in the theoretical architecture of this system being simply the reward circuitry of the brain.

Evolutionarily, it is easy to see the importance of such hoarding and how it relates to a SEEKING system concept. When stimulated, an animal has the urge to seek and gather, an urge that in hoarding creatures can be targeted toward whatever is available and potentially useful in the environment; when the motive force evoked by external brain stimulation is turned off, the animal no longer has such an urge (and drops whatever they were carrying). Presumably this system is in overdrive in many humans who gather more and more stuff and simply never throw anything away—a clinical issue that will be further explored later, since that is a problem of psychiatric and health significance, especially with the elderly (Gilliam & Tolin, 2010; Mataix-Cols et al., 2010).

Anyone having witnessed an animal receiving stimulation of the SEEKING system will immediately notice how intensely the animal has been "energized"—from facilitation of normal-appearing exploration at low current levels to frenzied agitation with movement from one object to another at high levels. Animals begin to gnaw on any object available and/or explore available spaces with greater frequency. When the stimulation ceases, animals typically promptly stop and begin to groom. This "mania" is just the opposite of behavior exhibited by depressed organisms as well as ones that are experiencing pleasure, which is one reason why the conceptualization of this system in terms of reward circuitry just does not make sense, even though it has remained mainstream for so long. Animals indulging in consuming rewards tend to settle down, as if they were experiencing parasympathetic dominance. Thus, there are both semantic and scientifically substantive differences between the idea of hedonic pleasure-reward and the broader idea of a euphoric, foraging action-oriented reward.

The murkiness and difficulty in separating reward, pleasure, and desire/SEEKING is well illustrated by interesting clinical examples of humans implanted with electrodes into the classical reward circuitry/SEEKING system. As Schlaepfer et al. (2008) described, soon after stimulation of rostal nucleus accumbens trajectories of this system, one patient started "to wear his wife's clothes, demanded sexual intercourse daily, and showed increased risk-taking behavior, particularly reckless driving. The patient was admitted to the hospital. He appeared agitated and understood that his behavior was wrong, but he explained that 'something was driving him.' Stimulation was shut off and his urges stopped almost instantaneously" (Coenen et al., 2009, p. 1109). Such behaviors raise a momentous question: Why, if a rewarding internal feeling is being directly chronically aroused with sustained brain stimulation, do rats and humans seek so much additional reward? Should they not decrease, or even cease, reward seeking, since they are already experiencing the neural essence of reward via direct stimulation? Should they not be "kicking back" and exhibiting some sort of satiated and satisfied relaxation, as opposed to urgent hopes and desires? Yet by activating this so-called brain reward system, humans want more rewards. Their appetite has been whetted, not slaked!

It is clear that stimulation of this system leads to increased seeking of various things that are typically thought of as rewarding rather than just as providing a reward. If they were receiving the psychological essence of conventional "rewards"—for example, by stimulating a sensory or homeostatic "reward"—the behavior should be more akin to activating some kind of a "satisfaction or satiety circuit" of the brain, but instead of being put into the mood, for example, to eat less, animals eat more. They also drink more and gnaw more, and, surprisingly, all these behaviors are interchangeable (Valenstein, Cox, & Kakolewski, 1970). Why? Is it because the animal is feeling the satisfaction of being "rewarded" (as predicted by the "reward circuitry theory") or because its desires are running wild (as predicted by the SEEKING system theory)? One can see how these strange behavioral and psychological effects can be explained under the SEEKING paradigm, even perhaps to some extent the secondary-process "wanting" paradigm, but not under the "reward system" hypothesis. So, one might wonder, why does the latter conceptualization still rule over the former? Perhaps this is because SEEKING is fundamentally a psychobiological concept, while "reward" is strictly behaviorist terminology.

A further example illustrating the explanatory power of the SEEKING vs. "brain reward" concept is the finding that a hungry animal will lever-press more for a nonfood reward than will a satiated animal (Carroll, France, & Meisch, 1979; Carroll & Meisch, 1984). It is difficult to explain this within traditional "reward circuitry" conceptualizations. However, it is simple and straight forward to understand within the SEEKING system paradigm—namely, that hunger (or as behaviorists would put it, a "food deprivation state," to avoid all affective implications) leads to an increase in feeding drive input into the generalized SEEKING system, which in turn increases a generalized SEEKING arousal that results in increased opportunities for nonrelevant adjunctive behaviors—for example, a strange phenomenon of schedule-induced polydipsia (excessive thirst) is caused by overarousal of the SEEKING system (Mittleman & Valenstein, 1984). Thus, as homeostatic detectors generate various drive states, they also arouse the SEEKING system to promote general foraging arousal. This potentiated state allows SEEKING to more easily *couple* to other mildly aroused drives and thus to promote motivated behaviors not specifically related to the experimenter-manipulated drive, as with food deprivation. However, if food is available, then the natural feeding drive, promoting SEEKING motivation, would lead to feeding, which, through homeostatic negative feedback, would gradually dampen SEEKING arousal as animals become satiated. Thus, a generalized SEEKING system can be seen as a very effective neuropsychological tool for getting diverse bodily needs satisfied by promoting generalized primary-process foraging urges. And when this is coupled to learning mechanisms, in dopamine-innervated basal ganglia (e.g., nucleus accumbens), ever more directed actions become available to animals when SEEKING pressures again increase because of hunger. From an evolutionary vantage, it is rather obvious why increased exploratory behavior in hungry animals would support survival.

Behavioral evidence for secondary-process SEEKING and anticipatory learning

This raises the question of how the SEEKING system promotes anticipatory learning processes in the brain. There seems to be a critical connection between an animal's ability to intrinsically seek resources and its gradual ability to anticipate (to learn about) relationships in the environment in a meaningful, life-supportive way. Indeed, there has long been data indicating that these two functions are intimately linked within the SEEKING system. Much of this data has been collected under the traditional behavioristic learning concept of operant conditioning. However, the work becomes more intriguing when, from a SEEKING perspective, we begin to understand how learning emerges *spontaneously* from the underlying neural substrates (e.g., as in fixed-interval temporal conditioning), and how this kind of learned anticipation is a key process in all forms of appetitive conditioning.

In 1993 it was demonstrated that neurons within the SEEKING system are involved in the anticipation of the future. Utilizing Pavlovian conditioning in monkeys implanted with electrodes in dopamine neurons, it was found that bursting (i.e., repeated action potentials) of neurons within the origins of the SEEKING system (mesodiencephalic dopamine neurons—namely, VTA and substantia nigra) occurred initially in response to just unconditioned stimuli (UCSs) (e.g., such as food), but after animals had learned predictive conditioned stimulus (CSs) and UCS (reward) relationships, the bursting shifted largely to the CSs (Schultz, Apicella, & Ljunberg, 1993). In other words, the SEEKING system began to anticipate the future presentation of food when the CS was presented. It should be noted that much of the work of Jim Olds, the main discoverer of this system (Olds & Milner, 1954), was devoted to demonstrating the role of the MFB and many related brain areas (Figure 3) in anticipatory appetitive conditioning (for summary, see Panksepp, 1998, Fig. 8.3, p. 158), but for some reason those important findings are generally neglected in the current era.

Indeed, the ability of the SEEKING system to form future anticipations spontaneously—that is, outside and independent of behavioral activity and responses (unreinforced temporal conditioning)—was discovered in the early 1970s. Rats were administered fixed-interval electrical stimulation to areas of the SEEKING system. Initially, bursts of sniffing occurred in response to and continued after each electrical stimulation, but following repeated short electrical bursts given every 20 seconds (i.e., on a fixed-interval schedule), sniffing bursts began to *precede* electrical stimulation in a graded or "scalloped" way—the SEEKING system had learned to anticipate the future stimulation independent of the animals behavior! (Clarke, 1971; Clarke, Panksepp, & Trowill, 1970; Clarke & Trowill, 1971; for full summary and theoretical implications, see Panksepp, 1981, 1998). As noted, concurrently Jim Olds was discovering, with direct neuronal recordings, that vast networks of neurons in the brain developed anticipatory capacities.

It is reasonable that a system conceptualized as the SEEKING system, based largely on work with laboratory rats, would lead to increased sniffing behavior when electrically stimulated, as smell is the primary sensory modality in rodents. Increases in sniffing are also observed during spontaneous exploratory behaviors. Indeed, the thresholds of sniffing evoked by stimulating the MFB are highly related to "reward" thresholds monitored in the same animals (Rossi & Panksepp, 1992). Spontaneous temporal conditioning, however, is not limited to just sniffing behavior. Fixed-interval stimulation within the SEEKING system has also been found to elicit anticipatory 50-kHz vocalizations in rats (Burgdorf & Panksepp, 2000). Studies suggest that both sniffing behavior and 50-kHz vocalizations are mediated by dopamine activity in the SEEKING system (Burgdorf, Knutson, Panksepp, & Ikemoto, 2001; Zarrindast, Mohaddess, & Rezvani-Pour, 2000).

Further evidence for the role of SEEKING in anticipation has been garnered using *in vivo* voltammetry measures of dopamine release (i.e., where a small voltage is applied across electrodes causing key neurotransmitters to oxidize/reduce after which the current from the altered charged state is measured, allowing the quantification of neurotransmitter release with high temporal and spatial resolution in awake behaving animals). Recent studies have revealed additional evidence in support of SEEKING system involvement in anticipation. For example, it has been repeatedly demonstrated that animals with electrodes implanted into the nucleus accumbens, either the core or shell, show dramatic spikes in levels of dopamine not only when they are exploring their environments, but also in anticipation of receiving a food reward (Gan, Walton, & Phillips, 2010; Robinson, Zitzman, & Williams, 2011; Wanat, Kuhnen, & Phillips, 2010; Wanat, Willuhn, Clark, & Phillips, 2009).

The extensive power of SEEKING theory comes not only from its predictive power in basic animal research, but also from its vast implications for an array of psychiatric issues. SEEKING theory promotes an intuitive psychoneurological integration and understanding of basic motivated/emotional behavior patterns and experiences. However, old concepts that are often used ambiguously, such as "drives" and "motivation," must now be restructured in a way that allows concurrent neurobehavioral and psychological interpretations, which permit rich clinical implications of SEEKING theory to be realized.

Drives, motivations, and consciousness: neuropsychoanalytic perspectives

Many psychological and neurological concepts have been developed and are in wide use throughout the lay and scientific community, yet it is important to ensure that psychological concepts (especially primary- and secondary-process ones) have clear neurological significance and that neuroscience concepts are not empty of psychological relevance. Our premise is that the primary-process frameworks provide scaffolding on which higher functions of the BrainMind can be studied in a relevant way. These concepts range from such widely used notions as "motivation" and "drives" (which for a long time have substituted for the real primal functional processes of the brain) to a vast array of higher cognitive concepts that simply do not have dedicated brain systems. In this section, the older generation of primal concepts will be defined in ways that will allow their integration with modern neurological findings. Our goal is to further exemplify the integrative holistic image that is able to emerge with SEEKING theory in the hope that this will facilitate neuropsychological understandings of primal behavioral urges, further enabling research in the fields of psychology, neuroscience, and neuropsychoanalysis. Each of the above-mentioned primal concepts will be incorporated into the SEEKING paradigm, bringing about a foundation on which to form a more integrated framework for discussing the neuropsychological functions from which basic behaviors and experiences arise.

To take a neuropsychoanalytic approach to understanding the BrainMind, we must first be aware of and consider the link between primal neural processes and mental events (which are initially instantiated as many shades of phenomenal experience/consciousness), while recognizing that all mental experience emerges from the activities of many neural components that are, in themselves, unconscious. Experience is a global emergent process that is greater than a collection of its parts (again, the analogy to the properties of water is germane here—*vide supra*).

Diverse unconscious neural components, and their joint emergence into experiences through poorly understood functional linkages, remain mysterious because there are seemingly endless unresolved questions about the neural properties that lead to activity that makes consciousness possible. Obviously, all neural activities (e.g., changes in global electromagnetic distributions over time) do not lead to experience. For instance, it is unlikely that electrically stimulating a single neuron in a human brain would lead to any form of experience, although some neurons do seem to respond rather uniquely to discrete stimuli, such as the face of a specific person. In contrast, it is clear that sufficiently intense stimulation of small chunks of neural tissue, especially those along the primary-process emotional systems, can lead to powerful and diverse emotional experiences (Coenen et al., 2011; Heath, 1972; Panksepp, 1985, 1998, 2011a, 2011b). It therefore seems that one principle of the operating interaction between neural activity and psychological experience is the rule of *threshold* activation of a critical mass of certain types of neural networks. A critical spatiotemporal pattern/magnitude must be reached for psychological experience to occur, similar to the voltage across a neuron's membrane having to cross a critical threshold to generate an action potential.

Experienced states may represent a distinct level of processing and perhaps perform a unique function. One unique aspect of the experienced state, at least affective experience, may be its ability to analyze certain aspects of an *entire* organism's state in the environment and to promote adaptive, *whole*-organism behavioral responses that *anticipate* the future. Thus the negative affect of pain indicates that one may be heading toward destruction, and behaviors that alleviate pain, generating "relief," generally promote survival. Without pain, most organisms would die prematurely because of diminished regard for bodily injuries. There are diverse aspects to experienced states that may provide survival value, but few have been formally evaluated. For instance, though not formally tested, self-observation suggests that a cap exists both on the magnitude and the complexity of psychological experience. The height of the magnitude of pain is not infinite; it is limited by some absolute that cannot be crossed. Indeed, pain can activate opponent analgesic processes to diminish the pain. Likewise, as pain increases, other aspects of the entire psychological experience must diminish. For example, imagine putting a sweet candy in your mouth just before you accidentally hit your thumb with a hammer. Do you think you will still sustain the experience of pleasure? Or, imagine being sexually aroused and then hitting your hand with a hammer. Would anyone still experience lust in the moment of intense pain? Competition between multiple brain-factors represents an important aspect of neuropsychological activity, most of it currently unstudied, albeit a general principle seems to be that higher-brain cognitive activity and affective intensity are often reciprocally related (Liotti & Panksepp, 2004).

The question in neuropsychoanalysis of how multiple neuropsychological processes can come together to form a unique experience, with perhaps different properties than either the sum of the parts or any of the individual underlying processes alone, remains a mystery. There are many possibilities, most of which are hard to empirically evaluate at present. For instance, one possibility is that the emergent experience is analogous to harmonics and disharmonics arising from multiple distinct neural network synchronizations and desynchronizations—this opens up the potential for an analogous shift in the fundamental frequency allowing a simultaneous shift of the entire symphony. Another possibility is that multiple processes are interconnected in facilitatory, inhibitory, and more complicated dynamics, and the psychological experience reflects dynamically changing aspects of each underlying process, most of which we do not currently understand (Lewis, 2005; Panksepp, 2000). The SEEKING system can be seen as a final product of many such interacting neural components. To some extent, imaging of dynamic functional connectivity patterns in the brain during various experiences is providing some evidence about such possibilities (Anand et al., 2005; O'Connor, Gündel, McRae, & Lane, 2007; Tschacher, Schildt, & Sander, 2010). Still, our thesis here is that experience is scientifically relevant, and thus it is critical to understand the diverse types the SEEKING system mediates/supports.

Drive and motivation

Since the nonspecific SEEKING system can be deployed toward many appetitive "ends," there must be sources in the brain that are programmed, through evolution or experience or a combination of the two, that, once triggered, arouse a global neuropsychological state that results in a distinct organismic presence in the world that is able to bring about specific motivated behavior patterns, especially when coupled to the cueing properties of predictive world events. For example, when a rat receives electrical stimulation of the SEEKING system in an arena filled with miscellaneous objects (many possible ends or "affordances" for funneling SEEKING activities), certain behavioral phenotypes develop spontaneously. Some rats spend their time chewing on sticks; others drink water, eat food, or simply nibble at their tails or sniff around.

In any case, various specific objects in the environment seem to become preferred targets for interaction. Interestingly, if an experimenter removes the sticks from "chewers," with continued periodic brain stimulation, those rats gradually begin to display another behavior, be it drinking, gnawing, or merely types of active exploration, etc. This suggests that the SEEKING system can be deployed generally for a variety of specific appetitive behaviors. If affordances in the environment are predicted by stable changing features of the world, then these psychological energies become temporospatially focused to optimize behavior. Behavior conditioning paradigms take advantage of this process by pairing CSs with UCSs. Regrettably, most such analyses tend to disregard the affective organizing properties of many emotional unconditioned responses (UCRs) evoked by UCSs.

How is it that multiple, seemingly unconditioned behavioral options could arise from MFB stimulation, yet a particular behavior gradually comes to the forefront? How does the brain process these options, and how does a coherent behavioral response emerge once an implicit neural "choice" is made? No one really knows, and there are many possibilities that remain to be evaluated. It may well be simply a matter of chance, or perhaps some unknown individual preference that may be an important issue for clinicians confronted by individual appetitive quirks, but for us the key issue is that without any specific goal objects, the brain stimulation produces a very characteristic behavioral coherence (an emotional UCR)—rats, the main subjects of such studies, exhibit sniffing (even when anesthetized; Rossi & Panksepp, 1992) and forward locomotion. Therefore, for the purposes of illustrating the integrative potential of SEEKING theory, we will focus on the manner in which traditional concepts of drive and motivation may relate to the arousal of the SEEKING urge.

At the beginning of Berridge's 2004 review on the concept of motivation in behavioral neuroscience, he states that "[motivation concepts are needed]. Yet, if our motivational concepts are seriously wrong, our quest for closer approximation to brain–behavior truth will be obstructed as much as if we had no concepts at all" (p. 180). Unfortunately the concepts of drive and motivation remain widely misunderstood and, indeed, are used interchangeably by many. It is our perspective that the concept of motivation is too broad to be applied consistently in primary-process affective neuroscience, since it does not represent a distinct type or category of neural system(s), but is the result of the merging of activity of multiple systems. Therefore, it should be considered a psychological concept that does not have any unitary neurological significance, since it not only reflects the operation of the SEEKING system (perhaps the biggest contributor to the higher order concept), but also all the other primal emotional networks as well as many other systems—from low-level specific "drives" as well as a variety of higher order neuromental processes.

Fortunately, the concept of "drive," at least in neuroscience/physiology, has a more specific meaning—namely, states of imbalance in various bodily regulations, instantiated in such processes as hunger and thirst, which reflect actual activity of particular subcortical, especially hypothalamic, neural processes (Panksepp, 1981). Thus, each bodily drive state has a distinct neural distribution with specific homeostatic regulatory functions, which exert some type of control over SEEKING urges (Figure 4). However, in common uses of "motivation" and "drive," in both classical psychological and psychoanalytic literatures, we are confronted by the differential use of the same concept for rather different, and more global, purposes. Here our concern is largely with the primary-process nature of SEEKING, but obviously we must also deal with learning/memory (secondary) as well as thought-governed (tertiary) processes, especially when we come to therapeutic considerations.

Explaining some of what is known about the feeding drive might help illustrate the framework being proposed. This, like all primal drives, is made up of distinct brain *control* and *regulatory* networks. Certain hunger-control networks are involved mostly in short-term control of meal size and termination, whereas regulatory mechanisms are more involved in long-term energy balance (Panksepp, 1974). At least one control component of the feeding drive, cholecystokinin (CCK), controls the actual cessation of feeding; it is extremely well studied, although there are many other brain neuropeptides that can inhibit feeding (e.g., for a few of many summaries, see Havel, 2001; Morganstern, Barson, & Leibowitz, 2011; Panksepp, 2010). Food entering the stomach and intestines causes the release of neuropeptides, specifically CCK. These signals arouse vagal afferent nerves, through which the signal propagates up into the hindbrain into the nucleus of the solitary tract (*nucleus tractus solitarii*: NTS)—a region that also receives taste information from the tongue (see Ritter, 2011, for review of some of the basic feeding-relevant physiology of the NTS; see also the many reviews in the recent Dube et al., 2010, compendium *Obesity Prevention*, in which the previously cited Panksepp, 2010, appears). When

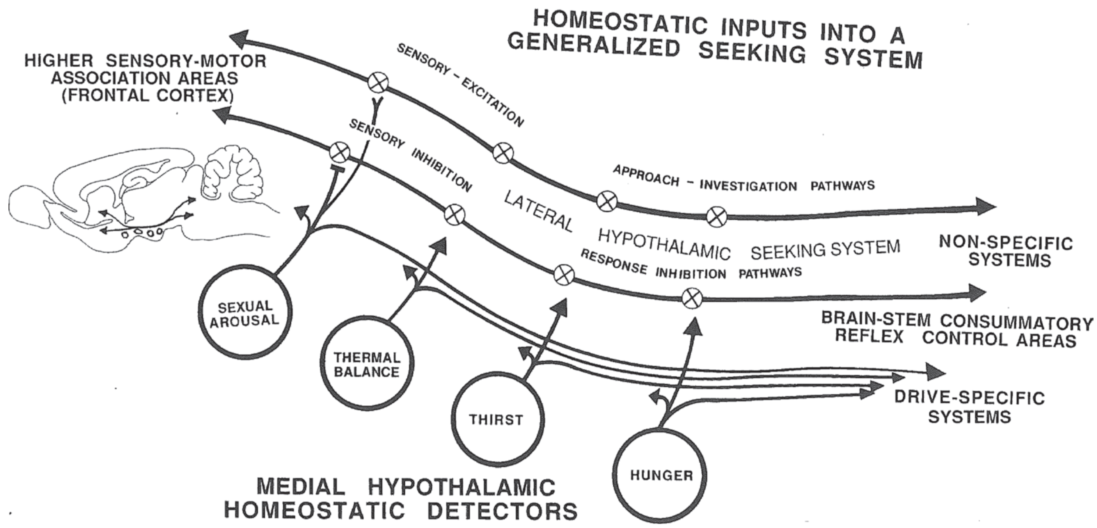

Figure 4. A conceptual schematic of how specific regulatory detector systems in medial strata of the hypothalamus access a shared SEEKING system coursing through the medial forebrain bundle. (Adapted from Panksepp, 1998, Fig. 9.1, p. 167, with permission of Oxford University Press.)

this signal reaches the NTS, feeding is abated, thus suggesting that the NTS is a region of importance for feeding *control* (though there is significant debate over this). Such a lower control center is likely a very primitive mechanism that signals gastrointestinal fill, protecting animals from overeating to the point of explosion and has since been integrated into more complicated regulatory systems in the hypothalamus. For instance, the housefly will eat itself to death if the feeding cessation control center is lesioned, which, similar to the NTS signals when the stomach fills (Dethier, 1967). Furthermore, that the NTS is connected with the VTA and many hypothalamic energy regulatory circuits suggests a potentially significant interaction with SEEKING.

Regulatory regions of the feeding/hunger drive are found predominantly in the ventromedial hypothalamus, especially the arcuate nucleus (Panksepp, 1974), which like the NTS sits close to an area outside the blood brain barrier, allowing easy sampling of nutrients in the blood. This brain region is one of the most important locations in the brain for long-term feeding and energy-balance regulation, and that circuitry directly controls SEEKING arousal. Lesions here lead to obesity (Hetherington & Ranson, 1940; Dube, Xu, Kalra, Sninsky, & Kalra, 1999; Olney, 1969). Furthermore, selectively destroying only neuropeptide-Y receptor-containing neurons in this region leads to obesity and decreases sensitivity to the feeding-regulatory signaling molecule leptin, while leaving the effects of the feeding-control signaling molecule CCK unaltered (Bugarith, Dinh, Speth, & Ritter, 2005). Conversely, lesions to the lateral hypothalamus, an integral part of the MFB trajectory of the SEEKING system, lead to severe weight loss (Anand & Brobeck, 1951). Therefore, a neurological network emerges in which the feeding drive can alter the SEEKING system and promote discrete motivations in order to fulfill bodily needs and, further up in the preoptic area, various social needs such as sexuality and maternal devotion (Panksepp, 1998).

Metaphoric visualization of "motivations"

For present purposes, the major type of "motivation" being considered is the neural instantiation of the experiential and behavioral energization arising from the functional coupling of basic homeostatic drives with the SEEKING system. The SEEKING urge must be *generated* for appetitive motivation to form, but it is important to note that confusion often arises when the term "motivation" is used to explain this general arousal of the SEEKING urge to interact with the environment. The concept of motivation might be best reserved to reflect specific goal-oriented behavior—that is, when the SEEKING urge is coupled with specific drives, objects, and/or higher cognitive plans. It is possible that this arousal and *coupling* can be initiated from within the SEEKING system via an "outward" push, or, alternatively, externally via an "inward" push from the many conditioned and unconditioned environmental stimuli and the body-state-linked drives of the brain that feed into it. The interaction between drives and SEEKING can be imagined as multiple amoeba-like bodies, each with many tendrils expanding and contracting. The SEEKING system itself can also be imagined as one large amoeba with many filopodia expanding and contracting outward toward different drives generating various functional arousal states. Drives can each be imagined as smaller amoebas also, with tendrils expanding and contracting as a function of activity based on system dynamics within each drive module. When a tendril of SEEKING meets with a drive, such as feeding, a specific motivation is formed. When SEEKING is heightened, its tendrils expand outwards and the "nearest" (highest active and/or most strongly linked to the outside world through experience or instinct) drive is coupled to form specific motivations (outward push). Conversely, a singular drive may also expand into the SEEKING system, to form introjected motivations (inward push), which may have special psychiatric significance. In any event, the coupling between a drive and the SEEKING system allows the arousal of the systems to converge in both cases. To step back from the analogy, convert "amoeba" to "neurons" in the above—or better yet, "neural networks"—and consider that the details of such processes can just now begin to be studied. It may be of some interest that in *An Outline of Psycho-Analysis* Freud uses an analogy of a protoplasm when explaining the mental apparatus.

> Throughout the whole of life the ego remains the great reservoir from which libidinal cathexes are sent out to objects and into which they are also once more withdrawn, just as an amoeba behaves with its pseudopodia. [1940, pp. 150–151]

In the Freudian sense, primary drives belong to the *Es* (id), whereas motivations (as we have defined) belong to the *Ich* (ego). For Freud, drives encompassed a wide range of constructs, far more than those simply reflecting thirst or feeding. It was because of the vast expanse of potentially existing drives, and the difficulty in determining and differentiating between them, that Freud proposed conceptualizing all drives under two major conceptual headings—the death drive and Eros (chaos/entropy and self-organization, respectively)—leading to perhaps the faulty belief that he only believed in two primal categories, namely aggression and sexuality. There are indications that he recognized more subtypes, but we would suggest here that SEEKING represents a major category that could be partially symbolized by Eros, since this system participates in all of the specific prosocial emotional systems—LUST, CARE, and PLAY—each of which has shared as well as unique neurochemical underpinnings—psychobehavioral forces—that could be envisioned to "drive" certain instinctual actions that are foundational for social joy.

There are several additional issues to consider to envision how SEEKING is an emissary for diverse drive-arousals: First, if all such drives could directly lead to distinct experiences (phenomenal consciousness), then we are, at least conceptually, still faced with the dilemma of how specific goal-directed behavior can emerge, as competing drives might equally affect a shared SEEKING process. The ability to process and "decide" between the drives might be lost if each drive is not also an independent generator. In other words, we have to sustain drive-specificity even as they converge into a central processing unit such as the primary SEEKING emotion. We cannot be sure how that occurs, but we here simply entertain that it does so by slightly different neurodynamic resonances of the SEEKING system. This may help explain a psychological fact. We rarely, if ever, experience concordantly thirst, hunger, and sexual drives. We may experience thirst, followed by hunger, followed by sexual arousal, etc., tied together by the memory, giving us the impression that we are able to experience multiple motivations simultaneously. This suggests an integrative system (SEEKING), where drives come together and are thereby intersystemically regulated in order to experience specific drive states. There is another puzzling feature we wish to conceptually consider. People who are suffering from severe depression may often stop eating, yet experience little or no hunger. It is unlikely that the feeding/hunger drive networks are no longer responsive to internal energy-balance signals. Since it has recently been repeatedly emphasized that a decrease in SEEKING is critical in the genesis of depression (Alcaro & Panksepp, 2011; Coenen et al., 2011; Panksepp & Watt, 2011; Watt & Panksepp, 2009; Zellner et al., 2011), we can envision how this system participates not only in bodily homeostasis but psychological homeostasis as well. In this speculative view, the SEEKING system may be the necessary psychological emissary for the feelings of homeostatic affects, which may help explain the interchangeability of goal objects in the classical experiments already described (Valenstein, Cox, & Kakolewski, 1970).

In sum, perhaps the SEEKING system functioning concordantly with a drive is required for the particular affective experiences relevant to that specific drive. This leads to a clear prediction: that severing the neural connections of the bodily drives to the SEEKING system and/or lesioning the SEEKING system itself will diminish the distinct *experiences* of the various major homeostatic imbalances of the body. In such a vision of brain organization, it is easy to understand that *experience itself* serves an important behavioral regulatory role for organisms. If such affects are generated low in the brain, their neural representatives can surely influence higher decision-making. In other words, visualizing neuropsychological functions in evolutionary hierarchical terms easily allows lower psychological processes (e.g., various affective qualia) to contribute to diverse secondary "drives" and thereby higher decision-making.

If we accept the basic view of deep subcortical drives proposed thus far, irrespective of whether or not they are intrinsically subconscious, then we realize that the adaptive behavior of more complicated organisms, especially mammals, cannot be explained by primary drive and incentive (UCS) systems alone. Primary drives and incentives are those that are instinctual and therefore unconditioned. Relative to learned secondary drives, primary drives receive restricted and preprogrammed input from bodily sources such as levels of bodily energy, heat, and water. But there is also a restricted neural output that, once triggered, brings about a coherent goal-directed SEEKING response that promptly leads to learning. Thus, secondary drives and incentives are learned, providing psychological resolution in the context of specific life events. Without secondary drives, we would be stuck with only a preset number of possible basic behaviors, with little ability to adapt to the environment. Likewise, with cortical evolution, we have the possibility of tertiary "drives." These can include purely conceptualized drives arising from higher cognitive processes, yielding innumerable possible forms, which may recursively come to interact with SEEKING urges in ways analogous to primary drives.

Cognitive goals of all sorts, both short and long term, reflect these tertiary "drives." Therefore, the use of the term "drive" in the classical homeostatic sense is very restricted and may not reflect the true nature of how SEEKING operates in the brain. Because of such evolutionary layering of the mind, we need to resort to cascades of "nested hierarchies" (Northoff, Wiebking, Feinberg, & Panksepp, 2011; see also Figure 1 in our Response to the commentaries), which can yield more malleable visions of overall brain–mind–behavioral control than postulated in classical learning theory, with a clearer partitioning of secondary and tertiary levels of appetitive organization. Thus in early bottom-up development, the lower powers of the mind (basic bodily drives and brain emotions) govern how higher systems get organized. At maturity, the higher order (top-down) systems govern complex decision-making based upon what is happening in lower brain systems. One important aspect of neuropsychological research will be to determine the many primary drives that exist in the brain, their psychological instantiation and interactions with higher brain processes, behavioral functions, and, of course, the neuroanatomies, chemistries, and physiologies of each, and how each relates to dynamic higher order BrainMind functions. It is an understatement to say that we are not there yet, but hopefully this contextualization will allow us to craft a realistic vision of how the primal SEEKING system impacts—indeed, helps create—the complexities of ordered and disordered human minds.

Although it seems clear that, in mature organisms, cortical/cognitive systems are relatively more active during what is normally thought of as goal attention and goal-driven behavior, it is important to note that the SEEKING system also becomes more aroused with each aspiration, thus allowing distant goals to be integrated with a basic urge to act. Furthermore, it is widely accepted that goals—that is, more cognitively derived drives, including those of explicit and/or declarative nature that are often subsumed under studies focused on planning—are critically linked to prefrontal cortical regions (for superb coverage see Owen, 1997), which send direct glutamatergic projections to the SEEKING system, especially the ventral striatum. Many studies have pointed out that planning and goals lead to a heightened arousal within frontal cortical regions (Andreasen et al., 1992; Owen, Doyon, Petrides, & Evans, 1996), an idea first raised by J. M. Harlow (1868). This makes sense, as some of the secondary drive formation is likely dispersed throughout the highly malleable cortex. However, studies have also found that classical substrates of the SEEKING system are also active during such states (Knutson & Greer, 2008).

The component-functions of the SEEKING system: theory and experimental evidence

One challenge facing systems, behavioral, and affective neuroscience is determining not only how neuropsychological processes are interconnected, but also deciphering intricacies of the operation within each individual system. In this section, the potential components of the SEEKING system are explored. The SEEKING system is composed, speculatively, of three parts or component-functions—*generating, coupling,* and *enacting*—in two ways: (1) at the whole-brain level which recognizes the primary, secondary, and tertiary levels of BrainMind processing, and also (2) within each of these levels. We first cover the more global view before proceeding to a short discussion of how each of these functions is elaborated within each level.

Because of the diversity of SEEKING functions, regulated by diverse bodily drives and molded into various learned-behavior patterns, parsing the basic component-functions may be necessary to develop a fully integrated understanding of a psychologically relevant neural system. Such a task has yet to be achieved, but researchers will need to consider the most important (i.e., replicable) experimental findings, perhaps issues of logical necessity, and surely some systematic existential self-observations, guided by something perhaps akin to a neurophenomenological framework (Varela, 1996). For example, it is common for a person to experience an urge to do something, but for some reason not initiate and/or carry out that urge, which in some cases becomes pathological ambivalence or timidity. Apparently, in the human mind, SEEKING operates in sequence with at least two steps—*generating* an urge to act and *enacting* that urge. From a survival standpoint such a sequential operating system provides the advantage of having numerous levels, or steps, of possible processing (and reprocessing), thus increasing the likelihood that actions carried out are the most advantageous for an organism. Furthermore, if each urge to act was automatically carried out (as it perhaps might be in “lower” organisms, but most likely is not for mammals, especially humans), then the “decision-making” process would occur subconsciously, and the common experience of trying to “will” one’s self into action would not exist. Thus, in many animals there would be little need for a conscious level of decision-making, since the intrinsic intentionality (i.e., intentions in emotional actions, which can generate affective qualia necessary for learning) would suffice; however, subconscious processing between different possible end behaviors, carried out by competing energy states in the neural dynamics of nonhuman organisms, remains likely—the study of which might bring insight into the evolutionary roots of conscious decision-making. Such an analysis of processing, including higher level “decision-making,” still requires the underlying *generating* to have already occurred. One neurological disorder that provides a particularly poignant dissociation between a primal motivation and the ability to bring about that motivation is illustrated in patients with Parkinson’s, where individuals are left unable to carry out actions but still have the desire to do so.

When SEEKING generates its general exploratory urge, it must then be compartmentalized or *coupled* into and with specific drives, environmental objects, cognitions, and other competing affective processes. This is the component-function of SEEKING that leads to specific goal-directed behavior and elaborates the spectrum of supporting processes for the animal to either enact or not. Good neuroscientific evidence is largely lacking at this point (except for the basic mechanisms of learning; e.g., see Ann Kelley’s work, 1999a, 1999b), though without additional, presently poorly understood, intrinsic *coupling* component-functions SEEKING would have a difficult time being deployed toward specific ends. SEEKING would remain a naked general urge, disconnected from specific objects in the environment and particular goals. One piece of basic experimental evidence supporting this, which has already been brought up in a previous section, is the phenomenon where rats receiving stimulation to the SEEKING system develop specific and differing behavioral phenotypes. For example, some rats preferentially exhibit the behavior of gnawing on anything that is available, including their electrode cable, while others preferentially display eating or drinking behaviors when SEEKING is artificially aroused (Valenstein, Cox, & Kakolewski, 1970). Thus, clear goal-directed behavior emerges via SEEKING arousal. However, the goals seem to be malleable, suggesting dissociation between a general urge to interact and a mechanism that connects that urge toward a specific end. Remember that “gnawers,” when their wood is taken away, will gradually shift to new stimulation-induced behavior such as drinking or eating; however, when wood is returned, they do not shift back to their old behavior, but sustain their new one. A new preference has been constructed by experiences in the world.

This critical finding leads us to consider three important issues. First, the exploratory-foraging urge generated when SEEKING is aroused is generalized, because even though all animals increase appetitive behavior, different specific consummatory behaviors emerge. Second, there is some sort of determining factor in the neural dynamics of the brain that leads certain animals to focus on a certain behavior while others focus on different behaviors. This suggests that a component-function of SEEKING gradually “locks” animals into particular behaviors. Third, and finally, the fact that animals will shift behavioral phenotypes when their initially preferred behavior is prevented but other options are allowed demonstrates that *coupling* is a malleable process and suggests that it is regulated by other dynamic processes in the brain. The three proposed component-functions—*generating, coupling, and enacting*—are now explored further.

Generating

To the best of our knowledge, the *generating* component-function of SEEKING is responsible for the creation of the core experiences of SEEKING—euphoria and/or anticipatory excitement, as well as a generalized urge to interact with or within the environment. The local control of affect within the emotional action systems of the brain is supported by the simple fact that wherever one arouses the coherent SEEKING urge, animals self-stimulate those brain sites (for review, see Panksepp, 1981), and the thresholds for foraging and reward are highly correlated (Rossi & Panksepp, 1992). Furthermore, the affect does not need to be "read out" by the cortex, since the rewarding property is not eliminated by radical neodecortication (Huston & Borbély, 1973, 1974; Valenstein, 1966). Most likely, those more rostral brain regions are involved in the experiences, and carrying out, of specific end points that utilize this urge, while deeper regions generate the "core affects," which for SEEKING is best thought of as an exploratory urge and/or euphoria. Evidence suggests that the basic neural architecture underlying both the exploratory urge and the euphoria that eventually becomes anticipatory excitement are very similar, perhaps identical.

We must here again make a distinction between an intrinsic SEEKING euphoria and sensory hedonic states (Panksepp, 1982a, 1982b). In general, the euphoria is associated with appetitive behaviors, whereas hedonic experiences arise from sensory stimuli and are often associated with consummatory acts—for example, taste receptors that promote eating—and/or perhaps partly even from the satiation (satisfaction) of a drive. For example, a small portion of the medial shell of the nucleus accumbens, and the ventral pallidum have been found to be "hedonic hotspots" because mu-opioid agonists in these areas dramatically increase "liking" behaviors associated with infusion of sugar directly into mouths of rats (Peciña & Berridge, 2005; Smith & Berridge, 2005). However, the desire (so-called wanting) response remains intact if the pleasure-promoting mu-opioid receptors are blocked (Smith & Berridge, 2007). In contrast, the liking response remains intact while the SEEKING/wanting urge is diminished markedly if dopamine receptors are blocked (Ikemoto & Panksepp, 1996).

Besides providing the impetus to explore the environment, the neural experiences generated by SEEKING seem to have an important place in the basic learning mechanisms of the brain. In anticipation of one of our conclusions, we propose that in emotional conditioning and therapeutic deconditioning, the shifting neuroaffective properties of emotional UCRs, as animals encounter objective rewards, are of critical importance in the consolidation of learning. Anticipating the future is a critical component in all simple forms of learning, including: Pavlovian, operant, and spatial learning. There is abundant evidence for such mechanisms in the basal ganglia, especially in the nucleus accumbens (Kelley, 1999a, 1999b). The only important point we need to make here is that one unrecognized key to learning is the channeling and focusing of the whole unconditioned appetitive SEEKING urge to cues that predict rewards. Our view is that affect is a critical aspect of this "reinforcement" process, and that issue has largely been neglected in the vast literature on classical (Pavlovian), operant, and spatial learning.

Let us first look at Pavlovian conditioning. In Pavlovian or classical conditioning, an organism is exposed to a conditioned stimulus such as a bell or light, followed rapidly by a UCS, such as food, a treat, or water for appetitive conditioning, and foot-shock or at times an air-puff for aversive conditioning. The UCS elicits a specific short-latency response in the organism (UCR) such as squealing and flexion and various autonomic responses, but that is not all. The foot-shock, besides eliciting this initial unconditioned pain-relevant response, also automatically sets up the arousal of the evolutionarily provided FEAR network (indeed, the autonomic arousal is part and parcel of this system). After repeated pairings of the CS with the UCS, the CS can elicit various UCRs, which are named the conditioned responses. In our estimation, the oft-ignored "gorilla" in the room is the overall arousal of the FEAR system in the case of aversive conditioning. In any event, when a CS is presented after conditioning/learning has taken place, there is an anticipatory response in the organism that reflects brain processes that have been set in motion by the UCS. For instance, when an organism hears a tone previously paired with a foot-shock UCS, which causes pain and squealing, and in our view activates the FEAR system (the so-called deep emotional UCR), the tone rapidly begins to evoke large-scale coordinated organismic FEAR responses to the CS. Thus, FEAR anticipates the future negative event of foot-shock, or, in the case of appetitive conditioning, the CS triggers SEEKING and anticipatory excitement, yet the generation of positive or negative affects has traditionally been neglected in classical analyses of learning.

Therefore, we suggest that as an animal comes to anticipate the emotion-instigating UCS, it is the UCR property of the nervous system, which is both behavioral and affective, that pulls the conditioning together (as discussed more fully in Panksepp & Biven, 2012). The same can be said for the SEEKING system. This is a radically new interpretation of classical conditioning, which brings emotions such as FEAR and RAGE for negative affect, and SEEKING and CARE for positive affective arousal, back into the overall equation. Put another way, using the more traditional fear-conditioning paradigm, the UCS of shock only has the capacity to promote affective conditioning to the extent that it arouses the central state of FEAR. Although, it is possible that some nonaffective behavioral components of the fear complex can also be conditioned, we posit that the most psychiatrically significant aspects are the shifting tides of the primary-process emotional-affective components. This can lead to novel preclinical modeling of psychiatric disorders (Wright & Panksepp, 2011). Thus, it is the *generating* component-function of FEAR that causes the dread in clinical situations, and that of SEEKING that creates the anticipatory eagerness that is the hallmark of appetitive conditioning. When this basic form of learning (classical conditioning) *couples* to higher mental mechanisms and objects in the world, we have the full package of trepidations and desires, including various hard-to-study cognitive components that are evident in humans and presumably in other thinking animals. In other words, *coupling* matches the prevailing primary-process emotional states and basic learning mechanisms to higher mental processes and different objects in the environment.

Though the radical logical-positivism approach of twentieth-century behaviorism did lead to many important gains in understanding behavior, the critical affective aspects of the anticipatory states of the brain that guide appetitive and avoidance learning were largely, if not entirely, ignored or marginalized—even disdained by some. This seems to have been a big mistake, perhaps unavoidable in that era because the basic nature of affect can only be understood through neuroscience, by recognizing that arousal of emotional/affective circuits of the brain can uniformly mediate reward and punishment functions of the mind. A similar exercise could be done for both operant conditioning and spatial learning, but we will instead move on to more meaty matters—namely, how simple forms of learning relate to what is happening in the brains of many creatures when faced with emotional challenges, which forces us to consider the higher aspects of the human mind (tertiary processes of the brain), which are difficult to study in preclinical models.

Coupling

The coupling aspect of SEEKING explains the ability of SEEKING to functionally link up with specific aspects of the world and mind. Whether providing the impetus for drives to come into action, linking the general SEEKING urge to specific objects in the world at the primary- and secondary-process levels, or linking SEEKING to higher cognitive agendas and sophisticated plans at the tertiary level, evidence suggests that SEEKING is able to filter into and through numerous aspects of the mind as it interfaces with diverse environments. At the primary-process level, SEEKING couples to instinctual drives (e.g., body energy and water balance). At the secondary-process level, SEEKING is coupled to objects in the environment having gained relevance through experience, as well as to secondary drives. At the tertiary-process level, SEEKING couples to a wide range of cognitively sophisticated plans, goals, objects, and drives.

The proposed *coupling* component-function of SEEKING is a much more esoteric proposition than *generating* and *enacting*, though it may provide some of the most fundamental insights into how particular human behaviors and experiences come about. The difficulty is that current brain science lacks the technology to observe brain activity with the temporal and spatial resolution needed to clearly test and study the proposed *coupling* component-function of SEEKING, though the relatively coarse resolutions of fMRI and PET imaging can provide some guidance for a gross understanding of the brain regions of interest. However, the evidence suggests that a coupling function is necessary not only for the overall patterned activity of the SEEKING system, but also for a realization of how diverse the behavioral consequences of this system can be—from drug addiction, to gambling and hoarding, and even to the highest scientific and spiritual aspirations.

Coupling of SEEKING urges, along with simple forms of learning, to higher mental functions, allows the generalized exploratory urge of SEEKING to weave mental tapestries of great individuality and variety. It allows our homeostatic drives and other primary affective processes to coordinate with socially and environmentally meaningful behaviors. Such higher c*oupling* of lower brain functions to the creation of higher brain functions is an emergent property that becomes, somehow, intrinsic to the whole hardware of the system. In a way, coupling is like both the director of an orchestra as well as diverse players of instruments creating different notes from the same instrument based on fingering, bowing, blowing, etc. (depending on the instrument) to create different coherent melodies. Coupling alters the output of the SEEKING system based on the unique inputs, thus transforming universal affective experiences that have *generated* a great deal of simple learning into the complexities of individual vicissitudes and culture. The *coupling* or *associative* functions of the SEEKING urges on the human neocortex are especially vast, not only because of our massive encephalization, but also because our dopamine circuitry penetrates far past the executive frontal functions of the brain, unlike most other mammals, deep into the sensory-perceptual functions of posterior cortical regions that help instantiate thinking processes, as orchestrated via frontal executive functions. In fact, perhaps this higher integration of SEEKING plays a prominent role in the delusions and hallucinations of schizophrenia, as overarousal of this future-oriented system might lead to false "projections," incorrect anticipations, and faulty connection of cause and effect—an issue that is explored in the clinical-application portion of this paper.

Enacting

A powerful piece of evidence supporting the actual existence of an *enaction* component-function of SEEKING comes from Parkinson's disease, a disease most commonly neurologically associated with a severe loss of dopaminergic cell bodies in the substantia nigra (which has dopaminergic projections into dorsal striatal areas that mediate instinctual action sequences as well as behavioral habit). A common symptom is a difficulty initiating movements despite a person's motivation (Parkinson, 1817). Thus a clear phenomenon illustrates the possibility of disconnections between the formation of higher motivations and the enaction of those motives.

Further support for the existence of an *enaction* component-function came in the 1980s, when it was found that administration of a systemic dopamine antagonist reduced anticipatory feeding responses to a CS signaling the onset of food, while not disrupting actual food consumption when food was presented directly to the rat (Blackburn, Phillips & Fibiger, 1987), thereby experimentally demonstrating a disconnection between motivational and enacted behavior components, perhaps partly because the dopamine antagonist affected memory. In the same year, a different group found that dopamine antagonists administered systemically dramatically reduced operant lever pressing for a water reward more than it reduced the actual consumption of water when presented (Ljunberg, 1987). In both examples, the motivation to consume (as demonstrated by no change in the magnitude of consummatory behavior once initiated) seemed to remain intact, while the ability to initiate or enact the specific motivation was attenuated.

In 1996, a similar effect was produced via the infusion of a dopamine antagonist into the nucleus accumbens. In this experiment, animals were trained to run down a path to receive a 20% sucrose reward. However, when a dopamine antagonist was infused into the nucleus accumbens, animals no longer ran down the runway for the reward (Ikemoto & Panksepp, 1996), but they still showed interest and consumed the reward when placed directly in front of it. This suggests that the nucleus accumbens might perform a critical function in *enaction.* It is not a new idea that areas in the striatum represent some sort of interface between a motivation and motor activity. In fact, the first major paper implicating the nucleus accumbens in motivation presented it as a bridge between motivation and action (Mogenson, Jones, & Yim, 1980), and it had already been implicated in motor action behavior. However, the above-mentioned experiments do not rule out the possibility that learning, rather than an interface between the formation of a motivation and its enaction, is being disrupted. To approach this level of specificity in the system, it is important to look at behavioral responses associated with unconditioned stimuli using test procedures that do not require explicit training/learning, such as the free temporal administration of rewards that leads to spontaneous anticipatory learning (*vide supra*).

Generating, coupling, and enacting at higher order levels

It may be important to emphasize that although the above analysis of the concepts of generating, coupling, and enacting were discussed in terms of our traditional distinction between primary, secondary, and tertiary processes of the BrainMind (Panksepp, 2011a, 2011b, 2011e) as one ascends through higher layers of brain processes, they can be increasingly distinguished. Thus, at the secondary-process level (learning and memory) the brain parses primal emotions into highly resolved time–space events so that those primal tools for living are used most efficiently to guide learned behavioral actions, through the associative capacities of the basal ganglia (e.g., amygdala, bed nucleus of the stria terminalis, nucleus accumbens, etc.). In this way the full package of primary-process generation, coupling, and enacting is now allowing a higher order level of enactment to be generated as primary processes are adjusted in ways that allow more efficient coupling (integration) with higher mental processes. What transformations occur at a psychological level when this happens is anyone's guess (for some reflections, see Vandekerckhove & Panksepp, 2011), but we assume that efficient coupling of lower automatized processes to higher mental processes requires some toning down of the raw-affective impact of the primary-process emotions. That, of course, is a well-established function of the neocortex (Liotti & Panksepp, 2004), and it probably permits more efficient thinking, less disturbed by affective arousals.

This spread of horizontal processing surely becomes most subtle at the tertiary-process level, where the temporally and spatially refined affective information become part of our storehouse of biases and ideas—the amalgam of our personal and cultural perspectives and convictions. This is where the brain begins to allow organisms "intentions to act" and the concept of "free will" becomes relevant, as one becomes able to experience the possibility of alternative actions via processes of the working memory and judgment. This tertiary processing is also where the greatest amount of confusion about one's own emotional life begins to be evident, leading to states of being that cannot be untangled with medications but, at the very least, require psychotherapeutic interventions, ranging from psychoanalytic to cognitive-behavioral to no doubt new affective-balance therapies (Fosha, Siegel, & Solomon, 2009). It is noteworthy that recent data suggest that dynamic analytic approaches often have the longest-lasting therapeutic influences (Shedler, 2010).

In sum, the above view suggests that at the primary-process level, all these distinct processes—generating, coupling, and enacting—are activated and coordinated sequentially, presumably under strict genetic control, although epigenetic influences are likely too. At the secondary-process level, learning probably regulates the impact of primal emotional arousals, thereby allowing core emotional issues to be more effectively used by higher mental processes. At the tertiary-process level, which allows cultural and personal meanings to be resolved, the lower levels *generate* the motivational influences, which now need to be *coupled* to modalities in the mind with the capacity to think, and *enacting* becomes a more complex process of decision-making.

Once one gets to such higher order levels of enactment, the role of the SEEKING system becomes more complex. The underlying forces of the mind, which were intrinsically motivational, now provide the future orientation needed for planning and the coherence for more explicit ideas in the mind, and a much more focused experience of motivation emerges, which still has intrinsic and often compelling urges to be enacted but also allows for the experience and analysis of other competing or alternative motivations. Since a cognitive delay occurs at this phase of SEEKING, a distinct symbolic processing component of SEEKING may exist to analyze different possible behaviors that could be coupled optimally, often bringing forward conflict. However, in a well-regulated mind, a single coherent behavioral response toward a particular end commonly emerges, diminishing the likelihood of running about in circles in an attempt to carry out competing motivations. At this level, it is clear that the formation of a motivation does not lead simultaneously to its enaction. Indeed, the *enaction* component-function of SEEKING now provides a thorough final level of analysis/processing, the last chance for optimizing an outcome, before the organism acts. This initiation is almost always accompanied by a burst of psychological and/or energetic motor sensation. Just so, when a motivation is enacted, the psychological pressure on the SEEKING urge is relieved, leading to a redistribution of affective energies analogous to an orgasm, though not necessarily containing that distinct hedonic experience.

The component-functions proposed represent a "horizontal" analysis of SEEKING in action—that is, they take the entire integrated organism and behavior into account, and represent a sequential operating system. Primary–secondary–tertiary processes represent a nested analysis, derived from evolutionary antecedents, and are important to take into consideration when interpreting the results of each specific study and provide a guiding overall framework for research. If we accept the possibility of the proposed "horizontal" component-functions of SEEKING as existing, then we can postulate that such a layout of SEEKING would allow for two distinct levels of behavioral regulation. First is the regulation of competing drives for the formation of a motivation; second, the competition of motivations to be enacted. Here, of course, the distinction between primary–secondary–tertiary-process levels becomes inextricably blended with ever more complex understandings of the details of the underlying circuits. The horizontal analysis takes into consideration the entire brain, with the guidance of a SEEKING system formulation, within a full integration of neural and psychological features.

SEEKING in addiction

Having outlined the SEEKING framework, we will now transition and talk about its relationship to specific psychiatric illness and general clinical applications. Addiction and depression are discussed first, since together these two afflict so many. However, we recognize that this system participates in an enormous number of addictions that can emerge from integrations with the learning and higher-mind functions of organisms. These range from the basic drug addictions and psychiatric problems to the obsessive addictive behaviors and enthusiasms that humans exhibit—from gambling to sexual obsessions to internet addictions based on virtual universes.

Neuroscience has focused almost exclusively on the SEEKING system in studies of addiction. However, since this research has been most often framed within the "reward circuit" paradigm, it has been difficult to translate these basic neuroscience findings into clinical practice, particularly because the reward circuitry viewpoint does not well address the cardinal alteration that occurs in addicted individuals—*craving* for the drug or behavior of choice. To be fair, many researchers now refer to the "reward circuit" as the "reward seeking circuit," yet attempting to amalgamate old theories to fit new data often leads to confusion and unnecessary complications. The reward circuitry paradigm emerged during a time when the brain was "black boxed" and behavior was analyzed based solely on the input and output of an organism, while simultaneously ignoring psychological brain states. Yet, the paradigm is currently often used with an implied hedonic valence to the term "reward" that was not originally intended. Reinforcement originated to explain a simple relationship: if an input lead to greater output (positive feedback) then it was "rewarding," whereas if the relationship was a negative feedback it was considered "punishment" (Figure 5). Alternatively, SEEKING was proposed as a primary-process neuropsychological theory, taking both the operation of the brain and the psychological state of the organism as being critical to understand behavior (Panksepp, 1981, 1992, 1998).

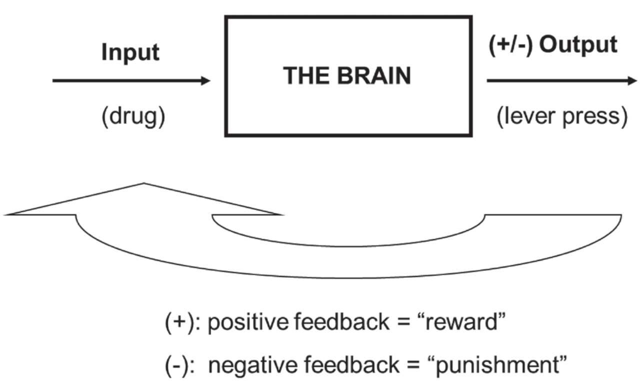

Figure 5. A simplified model of behavioral concepts of reinforcement in an operant lever-press situation where a drug is the reward or punishment. Modern neuroscientists often ignore the fact that the "reward circuit" theory emerged at a time when investigators knew little about the brain. At the same time, many often misunderstand "reward" as simply being constituted of "pleasurable" sensory experiences, as opposed to also certain intrinsic states of mind such as emotional feeling. Indeed, the "reward circuitry" paradigm emerged at a time when many investigators denied the utility of psychological processes in understanding behavior and the organization of the brain. We are now in an era where psychological processes are widely acknowledged in human research but not in animal studies (e.g., LeDoux, 2012).

Starting with a theory that takes both the brain and the mind seriously is a positive step toward the reality of understanding and treating addictions. A shift in preclinical research toward focusing on the affective aspects of treating and understanding addiction in humans will hopefully bring the bench closer to the clinic. Frameworks that fully consider emotional systems being evolutionarily homologous across mammalian species are necessary for this to occur (Watt & Panksepp, 2009; Zellner et al., 2011). Such a mode of interpretation would allow clinicians to better envision how neural alterations found in nonhuman species might be relevant to humans suffering from addiction.

As an illustrative point, let us consider some of the newest findings in addiction research that, when interpreted within a SEEKING framework and discussed from an affective neuroscience perspective, might provide new clinical perspectives to help understand addiction. It has been found that rats given daily systemic administration of cocaine form new "silent synapses" in the shell of the nucleus accumbens and that after a period of withdrawal, some of these silent synapses, perhaps all, become functional (Huang et al., 2009). Silent synapses are initially nonfunctional. The basic morphology is present, but the critical AMPA receptors needed for physiologic functioning are absent—only NMDA receptors are present. Evidence suggests, but is not yet conclusive, that drug exposure itself leads to the formation of the silent synapses, which become functional via the insertion of AMPA receptors during periods of drug withdrawal, when one might expect the strongest drug seeking (e.g., craving).

As already discussed for FEAR conditioning from an affective neuroscience perspective, this form of plasticity offers a plausible mechanism through which primary-process emotional systems could influence and alter secondary-process systems, potentially leading to a more permanent alteration in their dynamic. These changes take place at the secondary-process level, though alteration at the primary level would theoretically lead to a cascade of altered activity at those higher levels, where learning occurs. In other words, as primary-process SEEKING is coupled to new objects and world events, and integrated in various basal ganglia, new learning emerges. Thus, alterations of secondary-process systems requires activity at the primary-process level, and the transition between the formation of new "silent" synapses to their eventual functionality might represent the neurophysiological transition between the primary and secondary processes. Put another way, perhaps the formation of these new synapses represents various neuronal alterations and influences extending from the primary-process system to secondary processes—first via the elevated formation of silent synapses, followed by the insertion of AMPA receptors that initially allow conditioned stimuli access to the control of primary-process SEEKING urges, which are gradually molded into learned operant and instrumental responses. Once the new behavior patterns have solidified into habits, the whole behavioral structure may move rostrolaterally into the dorsal striatum (which is less affective than the ventral striatum) and become behavior patterns exhibited without much accompanying affective experience, unless the habits no longer succeed in extracting explicit rewards from the environment. Thus, we suggest that the formation of new silent synapses and their transition into functional synapses might represent a critical mechanism by which primary-process emotional systems alter and interact with secondary processes and gradually become unconscious habits. Perhaps a very similar cascading neuronal mechanism is also involved in the transition between secondary and tertiary processing, whereby stored memories become grist for the formation of new thoughts.

It may well be that an individual in the thrall of an overly focused SEEKING system becomes less likely/able to experience and bring about motivations related to even the most basic needs of an organism—that is, those related to the instinctual drives, ranging from hunger to sleep. The creation of new drug/drug-cue related connections within SEEKING might explain why addictive behaviors and associated experiences related to drug use are more likely to come about, although this does not explicitly explain the drastic decreases in various previously adaptive behaviors as drug seeking solidifies in severely addicted individuals. Perhaps this drastic decrease in "healthy" behaviors could be explained by the finding that the membranes of neurons within the nucleus accumbens shell become less excitable in rats previously administered cocaine (Ishikawa et al., 2009) and thereby previously adaptive habits gradually diminish—in other words, as basal activity levels of postsynaptic neurons within the nucleus accumbens shell decrease, the networks that mediated previous behavior patterns become harder to activate.

Considering that SEEKING arousal can promote feelings of euphoria, one also needs to focus on the increased potential for depression in addictive individuals. This perhaps explains the overall decrease in non-drug-seeking-related behaviors—for instance, those characterized by depression—that are seen in those suffering from addiction. As other drives and affects that normally interact with SEEKING have less effect due to this decreased background excitability, in the nucleus accumbens via decreased membrane excitability negative affects of psychiatric significance begin to emerge in a global fashion. This eventually shifts drug taking into an attempt to simply reduce negative affect and feel psychologically "normal" (Koob & LeMoal, 2001). Concurrently, we must recognize that drug exposures can also set in motion "incentive sensitization" processes where the mind is increasingly captivated by cues associated with drug experiences (Berridge & Robinson, 1998; Robinson & Berridge, 2003), which is perhaps partly explained by the increase in silent and eventually functional synapses related to the drug use (Huang et al., 2009), to a point where the temperament of an animal can be changed to ever-increasing attraction to all kinds of rewards (Nocjar & Panksepp, 2002, 2007).

Interpreting current findings within a refreshed and more valid neuropsychologically relevant framework may not be enough to yield clear gains in the development of new clinical approaches for treating the diverse addictions of the SEEKING system.

In preclinical models of addiction, for reasons of feasibility, drugs must be used, yet it is difficult to know which neuropsychological alterations are most important for the clinical treatment of addiction (see Zellner et al., 2011), since so much of the brain is altered when drugs of abuse are administered. Furthermore, this approach leaves one of the biggest questions unanswered—why do some, but not others, become addicted? We believe this reflects the affective SEEKING constitution of animals, which can now be monitored objectively both by the spontaneous exploratory behaviors and novelty seeking of rats (Flagel, Akil, & Robinson, 2009) as well as their tendency to emit positive-affect-indicating 50-kHz types of ultrasonic vocalizations (Brudzynski et al., 2011; Burgdorf, Wood, Kroes, Moskal, & Panksepp, 2007), which can be used as a spontaneous measure of drug desire (Browning et al., 2011; Panksepp, Knutson, & Burgdorf, 2002), as well as of the "health" of the SEEKING system.

A basic shift, at the preclinical level, toward looking at psychobiological factors that predispose one toward addiction should be especially useful. However, much of the research that does take this approach focuses on genetic variables, which do not readily translate to clinical treatments. Likewise, it is difficult for clinicians to specify the life events and critical emotional experiences that promoted the neural alterations that have predisposed individuals to addictive tendencies. Treatments focused on trying to get at the underlying psychobiological causative factors might have more long-term value than mere attempts to treat changes associated with the addictive behaviors, as is so common in behavior management programs. This strategy has already been used to develop new antidepressants (Burgdorf, Panksepp, & Moskal, 2011).

Animal models of SEEKING psychobiology might be helpful to get at some of the core affective issues of both addiction and depression. One preclinical approach that might be easily translatable to clinical practice would be to arouse specific primary-process emotional systems during developmental periods and see how the experience alters predisposition toward developing addiction or depression later in life. If addictive behavior emerges as a result of specific early-life emotional alteration, then the neural consequences of the intervention could be determined and interventions to reverse those neural changes and/or prevent the predisposition could be investigated. Furthermore, after finding the neural consequences of the intervention, a picture for real-time treatment (e.g., what affective systems might counteract the early-life experience alterations?) could emerge. We are currently pursuing such approaches in the treatment of depression (Burgdorf, Panksepp, & Moskal, 2011; Wright & Panksepp, 2011).

SEEKING in depression

Depression has been conceptualized as an increase in the persistence and magnitude of the PANIC/GRIEF system in the brain, which may be responsible for the negative feelings similar to those associated with the loss of a loved one, experienced during depression (Panksepp & Watt, 2011; Watt & Panksepp, 2009). In addition, a subsequent decrease in SEEKING may be responsible for the decreased ability to experience euphoria and the general loss of "motivation" that is often associated with fully developed depression. It is possible that a process similar to that described in the previous section regarding silent synapses might also play a role in the genesis of depression. But, first, let us look at the critical experiments that have directly or indirectly implicated the SEEKING system in depression.

In the 1960s it was accidentally discovered that increasing the level of monoamines such as norepinephrine in the brain seemed to alleviate some of the psychological symptoms of depression (Coppen, 1967; Schildkraut, 1965). However, the relative importance of the different monoamines remains unknown, and the majority of the focus has recently been on serotonin. Yet evidence suggests that dopamine, a key signaling molecule of SEEKING, is involved in depression. In fact, the SEEKING system has been periodically highlighted as being critically involved in depression in preclinical research (Nestler & Carlezon, 2006; Swerdlow & Koob, 1987; Willner, 1995; Zacharko, Bowers, & Anisman, 1984).

Perhaps the first evidence from human studies that dopamine might be involved in depression came about in 1984, when the cerebrospinal fluid of people suffering from depression was analyzed. Decreased concentrations of the dopamine metabolite, homovanillic acid, were found, suggesting that altered dopamine concentrations might be involved in depression (Asberg, Bertilsson, & Martensson, 1984; Lambert, Johansson, Agren, & Friberg, 2000; Roy et al., 1986). Brain imaging of dopamine-transporter changes agrees with this conclusion to the present day (Wu, Lou, Huang, & Shi, 2011).

The resurgence in the use of deep brain stimulation (DBS) has provided additional, anatomical, evidence that the SEEKING system may be involved in depression (for a review of the technique related to psychiatric disorders, see Coenen et al., 2011; Schlaepfer, Bewernick, Kayser, & Lenz, 2011). Indeed, DBS within the SEEKING system is showing promise as a potential treatment for depression (Volker Coenen and Thomas Schlaepfer, personal communications by JP, October 2011). Recently, it has also been found that stimulation within the ventral striatum effectively reversed treatment-resistant depression (Malone, 2009; Schlaepfer et al., 2008).

Animal research has helped clarify the involvement of SEEKING in depression. Take the nucleus accumbens, for instance, bearing in mind that the ventral striatum represents an important integrative node in the SEEKING system. Amphetamines injected directly into the nucleus accumbens, as well as electrical stimulation along the extended SEEKING substrates, have been shown to induce 50-kHz ultrasonic vocalizations (USVs) in rats (Brudzynski et al., 2011; Burgdorf et al., 2001, 2007). These vocalizations have been validated to represent a state of social positive affect (Knutson, Burgdorf, & Panksepp, 2002) and are particularly prominent during play behavior in rats, with arousal of the PLAY circuitry perhaps representing the antithesis of depression. Studies have also found that altering rats' nucleus accumbens in a way that mimics prolonged arousal, and perhaps therefore desensitization, seems to lead to an anhedonic state, or at least an animal that is less responsive to traditionally rewarding stimuli (Barrot et al., 2002; Carlezon et al., 1998; Pliakas et al., 2001; Zacharko, Bowers, & Anisman, 1984). A similar mechanism might be involved in a more recent study in which the FEAR and PANIC/GRIEF systems, and perhaps others, within aversive dorsal periaqueductal gray (PAG) zones of rats were repeatedly stimulated. It was found that these rats emitted far fewer 50-kHz vocalizations, under various testing conditions, even 29 days after the final stimulation (Wright & Panksepp, 2011). These data, taken together, suggest that diminished SEEKING is a critical aspect in the genesis of depression, though far more work here is still needed. This also provides a clear bridge between the limited enthusiasm of depressed people and their diminished capacity to learn about the "good" things of the world.

How could such a long-term change occur in human depression? One possibility is that new "silent synapses" are formed within the PANIC and other aversive systems of the brain, and with various learning experiences they become fully functional, amplifying the negative aspects of the world. There are, of course, many other options that need to be addressed. From a clinical perspective, it will be important to experimentally determine first in preclinical models whether environmental interventions, such as those that mimic play, can counteract, or reverse, the emotional changes found in depression. Such an approach could be directly translated into human clinical practice. Indeed, it could be used already. With the emerging concept of memory reconsolidation—namely, that every retrieved memory is reprocessed with the prevailing affective states—clinicians may be wise to follow attempts to deal with highly aversive life events, with an intentional lightening of mood. This may allow newly emerging cognitive understandings of life circumstances to be more readily accepted, since the sting of past memories has been mellowed through reconsolidation processes.

Our increasing understanding of the fields of silent synapses at the interfaces of primary-emotional processes and the basal-ganglia learning mechanisms—the junctions between primary and tertiary processes—we suspect highlights a general principle of how affects regulate learning. The UCR pathways (e.g., emotional command systems) may be critical in transforming silent synapses to active ones at learning (coupling) interfaces. This may be instantiated by the UCR of SEEKING promoting AMPA receptors in the nucleus accumbens to promote learned appetitive enacting. A similar mechanism may operate in all types of emotional learning, and it is surprising that in classical fear-conditioning studies, the UCR of FEAR has been neglected as a critical component in associative pathways (for full discussion, see Panksepp & Biven, 2012).

Many readers are no doubt familiar with the line of research implicating growth factors and the hippocampus in depression. It might be useful to illustrate one potential link between these findings and the SEEKING system—the hippocampus sends strong excitatory input to SEEKING. People with recurrent major depressive disorder have been found to have decreased hippocampal volume (Bremner et al., 2000; Sheline, Wany, Gado, Csernansky, & Vannier, 1996), which seems to positively correlate with the duration of depression (Sheline, Sanghavi, Mintun, & Gado, 1999). It has been found that antidepressant treatment increases the expression of brain-derived neurotrophic factor (BDNF) in the hippocampus (Nibuy, Moreinobu, & Duman, 1995; Rosello-Neustadt & Cotman, 1999), and injections of BDNF into the hippocampus have been found to produce antidepressant-like effects in behavioral animal models of depression, such as the forced-swim test (Shirayama, Chen, Russell, & Duman, 2002). Perhaps a decreased excitatory input to SEEKING from this hippocampal loss plays a role in the affective changes seen in depression; although more research is needed, perhaps therapy aimed at arousing the hippocampus might be valuable in "re-awakening" SEEKING in depressed patients. In this context, it is noteworthy that the tickling of rats has recently been found to promote hippocampal neurogenesis (Wöhr et al., 2009; Yamamuro et al., 2010).

General clinical applications and perspectives

The current trend in clinical psychology and psychiatry, institutionalized in the American Psychiatric Association's *DSM–I* to the forthcoming *DSM–V*, is to subsume individuals under conceptual–psychological categories representing different supposed disorders. This approach runs the risk of leading to overly generalized concepts that do not take into account the key neural systems and their aberrant activities that are potentially responsible for the alterations in the patient's impaired cognitions, moods, and behaviors. The "disorders" are treated without attempting to understand and treat the specific affective and hence underlying neurodynamic imbalances. For diagnostic concepts that will interface with neuroscience, we will eventually need to develop an understanding of the underlying psychologically relevant neural systems, using concepts such as emotional endophenotypes (Panksepp, 2006). Future clinical approaches may need to analyze changes in the functioning of specific affective systems, conceptualized in hierarchical neuropsychoanalytic ways. Presenting symptoms would provide hints at what neural systems might be problematic, and treatments could then focus on treating those malfunctions, hopefully implementing treatments that would alter the neural dynamic in a way that might help correct the presenting symptoms. This, of course, has been the goal of many therapies, but often the emerging neural understanding of the affective processes is not explicitly considered. In the next sections, we discuss how our emerging understanding of the SEEKING System could be illustrative of such an approach.

Determining the general level of SEEKING arousal

Convergent evidence indicates that if SEEKING is pathologically overactive, then psychoses and delusions can develop. A striking example of this is observed when symptoms of paranoid schizophrenia are induced by repeated amphetamine intake (Angrist, Sathananthan, Wilk, & Gershon, 1974; Connell, 1958; Tatetsu, Goto, & Fujiwara, 1956). Additionally, patients with schizophrenia have been found to show increased dopamine activity in the striatum when given amphetamine (Breier et al., 1997; Laruelle et al., 1996). The initial symptoms are hypomania grading into delusions of grandeur—namely, the positive symptoms of schizophrenia, which often cascade into paranoid delusions, each unique in different individuals. This, in our estimation, reflects the diverse ways the SEEKING system can captivate higher mental processes. A period of florid psychosis may be followed by persisting negative symptoms, together with cognitive impairments accompanied by dysphoric, confused states, and formal thought disorders.

Understanding that SEEKING is a major future-oriented anticipatory system of the brain, and a better appreciation of its role in linking drives, objects, and thoughts into coherent as well as incoherent mental patterns helps us better understand the delusions seen in schizophrenia. If SEEKING is overactive, then perceptions and other mental phenomena are increasingly linked together in idiographic ways, where they can easily generate patterns of apparent mental coherence that may no longer well represent reality, in their failure to promote adaptive behaviors. Similarly, with the emergence of the negative symptoms of schizophrenia, a "burn out" within SEEKING resulting from prior overarousal might bring about the general flattened affect. Considering that SEEKING plays such an important role in the functioning of most, if not all, emotional systems (Panksepp & Biven, 2012), we can also imagine why imbalances in this system can have such pervasive effects on emotional as well as cognitive functioning. When operating in a balanced way, this system promotes curiosity and interest and thereby helps all individuals construct coherent understanding of the world. When the system becomes excessively self-referential and focused on limited affordances in the world, it helps create distorted and confusional pictures of the world that are commonly recognized as defective by others but not by the individuals themselves.

The capacity of the SEEKING system to generate delusional thinking has been provisionally simulated with simple animal models through behaviors such as "autoshaping," where animals simply exposed to the pairing of CSs (neutral cues) and rewarding events (e.g., delivery of food to hungry rats) begin to interact with the cues in instrumental ways as if their behavior were in some way controlling reward delivery (for full discussion, see Panksepp, 1998, chap. 8). Indeed, recent work has indicated that rats tend to fall into two temperamental types, "sign trackers" and "goal trackers"—namely, only some animals persist in focusing their behavior to the predictive signals, while others seem more "philosophical" and direct their attention to the location where the food will be delivered (Flagel, Akil, & Robinson, 2009; Flagel, Watson, Akil, & Robinson, 2008; Flagel, Watson, Robinson, & Akil, 2007). We would predict that the former have a stronger SEEKING urge, and under stress or the chronic delivery of psychostimulants such as cocaine would become more likely to exhibit delusional behavior resembling a psychotic phenotype. This is because there are good reasons to believe that those animals are working more at the primary-process level and hence are more likely to be attracted by external cues (secondary processes) as opposed to more thoughtful approaches that need to be internalized (goal-tracking).

In contrast, if the SEEKING system is pathologically underactive, then one might be unable to experience excitement or euphoria and therefore might be highly predisposed toward developing major depression. We now have animal models where a tendency for high or low positive affect has been selectively bred in rats, and there is already preliminary data that such lines differentiate along such phenotypic traits (Brudzynski et al., 2011; Burgdorf, Panksepp, & Moskal, 2011).

A closer look at SEEKING suggests that the "directionality"—that is, where SEEKING coherence is originating—may also lead to insight into particular types of unusual behaviors. For example, if SEEKING is aroused, then many distinct appetitive action pattern can develop (as illustrated in the studies by Valenstein, Cox, & Kakolewski, 1970, where rats receiving SEEKING stimulation directly exhibit a wide range of behavior, and in human reports of impulsivity when SEEKING is directly stimulated). Thus, SEEKING is "pushing outwards," increasing the likelihood of a wide range of behaviors developing. A person predisposed to such an "outward-pushing" SEEKING system might be more impulsive. Conversely, as the many drives in the brain input into and connect with SEEKING, increasing the arousal of homeostatic drives can increase SEEKING activity. However, in this case, there is a clear homeostatic goal already *coupled,* perhaps by very early infantile learning, when SEEKING becomes aroused. Therefore, people with an overactive connection of this sort of "inward push" on SEEKING might be predisposed toward various compulsive behaviors.

How, then, does one clinically investigate the "state of SEEKING" of a client? Of course, here personal observations of the actual behavior of a client become important. How engaged is the client toward reaching therapeutic goals in sessions? This is perhaps an indicator of the *generating* component of SEEKING. Similarly, how able is the client to bring about these ends? This is perhaps an indicator of the *enaction* component of SEEKING. Does a client repeatedly show a grand enthusiasm to engage, but then is unable to bring about the behaviors and thoughts necessary for bringing about these ends? Answers to these questions, in addition to self-reported behavior, might provide a clinician with an understanding of the SEEKING dynamic of that individual. As the clinician repeatedly encourages the client to understand and come to terms with such universal neural powers of the mind, he or she can begin to have insight into the client's temperamental traits and diverse behavioral urges from the various addictions—drugs, sex, and the endless novelty of the internet—to the deep beliefs and delusions that so easily become ingrained features of one's cognitive personality.

Increasing SEEKING arousal in therapeutic relationships

Our goal here is briefly to entertain clinical possibilities that may arise naturally from a better understanding of the SEEKING system. Increasing directed SEEKING motivation, besides perhaps being therapeutically beneficial, might also aid in forming a more powerful interaction between a client and clinician. SEEKING is an ancient evolutionary system, and the "deeper" one goes in forming new life-affirming social, environmental, and cultural connections with this system, the more a client may become engaged with the beneficial as opposed to destructive higher mental dynamics that this system can mediate. For example, the mammalian brain is powerfully driven by strong instinctual social drives (LUST, CARE, and PLAY) and other primary-process affects that can be used by therapists to invigorate and sustain SEEKING in prosocial, life-affirming directions. Laughter—that robust affective emissary of PLAY, in humans and in other animals (Panksepp, 2007a)—is perhaps one tool that can be more effectively used in clinical interactions to aid in the therapeutic engagement of a client. Laughter can be thought of as a pulsation and cycling of SEEKING impulse and enaction, and it might serve to channel latent but unformed pressures from SEEKING in ways that help free the minds of both client and clinician to engage into deeper and more fruitful avenues of psychotherapy. The social bond that laughter can facilitate might be not only beneficial for the client–clinician relationship, but a potential medium for helping reconsolidate troublesome emotional memories for the client in ways that diminish the influence of past negative affective associations. It is not that such a laughter-fertilized relationship need become unprofessional or informal, but it can put client and therapist on a level playing field, which may enable the client to feel more comfortable exploring the deeper folds of his or her own mind. But most importantly, from our preclinical vantage, positive affects, from social care to euphoric laughter, might be useful in "reshaping" old negative experiences, and ruminations, into a more positive and less stifling light. We have preliminary data that play can promote emotional resilience, diminish the negative affective consequences of stressful emotional experiences, and fertilize affectively positive gene-expression patterns within the BrainMind (Burgdorf, Panksepp, & Moskal, 2011; Moskal, Burgdorf, Kroes, Brudzynski, & Panksepp, 2011).

Positive social bonds and playfulness, when appropriately used, even as professional seriousness is concurrently sustained, might also be used to fuel a clients SEEKING "energies" in productive directions. One possible route of accomplishing this is through the enthusiastic (not just cognitive) acknowledgement of chosen motivations that a client possesses or has possessed in the past. The therapist may be able to creatively channel and strengthen the impetus of the underlying SEEKING urge via the recruitment of socially relevant affects. In such endeavors, the creative use of our mirroring networks, which help establish therapeutic alliances, can help transmit mutual understanding as effectively as words. In any event, if a client is brooding on negative events, then perhaps lightening the mood and providing a "safe haven" for an hour may be very beneficial—facilitated not through over-serious searching of the soul, but through socially contagious laughter and light spiritedness and encouragement. Such approaches may be especially effective in recruiting an optimal balance of primary-process affective network dynamics with the overall goal of facilitating therapeutic growth and understanding.

With a "well-oiled" SEEKING system, both friends and therapists may better instill new goals more efficiently in short periods of time than through any higher order cognitive interpretations. Often, those who are severely depressed are unable to either form clear motivations or instantiate nascent motivations, and thereby they become increasingly alienated from the positive experience of life. However, even if SEEKING "energies" are in deep "hibernation," small movements toward positive actions and goals, perhaps able to be completed in a session, may help shift the dynamic of SEEKING toward "reawakening." Of course, this would be an adjunct to a more integrated established emotion-based therapy. We are not suggesting a wholesale change in approaches developed across the decades by many revolutionaries in the area (Abbass, Kisely, & Kroenke, 2009; Davanloo, 2005; Fosha, Siegel, & Solomon, 2009; Freud, 1940; Greenberg, 2002; Malan, 1979; ten Have-de Labije & Neborsky, 2012), but we suspect that it might we wise, depending on the receptivity of clients, to spend the first few minutes of a session on such interpersonal social bonding before getting down to more specific tasks. If at all possible, the affirmation of each other's positive humanity may set the stage for optimal progress. But this is not always possible.

There are primal affective forces that can inhibit SEEKING, from FEAR and PANIC to RAGE. Optimizing the therapeutic environment and interactions to be a "safe zone," imbued with supportive social bonding, should attenuate the activity in the primal negative affects. If too severe, similar goals can be approached medicinally, but such approaches need to be individualized both in terms of types of medicines as well as doses. Although one might imagine that amphetamines might be a good option, since they are remarkably effective in increasing SEEKING, it would be foolish to go in those directions therapeutically when there are gentler options—from dopamine reuptake inhibitors such as bupropion and safe MAO-A inhibitors such as selegeline. If mental clarity is impaired, the utility of modafinil is surely wiser than rapidly acting direct psychostimulants. Similar principles can apply for excessive social pain (overactive PANIC systems), where mild facilitation of various biogenic amine facilitators, such as low doses of impipramine which can have antipanic effects (Klein, 1964), and in our estimation using safe opioids such as buprenorphine, which can be used initially at incredibly low doses (e.g., ~0.1 mg sublingually or even intranasally; Bodkin, Zornberg, Lukas, & Cole, 1995), can promote a sense of security and confidence that often cannot be obtained rapidly in any other way.

We realize that such possibilities are highly debatable, but we believe a true understanding of affective neuroscience principles coaxes us to at least put them on the intellectual table. There are many other possibilities, but our only wish here is to highlight creative possibilities that medically qualified clinicians may wish to consider. We trust that clients can be guided into utilizing gentle biological ways to facilitate well-structured SEEKING urges to promote beneficial psychological ends. Perhaps the use of gentle cognitive facilitators, only occasionally at low doses, in tandem with goal-oriented socially facilitated emotional-motivational therapies may effectively promote sustained positive long-term changes. Obviously, such mediations would need to be used in ways that do not promote addictive SEEKING behaviors or neuropsychological sensitization (e.g., Nocjar & Panksepp, 2002, 2007) but that magnify the scope of one's intrinsic psychological powers for creative, productive living.

Neurological intervention to increase the arousal of SEEKING might be highly beneficial for some who are profoundly depressed and have found no sustained therapeutic relief (e.g., Coenen et al., 2011; Holtzheimer & Mayberg, 2011), since obviously the need for brain "pacemaker" surgery must currently be a last resort. In any event, DBS is becoming increasingly accepted as a relatively safe and effective psychiatric intervention, and in many cases it may perhaps be safer and more effective than pharmacological interventions. One more general approach that might help utilize neuroscientific findings to increase SEEKING would be to look at the anatomical substrates of the brain that have excitatory projections to SEEKING, and then see what activities have been found to arouse those regions. In such a way, one might be able to indirectly activate SEEKING by therapeutically instigating activities found to arouse those facilitatory neural regions such as TMS (transcranial magnetic stimulation), or EpCS (epidural prefrontal cortical stimulation), applied to frontal lobe regions (Nahas et al., 2010). Obviously, growth-promoting human interactions are the best of all possible options.

Analysis of the component-functions of SEEKING

It would be good for clinicians to be able to estimate where clients are, temperamentally, in "SEEKING space." In order to be able to evaluate such issues in most of the primary-process emotional systems, we developed the Affective Neuroscience Personality Scale (Davis, Panksepp, & Normansell, 2003), which has been slightly updated and is available for free use (Davis & Panksepp, 2011) and has now been translated into many languages. It is noteworthy that scores on the SEEKING scale are not statistically related to any of the other emotions, except for a positive relationship to PLAY. This relationship has been established formally in preclinical research, since rat laughter emerges during social play, and this indicator of positive affect arises substantially from the SEEKING system. This immediately suggests, as already noted, the possibility that being able to establish a playful attitude in the therapeutic relationship may have considerable benefits. Obviously, this could only work if done with the right sensitivity—an attitude enriched with mutual mindfulness. It is hard to specify how to use this therapeutic modality, for it has to utilize the living moment in ways that promote shared positive affect, which is no doubt subject to great individual differences.

Still, investments in this direction have the potential to utilize one of the great new findings in memory research—namely, the phenomenon of *reconsolidation*. It has become clear that our long-term memory stores are not as stable affectively as most investigators have assumed. In fact, the affective linkages to specific events can be modified by retrieval of past events in totally different affective contexts, and painful memories can be "softened" since they return to the memory stores, in part, with the coloring of the most recent affective penumbra (Nader & Einarsson, 2010). The clinical implications are obvious. If traumatic memories are retrieved during therapeutic interactions, clinicians may want to consider whether being able to humanely reflect on such events from a trajectory that can bring a chuckle and sincere smile to the client's face, which will obviously have immediate value in dulling the painful edges of the memory. To our knowledge this has never been formally described or empirically evaluated in the clinical literature. As noted, our preclinical work is promising.

Having a *disenacted* SEEKING system, where urges to perform everyday tasks, as well as long-term hopes and dreams, that are not pursued may lead to profound feelings of disappointment, even to the shame and guilt that prevails in so many lives. Such ideational states are common in mild depressions, where individuals can still experience joy and euphoria upon successful completion of tasks but easily slip back into dysphoric states. However, it is possible that by performing basic tasks and completing simple goals, the somewhat atrophied muscles of the SEEKING system might begin to strengthen. Though these are self-evident issues, the recognition that we have a robust emotional system that underlies the "energetic" engagement of both body and mind has not been sufficiently well recognized in therapeutic practice.

SEEKING relations to positive psychology

Obviously the proper training of the SEEKING system is bound to be important for the emerging field of "positive psychology" (for most recent compendium, initiated by pioneers such as Mihaly Csikszentmihalyi and Marty Seligman, see Sheldon, Kashdan, & Steger, 2011). In the preclinical sciences, our own efforts have long been devoted in that direction through the recognition of a variety of primary-process emotional systems (Burgdorf & Panksepp, 2006; Panksepp, 1998, 2007b, 2011c). Indeed, contrary to popular opinion, there are just as many positive primal emotions (PLAY, CARE, LUST, SEEKING) as primal negative emotions (FEAR, PANIC, RAGE), although all are heavily dependent on the SEEKING system.

However, as we have emphasized, the SEEKING system has a dark side—promoting addictions, mania, and obsessions that can cut deeply into the quality of life and the search for happiness. Thus, as always, the SEEKING urge needs to be tempered with Aristotelian *phronesis* and meditative *mindfulness* in order for a person to achieve happiness (Siegel, 2007). Since emotional-cognitive wisdom is not built into the nervous system, a critical aspect of life and therapeutics is the balancing of emotional and cognitive forces, but the SEEKING system is especially adept at achieving that through its vast influence over the cognitive apparatus. It has long been known that decortication of animals can make them hyperemotional, and that when one is engaged in thoughtful higher brain activities, those cerebral influences inhibit emotional arousal (Liotti & Panksepp, 2004; Northoff, 2011). Indeed, these interactions can be monitored at the autonomic level, as indicated by the reduction of heart rate during emotional self-regulation (Segerstrom, Smith, & Eisenlohr-Moul, 2011).

We do not have space to delve into the many dimensions of positive psychology in life and therapy but anticipate that commentators may develop such themes. We would simply note that an evolutionary understanding of positive psychological influences on the human species will require further investments in evolutionary psychophysiological analysis that focus on the full force of human emotional adaptations on mental health and disorder (Gardner & Wilson, 2004). The fundamental rule in the brain appears to be that various positive and negative affects are in sea-saw balance in the brain and within the mind (Liotti & Panksepp, 2004; Northoff, 2011). This can almost be seen as an affective battlefield for optimal and suboptimal human functioning (Tamir & Gross, 2011), where early developmental vicissitudes loom large, ever since John Bowlby collated the evidence for such psychiatrically relevant early emotional dynamics (for neuroclinical updating see Watt & Panksepp, 2009). In short, the SEEKING system can be used to promote mental health and well-being, or for the degradation of the human spirit. We should not forget William James's (1890) insights into the power of habits (which are mediated more by nigrostriatal rather than mesolimbic dopamine systems) in the molding of character: "The hell we make for ourselves in this world by habitually fashioning our characters in the wrong way. . . . We are spinning our own fates, good or evil, and never to be undone. Every smallest stroke of virtue or of vices leaves its never so little scar . . . it is being counted. . . . Down among his nerve-cells and fibres the molecules are counting it. . . . Nothing we ever do is, in strict scientific literalness, wiped out" (p. 127). But fully mindful confrontations with the SEEKING system, in life and in therapy, have the potential to restructure the furies of the BrainMind.

Conclusion and future outlooks

The field of neuropsychoanalysis represents a new epoch of modern BrainMind science, linking the philosophical and visionary antecedents of modern neuroscience and psychology with the current possibilities to empirically investigate some of the primal tools of the mental apparatus. Neuropsychoanalysis offers abundant new vistas for lines of inquiry, open to new philosophical and practical avenues of thought, that take the very nature of lived lives as the target of both scientific inquiry and clinical practice. As such, the field of neuropsychoanalysis is uniquely situated to provide a useful synthesis of the many disciplines that have been seeking a realistic confrontation with the nature of both brain and mind. The SEEKING system is one of the most important emotional powers of mammalian minds for us to consider scientifically and utilize more effectively in psychotherapeutic endeavors.

There is an increasing number of theories about what "the brain reward system" actually does in the organization of behavior. We have not attempted to cover them all in detail, but we believe that the SEEKING system perspective is the most comprehensive and is the only one that explicitly situates itself as a specific type of the primary-process emotional system of the mammalian brain. Hence, it is fundamentally an action system, with unique affective qualities, but totally compatible with "effort" facilitation views, as enunciated by Salamone (2006), and also with the "wanting"/incentive salience perspective of Berridge (2007) and the "reward prediction error" hypothesis of Schultz (2005), with appropriate methodological qualifications (Panksepp & Moskal, 2008). Indeed, the latter two concepts use semantics that we think would be more appropriate for secondary- and tertiary-process behavioristic descriptions of more limited scope than SEEKING: The "wanting" and "reward prediction error" views are more appropriate to sensory-perceptual processes and cognitive-learning correlates, respectively, rather than the felt sensorimotor action qualities that characterize all primary-process emotional networks.

We would submit that the SEEKING view is currently the most comprehensive and clinically illuminating view out there. But we most certainly agree with Salamone's pithy assessment of the state of the field (*vide supra*)—will the last person who designates this as "the reward system" please turn out the lights?—while never forgetting that the MFB is a highly rewarding system, containing the majority of neurochemistries within the brain. Regrettably, experiencing the rewarding pleasures of life is not its main domain. But foraging for pleasure is a key function—an idea first advanced 30 years ago (Panksepp, 1981, 1982a, 1982b).

And while we are turning out the lights on this overview, we should have raised many other issues, which we trust many commentators will elaborate, including especially why the dopamine-energized SEEKING system is especially active in REM sleep (Gottesmann, 2010; Panksepp, 1998), or, more accurately, in dreaming, since the two can be dissociated (Solms, 2000). This makes it an even more intriguing and important system in helping "solve" the emotional problems one is confronted by in waking, with profound implications for many of the joys of life as well as for psychiatric disorders (Gottesmann & Gottesman, 2007) and their treatments (Panksepp, 2004).

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Seven Missteps of Desire

Commentary by Gordon M. Burghardt & Matthew A. Cooper (Knoxville, TN)

We very much value the integrative formulation of the neural basis of the seeking system put forth by Wright & Panksepp, but we have several concerns that might be incorporated or acknowledged in future versions. These revolve around the need for a more rigorous and modern evolutionary backdrop, a greater appreciation for earlier discussions of appetitive and consummatory behavior, more integration with other neural models of learning and reward, questionable terminology, clarification of hierarchical claims, greater attention to genetic polymorphisms and individual differences, and greater acknowledgement of earlier attempts to integrate ethological and psychoanalytic formulations that address neural and motivational systems, conflicts underlying behavior, and implications for treatment.

Keywords: seeking; appetitive behavior; ethology; reward; motivation; mind

The neuroevolutionary framework advanced by Jason Wright and Jaak Panksepp is truly a wide-ranging and remarkable scheme. Large-scale innovative and integrative perspectives are all too rare, especially ones that bridge basic research and applied ambitions. It is also important to help solidify the empirical and conceptual bases as much as possible, so that the edifice can withstand the inevitable buffeting it will receive. To that end we offer seven missteps that may potentially weaken the framework's scaffolding. We will not go as far as one of the authors did in criticizing, often appropriately, the commission of seven *sins* by evolutionary psychologists (Panksepp & Panksepp, 2000). Nonetheless, we hope that these necessarily brief comments are viewed as constructive as well as critical. In the end, a "neuropsychological tapestry" needs to hang together to effectively cover a wall with existing holes, of which certainly many exist. Note that we are not questioning the neuroscience on which the framework is constructed.

The lack of a credible phylogenetic approach

The vertical perspective proposed by the authors is not a substantive evolutionary approach and shares some of the problems of the triune brain formulation of MacLean (1990). Wright & Panksepp propose that primary, secondary, and tertiary processes reflect instinctual, learned, and cognitive levels of mind. They also suggest that some tertiary processes are unique to humans or at least other "complex" mammals. This argument resembles a *scala naturae* that suggests that evolution operates as a ladder of progress. The view of an evolutionary ladder was challenged as early as 1892 when William James suggested that humans have more, not fewer, instincts than do other animals. Overall, an effective evolutionary perspective is best served by a rigorous comparative approach, rather than jumping across species for which studies are available without an explicit rationale or consideration of the evolutionary origin of brain tissue. Sufficient comparative data now exists to test hypotheses for the evolution of various brain structures underlying specific functions in a comparative context (e.g., Lewis & Barton, 2006).

Use of an outmoded conception of reward and learning systems

We agree that the SEEKING system proposed by Wright & Panksepp is an advance over the reward system. However, the reward system itself is outdated and was set up as a straw man. Wright & Panksepp have missed an opportunity for a more robust comparison with the incentive sensitization model proposed by Kent Berridge and colleagues (Robinson & Berridge, 2008). The SEEKING system appears to overlap a great deal with the wanting process of the incentive sensitization model. Wright & Panksepp suggest that the wanting system is too narrowly focused on the stimuli underlying motivation, whereas the SEEKING system more broadly captures an integrative sensorimotor system. While this distinction may be true, it is unclear how a SEEKING system improves our understanding of the biological bases of addiction and depression compared to a wanting system. A more detailed comparison of the SEEKING system and wanting system would have been helpful, along with perhaps a clear presentation of the hy-

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potheses underlying the systems, any distinctive predictions derived from these two model systems, and guidance as to how they can be tested.

Also, Wright & Panksepp suggest that including positive or negative affect in analyses of learning will result in a radically new interpretation of classical conditioning. It is true that some researchers have deemphasized emotional feelings in the study of fear conditioning (LeDoux, 1996). However, others have suggested that aversive stimuli of different durations can produce fundamentally different emotional states. For instance, Michael Davis and colleagues have shown that short-duration aversive stimuli produce fear that is mediated by the amygdala and that long-duration aversive stimuli produce anxiety that is mediated by the bed nucleus of the stria terminalis (Davis, Walker, Miles, & Grillon, 2010). It is unclear whether this is the type of radical new interpretation that Wright & Panksepp allude to, and thus some additional clarification on this issue would be helpful.

The need to acknowledge conceptual forerunners

As described in Wright & Panksepp's introductory paragraphs and elaborated throughout, the SEEKING system involves generating, coupling, and enacting and "at higher levels is accompanied by various thoughts or cognitive perspectives." While the attempt to identify the neural substrates of this system is most useful, it should be noted that the basic ideas underlying this system were laid out in a remarkable classic paper by Wallace Craig (1918). His sequential analysis of behavior from need/drive to appetitive behavior to consummatory act to relative rest was not only a lynchpin in early ethological theory, but has had continuing resonance. For example, Craig noted that appetitive behavior involved seeking a stimulus setting in which consummatory acts would be instigated and that it was during the appetitive phase that most learning and cognition took place. The SEEKING system is really, arguably, a more sophisticated articulation of a key and well-known process with a somewhat different label. In fact, the prominence of the Craig paper is shown by the fact that it is the only paper that overlaps in the two broad historical collections of readings in animal behavior (Burghardt, 1985; Houck & Drickamer, 1996). Likewise, the ethological discussions of motivational (behavior) system conflicts (e.g., ambivalence, redirection, displacement) as sources of important behavioral dynamics and dysfunction are relevant and were related to psychoanalytic writings years ago (Fletcher, 1957—see in particular chaps. 6, "Instincts in Psycho-Analysis," and 7, "Some Comments on the Ethological Account, the Psycho-Analytic Account, and the Early Doctrine of Instincts," as well as the extensive Table 1, which refers to "seeking" repeatedly in a manner nearly identical to Wright &Panksepp). More recently, Timberlake and Silva (1995) presented an integrative scheme of appetitive behavior.

Utilizing imprecise or misleading terminology

Comparative cognition and the study of animal minds and mentality have had a long history, beginning well before Darwin. Wright & Panksepp explicitly equate mind with phenomenal consciousness. This then raises the hoary issues of both what is consciousness and how it is to be identified in nonhuman species (not to say in humans). Theorists currently struggle with how to identify theory of mind in children, apes, and so forth. The way in which Wright & Panksepp conceptualize instinct seems problematic as well. Primary processes (instinct) as somehow separate from secondary processes (conditioning) was never part of the ethological approach to instinctive behavior—for example, imprinting explicitly incorporated a type of learning, and it has already been noted that Craig's approach did likewise. More to the point in the psychoanalytic context is that the major contribution of Freud was to understand that much of the mental apparatus was unconscious or preconscious and thus seemingly outside the purview of the study of mind! Some clarifications here seem needed, given the psychoanalytic orientation of this journal. If the authors are making a strong claim regarding psychoanalytic perspectives, this should be more explicit and unpacked.

Need more compelling justification for a hierarchy of drives

The authors suggest that primary drives are emotions that are instinctual and therefore unconditioned, that secondary drives are emotions that reflect basic learning processes such as classical conditioning, and that tertiary drives are emotions that depend on higher cognitive functions. This hierarchy of drives begs the question of the relationship between the cognitive and the affective, which so animated Panksepp's groundbreaking book *Affective Neuroscience* (Panksepp, 1998). And, as noted above, the exclusion of learning from primary-process instinct is problematic. Perhaps innate attributes or components are meant rather than instinct in the more global sense used for decades by ethologists and comparative psychologists. In this sense, the pioneering studies on brain stimulation of ethotypic behavior in chickens of Erich von Holst (1962), which went far beyond the cat studies of Walter Hess, may better support primary process as used by Wright & Panksepp. Still, the value of separating secondary and tertiary drives is unclear. If tertiary drives are higher emotional functions that are based on episodic memory and symbolic thought (Panksepp, 2009), they appear too idiosyncratic to be called a fundamental drive. Humans may have complex cognitive functions that generate secondary drives rather than tertiary drives. While an understanding of the biological bases for secondary drives appears within reach, the biological bases for tertiary drives seem far more elusive. We also think that the developmental behavior system approach of Hogan (2001) has been insufficiently recognized in behavioral neuroscience generally and may be particularly useful here (e.g., comparing Figure 4 in the Target Article with Hogan's Figs. 1 and 3).

The need to seriously accommodate individual differences

Evolutionary processes are dependent on variation in phenotypic expression and fitness. Thus, it is somewhat distracting that Wright & Panksepp largely discount genetic factors that underlie individual differences. A vast literature now exists on genetic polymorphisms and the development of drug addiction, for example. Although advances in personalized medicine have been slow in coming, it is premature to discredit this approach. The early evolutionary psychology so critiqued by Panksepp and Panksepp (2000) clearly underplayed behavior genetics (but not sex differences) as well, but now individual differences, such as the big five personality traits, are not only much studied but also increasingly common in nonhuman animal research, from octopus to fish to mammals and birds. A reconstructive phylogenetic approach that seems promising has started with primate studies (Weiss, Adams, Widdig, & Gerald, 2011). Do the authors agree?

Need for treatment options actually derived from the framework proposed

It is unclear how conceptualizing major depression as a deficit of the SEEKING system produces fundamental advances in treatment options. Wright & Panksepp suggest that clinicians encourage clients to laugh, play, and learn about good things in the world. These recommendations seem vague, not particularly novel, and their modes of application unspecified. Furthermore, similar recommendations might be generated from reward, motivation, or wanting conceptualizations as well as the extensive play therapy literature (though unfortunately too restricted to children). Finally, Fletcher (1957), in his comprehensive comparison of ethological and psychoanalytic approaches to instinct, discusses many of the major phenomena of the latter (e.g., transference, regression, projection, conversion, repression, idealization, sublimation, reaction formation, dreaming). It would be interesting to know if there are identifiable neural substrates for these and if the neural systems involved interact in such ways that treatment options can potentially emerge and how they specifically relate to the SEEKING system.

Finally, we want to emphasize how provocative the Target Article was for us and that it stimulated some new thinking and rereading in ways that will influence our future teaching and appraising of behavioral processes.

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Panksepp's SEEKING System Concepts and Their Implications for the Treatment of Depression with Deep-Brain Stimulation

Commentary by Volker A. Coenen & Thomas E. Schlaepfer (Bonn, Germany)

Panksepp, as the true founder of the field of affective neuroscience, has predicted that the understanding of the emotional systems of animals will lead to understanding on the nature of human feelings. The Target Article that we comment on most convincingly shows a careful analysis of impaired SEEKING function for the clinical entity of major depression. It becomes increasingly clear that certain affective imbalances of this and other disorders (e.g., addiction) converge on a common subcortical emotional system, the very SEEKING system that Wright & Panksepp discuss. We conclude our comment with the first report of actual medial forebrain bundle (SEEKING system) stimulation results in humans, treated for therapy refractory depression and performed by our group.

Keywords: appetitive motivation; depression; deep-brain stimulation; diffusion tensor imaging; reward system

> There are now electrical appliances with the main unit so sealed in that it cannot be got at for repair. There have always been human beings like that.
>
> Mignon McLaughlin, *The Neurotic's Notebook* (1960)

Sigmund Freud developed in the late nineteenth century a theory attempting to describe and explain what exactly drives human emotion, behavior, experience, and cognition. This theory of psychoanalysis—in its three applications: as a *science* of unconscious driving factors, as a *methodology* to assess human thinking and behavior, and as a *treatment* method for disordered behavior—quickly developed into the leading paradigm guiding psychiatry. A criticism of psychoanalysis has always been that it had not been developed by careful and deliberate study following the classic principles of scientific observation, hypothesis, and experimentation in animals and man but, rather, by interpretative phenomenology (Webster, 1996). Freud started his career as a neuroscientist but probably quickly realized that convincing scientific explanations for complex human behavior could not be found with the methods available to neuroscience in the nineteenth century (Freud,1940). Already in 1998, Panksepp asserted that "the failure of psychology to deal effectively with the nature of the many instinctual systems of human and animal brains remains one of the great failings of the discipline. The converse could be said for neuroscience." This statement can be seen as a formulation of a goal that is addressed in Jason Wright and Jaak Panksepp's Target Article.

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In their *tour de force,* Wright & Panksepp indeed develop a *neuroevolutionary framework* and a truly neurobiological framework for some key aspects of human behavior by broadly discussing the germane importance of the SEEKING system for understanding normal and disordered affective functions in humans. Their article integrates, in a bold conceptual framework, findings from neurobiology, neurophysiology, neuroanatomy, and ethology on a system in the mammal brain that might be responsible for the psychoanalytic concept of motivational "drives." They thereby take advantage of the wealth of data on substrates of appetitive motivation that has been accumulated since the beginning of the twentieth century and, more originally and perhaps somewhat controversially, integrating wrongly ignored results from animal research.

Panksepp, the founder of the field of affective neuroscience, has for a long time made the point that studies of emotional and other affective systems of animals will shed a profound light on the nature of our own feelings (Panksepp, 2005). It is assumed that so-called primal emotions, such as fear, are associated with ancient parts of the brain and evolved among our premammal ancestors and that social emotions evolved among social primates. However, this is an assumption and "As long as psychology and neuroscience remain more preoccupied with the human brain's impressive cortico-cognitive systems than subcortical affective ones, our understanding of the sources of human consciousness will remain woefully incomplete" (Panksepp, 2004). The authors are to be commended for the masterful integration of their research on affective consciousness in animals with human drives as posited but not biologically explained by the psychoanalytic method. From a conceptual standpoint, probably most convincing is their careful analysis of impaired SEEKING function for the clinical entities of depression and addiction, as it becomes increasingly clear that certain affective imbalances of both disorders converge on a common subcortical emotional system, the very SEEKING system they discuss (Coenen, Schlaepfer, Maedler, & Panksepp, 2011).

The concept of the hedonic principle says that we are motivated to approach pleasure and to avoid pain; prototype disorders associated with dysfunction of the reward system—or, more correctly, the SEEKING system—are substance abuse and depression. Indeed, the opioid-withdrawal syndrome is an integral diagnostic part of opioid dependence and is characterized by both behavioral and physiological responses that reflect actions opposite to those of the acute effects of opioids. Withdrawal from a drug of abuse induces symptoms of negative affect such as dysphoria, depression, irritability, and anxiety; dysregulation of the SEEKING systems involves some of the very same neurochemical pathways implicated in the drug's acute reinforcing effects, but in this case they represent an opponent process (Koob & Le Moal, 2001, 2008). For depression, it has been demonstrated, that modulation of activity of a substructure of the SEEKING system (the nucleus accumbens) may modulate neural activity in other emotion and motivation centers of the brain. Indeed, bilateral stimulation of the nucleus accumbens results in acute anti-anhedonic and antidysphoric effects (Schlaepfer et al., 2008) and longer-term antidepressant effects in extremely treatment-resistant patients suffering from major depression (Bewernick et al., 2010).

In their article, Wright and Panksepp posit several hypotheses that, given today's level of methodological refinement, are testable. Indeed, during the development of hypotheses for a new understanding of depression and its therapy with deep-brain stimulation (DBS) in very treatment-resistant patients, the analysis of experimental DBS targets that have been used to date (nucleus accumbens septi, subgenual cingulate gyrus) with modern sophisticated imaging and electric-field modeling techniques (among others, diffusion tensor-imaging-based tractography) led to the discovery by our group (Coenen, Panksepp, Hurwitz, Urbach, & Mädler, in press) that a structure that has long been associated with euphoric drive and anticipation of reward (appetitive motivation), and not so much reward itself, might be an important protagonist that probably can play a key role in the treatment of major depression. This structure—the medial forebrain bundle (MFB)—was stimulated by our group in an experimental setting for the treatment of very treatment-resistant depressive patients in a study under the prerequisites of a local ethics committee permission in $n = 7$ patients.

As a concept it was proposed that a dysbalance between two dichotomic systems—the SEEKING system, promoting positive euphoric drive and anticipation of reward, and the PANIC system, promoting the feeling of separation distress—plays a major role in the clinical syndrome of depression (Coenen et al., 2011). Very likely, the two systems that promote these opposite affects can be described, using the diffusion tensor imaging–FT (magnetic resonance fiber tracking) technique (Coenen, Panksepp, Hurwitz, Urbach, & Mädler, in press). With the help of the same technique, the area of the most densely packed MFB fibers was aimed for, implanted stereotactically and effectively stimulated. The acute effects that were seen intraoperatively with unilateral high-frequency stimulation are very reminiscent of acute activation of the SEEKING system: All 7 patients showed clear effects of increased appetitive motivation. All patients showed explorative behavior. They visually searched the room instantaneously after initiation of test stimulation. They reported motivational behavior such as an increased interest in travel or other activities they would not have performed for years. In our understanding, these are clear signs of what is best explained as "SEEKING behavior." However, none of the patients reported any sign of hypomania/mania or altered mood, indicating that acute stimulation induces anticipation of reward and not reward itself, as has been defined in Panksepp's description of the action of the SEEKING system (euphoric drive—Panksepp, 1998).

In summary, we believe that the article by Wright & Panksepp has the potential to be viewed as one of the most important contributions to thoughts on psychiatry for some time to come, provided that some of its basic tenets are substantiated by future research. At the very least, it provides a convincing logical and in many points testable framework elucidating the inner workings of the "electrical appliances with the main unit so sealed in that it cannot be got at . . .," insights that will potentially lead to therapeutic approaches for humans suffering from the most horrible disorders there are.

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Reconsidering the Neuroevolutionary Framework of the SEEKING System: Emphasizing Context Instead of Positivity

Commentary by Todd B. Kashdan (Fairfax, VA)

Wright & Panksepp make an important contribution by presenting their neuroevolutionary model of the SEEKING system. This system allows for the eager anticipation and discovery of various resources needed for survival, propagation, and personal growth (Panksepp, 2011; Panksepp & Moskal, 2008). In this article, attention is drawn to salient characteristics of the SEEKING system that have been left out of this theoretical account. Instead of focusing on the mental content inherent to the SEEKING system (emotions, sensations), I argue for the need to delineate contextual factors that influence the activation of this system. Furthermore, I comment on the problems of bypassing the uniqueness of human beings for a framework of SEEKING that is relevant for all mammalian species. Finally, I revisit the claim that the SEEKING system entails primal positive emotions by detailing the distress or pain that often occurs during meaning-making efforts. A functional contextual approach, which addresses when the SEEKING system helps an individual make progress toward personally meaningful goals and when this system disrupts these desired efforts, may be more promising for science and clinical work.

Keywords: curiosity; SEEKING; functional contextualism; distress tolerance

Human beings possess an innate desire to find meaning that promotes the creation of knowledge, competence, and personal growth (Baumeister, 1991; Frankl, 1963). To find or create meaning, human beings require the proper neurobehavioral mechanisms. Meaning-making would come to a halt without the ability to conjure up ideas about what the future might hold, be curious about one's surroundings and inner world (thoughts, feelings, memories), and explore these events (Kashdan & McKnight, 2010; McKnight & Kashdan, 2009).

I agree with Jason Wright and Jaak Panksepp that something akin to a SEEKING system, which subsumes each of these behaviors, would be of great evolutionary advantage in terms of survival and propagation. The aim of this commentary is to increase the precision of what is meant by a seeking or exploratory system. Instead of referring to seeking as a "primal positive emotional system" (Panksepp, 2005, 2011), I argue for a functional contextual approach. Simply expressed, of greatest clinical relevance is understanding when the SEEKING system helps an individual make progress toward personally meaningful goals and when this system disrupts these desired efforts.

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Todd B. Kashdan was funded by the Center for Consciousness and Transformation at George Mason University.

Mental content vs. context

Psychology has made great strides in developing evidence-based interventions for a wide range of disorders including anxiety disorders, mood disorders, and eating disorders (Abramowitz, Deacon, & Whiteside, 2011; Barlow, 2008). Most of these treatments are based on the assumption that human suffering can be reduced by directly changing the form and/or frequency of negative cognitions (e.g., Dobson & Dozios, 2010). Based on this model, therapists attempt to understand and influence how people interpret the events in their lives. When a therapist believes that a client's set of assumptions about him/herself, the world, and his/her future is "distorted," the therapist in turn is given assistance in how to challenge and alter mental content (e.g., Beck, Rush, Shaw, & Emery, 1979). Common techniques include assisting clients in (1) psychoeducation about the causes of suffering; (2) monitoring of negative events, beliefs about events, and emotional reactions to them; (3) restructuring thoughts to be less negative and more grounded in reality (e.g., accurate judgment of the probability of flubbing a public speech and the costs of such a failure); (4) gradual exposure to feared stimuli, with the aim of reducing emotional reactivity; and (5) scheduling activities that increase reinforcement and/or engagement with personally meaningful goals.

Meta-analyses suggest that cognitive-behavioral therapy procedures, particularly exposure-based approaches, generally outperform wait-list and placebo groups, as well as other psychosocial and pharmacological interventions (Butler, Chapman, Forman, &

Beck, 2006). A closer examination suggests that approximately 40–60% of clients at posttreatment can be described as being at a level of functioning that is significantly closer to that of healthy individuals than to that of those suffering from disorder (Jacobson, Follette, & Revenstorf, 1984). However, this means that the other 40–60% of clients are showing change that cannot be described as practically or clinically significant. For these reasons, some researchers and clinicians challenge the assumption that altering mental content is the mechanism for improving the human condition (e.g., Hayes, 2004).

There is a lack of evidence that altering the balance of negative to positive cognitions is what mediates client improvement in therapy (Longmore & Worrell, 2007). From the perspective of functional contextualism, it is more useful to identify when emotions and beliefs interfere with progress toward personally meaningful goals *and to directly target that interference* rather than the emotions or beliefs themselves (Biglan & Hayes, 1996; Gifford & Hayes, 1999). Instead of focusing on the valence of emotions or reality basis of beliefs, therapists working from a functional contextual perspective assist clients in contacting their deepest, central values and assessing their own progress toward (and struggles with) these abstract life aims (Wilson & Sandoz, 2008).

Interventions have been designed to increase engagement in the ultimate concerns of an individual—behaving in a way that is consistent with his or her deepest, central values—regardless of the emotions or beliefs he or she may experience (Hayes, Strosahl, & Wilson, 1999, 2011). This is made possible through the development of four skills: (1) defusion: changing the role of unhelpful thoughts, beliefs, and memories such that they do not dominate attention or other behaviors when present; (2) acceptance: making room for painful feelings, urges, and sensations such that they can come and go without a struggle; (3) perspective-taking: shifting points of view among different times, situations, and persons in a way that broadens experience; and (4) present-moment awareness: being fully engaged with openness and curiosity as events unfold (Hayes, Strosahl, & Wilson, 2011).

As these skills develop, unwanted mental content is not treated as requiring alteration or avoidance. Instead, clients experience and respond to thoughts, feelings, sensations, and memories in new ways. When the internal struggle for more positive and less negative mental content is abandoned, efforts can shift to contacting central values and pursuing goals aligned with these values. For instance, instead of targeting a reduction in negative, delusional thoughts in a client with schizophrenia, the aim would be to reduce the impact of those thoughts and encourage values-consistent choices. Defusion, acceptance, perspective taking, and awareness skills promote flexible ways of being in the world such that meaningful goal-striving can occur even in the presence of pain.

Clarifying the nature of the SEEKING system

The SEEKING system, as defined by Panksepp and colleagues, overlaps with the capacity of an individual to maintain the quest for a satisfying, engaging, meaningful life despite the inevitability of pain. According to Wright & Panksepp, humans and other mammalian creatures "show increased interaction with and exploration of the environment when the SEEKING system is chemically or electrically aroused, and the psychological urge evoked is one of positive euphoria accompanied by increased engagement with all of the life-supporting 'affordances' of the world." In prior work, Panksepp (2011) has emphasized that the activation of this general-purpose, appetitive motivational system spontaneously leads individuals to experience highly aroused interest or curiosity. It is this psychological manifestation of SEEKING that I turn to, as it provides a more precise understanding of how (1) SEEKING is necessary for survival and personal growth and (2) SEEKING can serve as a backdoor route to fulfill a person's psychological, physical, and social needs when related systems such as FEAR are activated (Deci & Ryan, 2000).

One of the difficulties of understanding the SEEKING system is that much of the supporting evidence stems from experimental work with laboratory mammals that have simpler minds than humans (see Wright & Panksepp). Humans have a unique ability to contact and learn from contingencies that are not immediately present (Hayes, Barnes-Holmes, & Roche, 2001). The ability to imagine scenarios that involve happiness, suffering, and mortality changes the function of the SEEKING system. For instance, it is useful with humans to distinguish between two aspects of curiosity,[1] which is the motivational state inherent to the SEEKING system (Panksepp, 2011; Panksepp & Moskal, 2008; Tomkins, 1962).

[1] For historical reasons, certain research traditions favor *curiosity* (e.g., behaviorists, personality science), whereas others favor *interest* (e.g., fields of education and affective science). Similarly, curiosity is often used in reference to stable individual differences but interest in reference to momentary states. The underlying appetitive, motivational state is the same (for a review, see Silvia, 2006, chap. 9); thus, I use them as synonyms in this article.

Bottom-up curiosity is driven by immediate data and a history of reinforcement of exploratory behavior. A novel, complex, unexpected, or uncertain event results in a sense of wonder and a desire to explore it. For instance, your romantic partner comes home from their law-firm position dressed as a centaur playing the lyre (and it isn't Halloween). Nobody has to remind you to be intrigued, orient attention, and probe further—the experience of curiosity will be rapid and reflexive. Your curiosity is comparable to curiosity elicited in a laboratory rat when the light changes color or a new hopper is installed. Introduction of a novel stimulus elicits curiosity and evokes exploratory behavior. This direct-contingency account is consistent with how individuals typically define curiosity (Loewenstein, 1994; Silvia & Kashdan, 2009; Spielberger & Starr, 1994). Likewise, the SEEKING system has been defined as being activated by novel stimulation.

What is often forgotten, especially when the scope of the analysis extends beyond human beings, is that curiosity can also be wielded intentionally in a *top-down* manner. Top-down curiosity involves purposely holding a state of awareness and openness in any given moment. For instance, when sitting down for dinner with the family, instead of resorting to the trite and contrived everyday conversation, you might pay careful attention to the subtle cues of what other people are feeling, what might be on their minds, and how you are being received. You intentionally explore what is unique in this particular moment without expecting or pursuing any specific answer or result beyond the experience itself. Unlike the lab animal, your exploration may persist even when you contact pain. Your search for the unfamiliar in the seemingly familiar is part of a larger behavioral pattern that is reinforced by engagement in the search itself. This is a class of behavior that is uniquely human and distinctive of meaning-based living (Wilson & DuFrene, 2009; Wilson, Sandoz, Kitchens, & Roberts, 2010).

It is this form of top-down curiosity that can lead to an attitudinal transformation toward people and situations that are encountered regularly and without introspection (Kashdan, 2009). For instance, there is evidence that curiosity leads to less defensive reactions to mortality salience cues (Kashdan, Afram, Brown, Birnbeck, & Drvoshanov, 2011) and less aggression in response to provocation (Kashdan et al., in press). By separating the SEEKING system into bottom-up and top-down functions, researchers and practitioners can gain greater clarity about the nature of curiosity and exploration, as well as clinical strategies that can be undertaken to increase effective goal-related behavior and a subsequent meaningful life.

Revisiting the positive emotional core of SEEKING

I applaud Wright & Panksepp for describing suffering associated with overactivation of the SEEKING system, including mania, obsession, and a wide range of addictive behaviors. Despite recognition of these tipping points (of too much SEEKING), I believe that the authors overstate empirical support for the coupling between the SEEKING system and positive emotional states (enthusiasm, euphoria, PLAY). I believe this could be extended and elaborated. For humans, curiosity and exploration may be inevitably associated with painful consequences. For one, novelty itself is challenging. We seek experiences that are consistent with our narratives about ourselves, others, and the world, and we experience a level of distress when they must be revised (Loevinger, 1987; Piaget, 1952). In addition, curiosity and exploration put us at increased risk for contacting both rewarding and aversive consequences (Kashdan & Rottenberg, 2010; Loewenstein, 1994). We humans can find pain inside the loveliest of moments. It may be that the same system that allows for new and meaningful experiences in routine or familiar situations also allows for the stressful transitions that are often required for personal growth to occur.

In fact, the pursuit of meaning may put us at particular risk for pain. Following loss and adversity, the meaning-making process often requires periods of distress (Joseph & Linley, 2006). Similarly, questioning of beliefs, identity, or personal goals is rarely described as a positive emotional experience. Contacting values may necessarily mean contacting our own vulnerabilities (Wilson & Sandoz, 2008). The ability to tolerate the inherent distress of exploring new, complex, or challenging events might even be a required attribute for the SEEKING system to move from an exploratory urge to effective action (Silvia, 2006, 2008).

Overall, I believe the evidence is less than compelling for describing the SEEKING system as a primal positive emotional system. Moreover, the use of a positive emotional descriptor can lead scientists and practitioners to overlook component parts and contextual influences of the SEEKING system.

New insights on the benefits of seeking

From an evolutionary perspective, the acquisition of new experiences and knowledge is essential for survival. But to benefit from these experiences, human beings and other animals cannot be in a perpetual state of novelty seeking. Equal attention must be granted to synthesizing and making sense of incoming information. These incubation periods, which are essential to personal growth, require the deactivation of the SEEKING system. In a similar vein, individuals need to be able to cope with boredom, which is often a springboard to learning new information and competencies.

As an alternative to cataloging clinical disorders that reflect an overactive (e.g., substance-use disorders) or underactive (e.g., major depressive disorder) SEEKING system, I believe a more complete and beneficial analysis would result from an account of divergent functions of the SEEKING system as they relate to specific contexts. Despite decades of research on curiosity, seeking, and exploring, more studies are needed that address these variants of dynamic change over time instead of simplistic assessments of active/inactive brain systems. This includes careful manipulation of the contexts that might result in functional changes in SEEKING. Consider two examples: Under what conditions does activation of the SEEKING system result in contact with painful emotions? How can these conditions be manipulated to facilitate curious exploration despite contact with pain?

Functional contextualism emphasizes the importance of analyzing behavior in terms of its function in specific contexts (Pepper, 1942). Applications of functional contextualism in human cognition suggest that human beings are relatively ineffective at altering the mind directly with psychological strategies (Hayes, Barnes-Holmes, & Roche, 2001). Applications of functional contextualism in psychotherapy suggest that a more efficacious strategy is to manipulate context in order to change the function of the mind so that individuals can behave in ways that are aligned with deeply held values regardless of the contents of consciousness (Hayes, Strosahl, & Wilson, 2011). When the SEEKING system enables these value-congruent behaviors, the system can be viewed as helpful; when the SEEKING system interferes with these behaviors, the system can be viewed as unhelpful. Clarifying the contexts when the SEEKING system facilitates and thwarts value-congruent behavior will serve to increase the precision of the basic science and broaden the scope of subsequent clinical applications.

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The Seeking System and Freud's Dual-Drive Theory Today

Commentary by Otto F. Kernberg (White Plains, NY)

This commentary on Wright & Panksepp explores the implications of the functions of the SEEKING system for the psychoanalytic theory of aggression and libido as basic drives. It proposes that, in contrast to the temptation to relate the SEEKING system to Freud's libido drive, it should be understood that the SEEKING system is a basic drive that couples with both rewarding and aversive affective systems, and that Freud's dual-drive system may better be understood as a "tertiary" motivational system—that is, a hierarchically supraordinate integration, respectively, of positive- and negative-affect systems. Libido and aggression, thus conceived, would operate as an ultimate system at a symbolic, experiential level, in contrast to the organization of basic affective drives at a neurobiological level. The need to explore motivational systems both at a neurobiological level and at a derived, symbolic level is illustrated with the examples of addiction and depression, referred to in Wright & Panksepp's article.

Keywords: drives; affect systems; motivation; desire; emergent monism; libido; aggression; object relations

Jason Wright and Jaak Panksepp's path-breaking article conveys convincing evidence for the consideration of the SEEKING system as a basic drive—a "primary-process" affective system that promotes psychomotor eagerness to obtain resources that generate pleasure and eliminate disasters, provides a euphoric anticipatory excitement, and links up with other, specific drives, particularly the rewarding affective systems of LUST, CARING, and PLAY, but also, if organismic

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priorities warrant it, with the aversive affective systems of FEAR and RAGE. It is a foundational system for mental processes and intentionality, with a specific mesocortical limbic pathway spelled out in detail in the Target Article. The SEEKING system generates an exploratory euphoria, directed toward objects in the external environment, and reinforces the respectively dominant affective systems while promoting "secondary processes" of affective learning and memory.

The pathology of the SEEKING system affects the psychobiological functioning of the organism and has significant implications for human psychopathology. Hyperactivity of the SEEKING system may be reflected in addictive syndromes as well as in the hypertrophic search for and attribution of meaning in schizophrenia, while its inhibition is an important feature of the total loss of pleasure in the activation of reward systems in depression.

From a broader perspective, the exploration of the SEEKING system continues the important work that Panksepp and his coworkers are carrying out at the challenging border of mind/brain phenomena, the generation—on the basis of neuronal network systems—of phenomenal consciousness and intentionality. Insofar as the functions of the SEEKING system, and its relations with the functions of specific affective systems (LUST, CARING, PANIC/GRIEF, PLAY, RAGE, FEAR) cover the basic psychological motivational systems, they have fundamental relevance for the psychoanalytic theory of drives and their expression as conscious, and, particularly, unconscious desire. Here, a first, semantic problem emerges: how does one define drives, in relation to motivation and desire?

Wright & Panksepp define drives as neurobiological systems that include greater control centers and regulatory mechanisms. Motivation, in contrast, is defined as the expression of experiential and behavioral organization that arises from the coupling of homeostatic drives with the SEEKING system: motivation reflects specific, goal-oriented behavior. From a psychoanalytic viewpoint, motivation would correspond to desire—that is, specific unconscious wishes and fears that reflect the underlying dual drives, of aggression and libido, postulated by psychoanalytic theory.

It would be tempting to consider the SEEKING system as corresponding broadly to the Freudian concept of libido. From a strictly conceptual perspective, however, if Freud's dual-drive theory is taken seriously, the very fact that the SEEKING system not only couples with positive reward systems but also with RAGE and FEAR—evidently affective systems related to aggression—reflects its nonspecific nature, in contrast to the libido-aggressive antimony. One could argue however, that the SEEKING system, in coupling with RAGE and FEAR, reflects precisely the instinctual fusion of libido and aggression also conceived in Freudian theory.

From Wright & Panksepp's viewpoint, I would argue that the Freudian theory of libido and aggression (or, in the case of the latter, the "death drive", or the "negative" in André Green's formulation, 1993) would be situated hierarchically at a "tertiary" level in Panksepp's formulation. For Panksepp, at a "primary-process" level, drives are activated under strictly genetic control, with sequential generating, coupling, and enacting basic affective urges; at a "secondary-process" level, learning processes and memory intervene to generate more focused goals; while on a "tertiary-process" level cultural and personal meanings are involved in the activation of drive derivated motivational enactments and decision making. Freud, in describing the oral, anal, and genital developmental phases of libido—that is, individual libidinal development as one of the fundamental drives—is implying complex influences of the interaction of baby and child with its object-related environment, even if these are, of course, profoundly unconscious processes, signaled by the development of unconscious fantasy that plays out the relationship between libido and aggression.

It is true, at the same time, that Freud considered the dual-drive theory as reflecting the most profound level of the demands the body makes on the psyche. But Freud, naturally, at a time of only rudimentary knowledge of neurobiology, could not integrate modern affect theory and its neurobiological basis in his theoretical formulations: he placed the origin of libido at the erogenous zones! He could not bridge the extraordinary gap between genetic determinations of both homeostatic and object-related drive systems, on the one hand, and the role of affect systems in the organization of motivational experiential behavior from birth on, on the other. I have proposed that affect systems are the primary, biological motivational systems and that the developmental integration of affects and internalized object relations leads, on the one hand, to the development of the tripartite structure (ego, superego, and id) and, on the other, to the coalescence of positive affective systems into a hierarchically supraordinate integration as libido, and the corresponding hierarchically supraordinate integration of negative affect systems into aggression. The libidinal drive would coalesce on the basis of the combined lust, attachment, panic/grief, and playful bonding systems, and the aggressive drive on the basis of the combined rage, fear, and disgust systems. Libido and aggression would represent a complex organization, at a symbolic level of experiential motivational behavior, that is manifest clinically in the expression of positively and negatively invested focused motivations and conflicts, organizing, one might say, psychic functioning at that symbolic level in a similar fashion to the integrating organization of secondary affect systems under the influence of the primary-process SEEKING system at a neurobiological level.

In short, in parallel fashion to the complex integration of basic neurobiological functions, such as each separate affect system, into more complex affective organizations, a similar organization at a purely symbolic level of organization of phenomenal experiential developments leads to the hierarchically supraordinate integration of all positive intrapsychic as well as object-related experiences, on the one hand, resulting in libido as the life and pleasure organizing "drive"—or rather, motivational system—and, on the other, "aggression" as the corresponding, negative, destructive, and self-destructive motivational system on the basis of all aggressive and self-aggressive internalized object relations. I also have proposed that the concept of "death drive" be retained for the pathological predominance in some clinical conditions of negative internalized object relations that may lead to an overwhelming dominance of self-destructive motivation.

Thus, an emerging monistic viewpoint that conceives of a hierarchical organization of neurobiological subsystems into affect systems, and of these into supraordinate systems at a cognitive–affective level, gives rise to subjective and intentional experiences. These experiences, in turn, become organized into complex symbolic and emotional systems. Finally, the hierarchically supraordinate dual-drive system of Freudian theory—integrating, respectively, positive and negative affect systems—involves the interaction, at various levels, with the underlying neurobiological systems and thus would seem to do justice to the challenge of relating biological drive systems with the dual-drive system proposed in psychoanalytic theory.

I shall try to illustrate this proposed formulation with the case of the two clinical conditions referred to in Wright & Panksepp's paper: addiction and depression. In the case of addiction, a hypertrophic function of the SEEKING system, coupled with the learned search for sensuous pleasure derived from a particular drug, may be combined with a severe deterioration of object relations related to a narcissistic personality structure. The corresponding devaluation of others, the pursuit of sexual relations as a defense against unconscious envy, and a replacement of the deteriorating pleasures of erotic love with the dependency on drugs would imply a self-destructive mutual reinforcement of a hyperfunctioning SEEKING system and a defensive character constellation reflecting the unconscious dynamics of envy and devaluation. Regarding the development of a major depression, the genetic disposition to the hyperactivity of the PANIC/FEAR system activated by the experience of abandonment may be interacting with an abnormally strict and autopunitive superego, in turn a consequence of the internalization of sadistic and prohibitive parental images, leading to an extreme internalized abandonment by pathological guilt findings. Clinically, such combined etiological features are not uncommon. Thus, direct genetic, primary and secondary processes and experiential pressures stemming from intrapsychic structures and complex symbolic organizations may influence each other.

Wright & Panksepp's fundamental contribution to the primary-process SEEKING system signifies an important advance in our knowledge and understanding of the organization of basic neuroaffective systems that constitute the ultimate basis for the development of motivational–intentional systems at the level of unconscious and conscious psychological processes. Freud's conclusion that libido and aggression were the ultimate underlying drives determining unconscious conflict and the organization of the tripartite model was, I believe, a revolutionary advance in the understanding of the development of the normal personality as well as of psychopathology. And Freud, of course, developed the fundamental basis for our understanding of the relation between drive-derived motivations and the internalization of object relations from birth on. But he could not foresee that the erroneous genetic assumptions regarding the origin of libido—and his lack of detailed hypotheses about the genetic origin of aggression—were the consequence of the unavailability, at his time, of the fundamental bridge that primary and secondary affect systems represent in the still mysterious interphase of bodily and mental functioning. Wright & Panksepp's present article illuminates and provides advances in that territory.

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Are Freud's "Erogenous Zones" Sources or Objects of Libidinal Drive?

Commentary by Mark Solms (Cape Town)

Wright & Panksepp's "SEEKING" closely resembles Freud's "libido". SEEKING is unconditioned pleasure-seeking; it yields pleasure for its own sake. This is described as *appetitive* pleasure. SEEKING is stimulated by vital needs. Its biological purpose is to interest us in external objects, some of which deliver *other* forms of pleasure. These include consummatory pleasures, and there are a great variety of them (genital orgasm being one). The coupling of SEEKING with consummatory objects is a major task of development. Where Freud spoke of "sources," "aims," and "objects" of libido, Wright & Panksepp speak of "generating," "enacting," and "coupling" of SEEKING. Homeostatic imbalances in vital needs are the sources of SEEKING. On this view, stimulation of the mucous membranes of the oral, anal, and clitoral (phallic) regions are appetitive—not consummatory—acts. In this light, the classical erogenous zones should be described as "objects" rather than "sources" of libidinal drive.

Keywords: libido; SEEKING; dopamine; erogenous zones; Freud; drive

It is gratifying for me, as one of the Founding Editors of this journal who first invited Jaak Panksepp to engage in a dialogue with psychoanalysis in its inaugural issue (Solms & Nersessian, 1999), to read him and Jason Wright saying here that neuropsychoanalysis "represents a new epoch of modern BrainMind science" and that it is "uniquely situated to provide a useful synthesis of the many disciplines that have been seeking a realistic confrontation with the nature of both brain and mind." In this regard, their emphasis on the "vertical" (hierarchical) organization of human motivation, whereby primary instincts are perforce represented, elaborated, and symbolized at higher cognitive levels, is especially important. It breathes new life into the very notion of "depth psychology." It is also gratifying to see how far we have come in terms of the detailed issues we are now almost matter-of-factly discussing and debating.

This does not mean that high levels of agreement have yet been achieved in all areas; Wright & Panksepp's final section, "General Clinical Applications and Perspectives," amply demonstrates that. But the theoretical position set out in their article, regarding the nature and function of what they call the SEEKING system, is deeply resonant with some of Freud's fundamental hypotheses. This applies especially to his formulation of the libidinal drive, which was surely one of his most fundamental concepts. More important than the resonances, however, is the way in which the SEEKING concept diverges from, and thereby potentially develops, Freud's original conception.

To begin with the very basics: Freud (1905) came to the view, apparently on clinical grounds, that the human mind was possessed of a drive to seek pleasure in and of itself. He termed this drive "libidinal," saying that libido was the appetitive dimension of sexuality—analogous to hunger in relation to nutrition. He explicitly stated that this Latinate term was preferable to the ordinary German word *Lust* for the reason that "*Lust*" denotes both appetitive and consummatory dimensions of pleasure. From the start, therefore, Freud conceived of libido as an appetitive drive. It was synonymous with "desire."

In describing libido as the appetitive dimension of sexuality, Freud drew attention to the important theoretical observation that there was no obvious (self-preservative) motive for us to engage in reproductive behavior, other than the large yield of pleasure attaching to it. It is this pleasurable yield that is rewarding to the individual, rather than the act of copulation itself. Freud concluded that this was why (biologically speaking) erotic pleasure and copulation are so tightly linked; without the pleasure we simply would not reproduce. Next, Freud observed that voluptuous sensations analogous to those attaching to reproductive behavior also occur in other spheres of life. In fact, once purely hedonic motivation is recognized, it is obvious that pointless (but pleasurable) behaviors are everywhere to be seen.

These facts, combined with commonplace observations of cases in which the sexual act is not experienced as pleasurable (frigidity) whereas other behaviors are, led Freud to the view that pleasure and copulation were not intrinsically linked; to bring them into conjunction with each other was a developmental achievement. This had many psychological implications, which Freud spent much of his scientific life working out, but the one that concerns us here is the core fact that the "libidinal" drive is an independent mental force, not

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intrinsically bound to any particular object or aim—its objects and aims are *learned*.

I hope it will be evident to readers why I believe it is this self-same force that Olds and Milner rediscovered in 1954, when they observed apparently pointless self-stimulation behaviors in appropriately implanted laboratory rats. Freud's inherently objectless libidinal drive is, in a word, identical with the Olds–Milner "self-stimulation system," which Panksepp now calls the SEEKING system. Its rediscovery in the form of an anatomical circuit within the mammalian brain not only counts as independent confirmation of Freud's original discovery, it also presents massive opportunities to subject the concept of libido to rigorous experimental scrutiny. This is what is so exciting for psychoanalysis about the facts that Wright & Panksepp summarize in their review.

What new light, then, does their review cast on the nature and function of the libidinal drive as Freud conceived it?

I have already drawn attention to the fact that the unconditioned SEEKING system, like Freud's libidinal drive, is devoid of intrinsic objects and aims. Wright & Panksepp review the relevant facts under the headings of what they call "coupling" and (to a lesser extent) "enacting," respectively. There is much in these parts of their review that is novel and interesting, but of more fundamental importance I believe is the data they bring together under the heading of "generating" SEEKING activity. This heading is equivalent to what Freud called the *sources* (as opposed to *objects* ["coupling"] and *aims* ["enacting"]) of the libidinal drive.

Foremost among the new facts are those that prompted Wright & Panksepp to conclude that psychoanalysts use the term "drive" too loosely:

> The concept of "drive," at least in neuroscience/physiology has a more specific meaning—namely, states of imbalance in various bodily regulations, instantiated in such processes as hunger and thirst, which reflect actual activity of particular subcortical, especially hypothalamic, neural processes (Panksepp, 1981). Thus, each bodily drive state has a distinct neural distribution with specific homeostatic regulatory functions, which exert some type of control over SEEKING urges (Figure 4).

In the figure they refer to, all bodily needs (whether they be sexual, thermoregulatory, nutritional, etc.) are described as "homeostatic inputs into a generalized SEEKING system." In short, such inputs (which Wright & Panksepp call "drives") *generate* SEEKING activities; they are not SEEKING activities themselves. SEEKING activity invokes a higher-order concept than drive; SEEKING, for Wright & Panksepp, is better described as an "instinct" than a drive.[1] Freud would probably have described the "states of imbalance in various bodily regulations" that Wright & Panksepp call "drives" as *sources* of drive.

This is not merely a semantic point; it draws attention to the fact (which Freud himself eventually discovered on independent grounds) that self-preservative needs, no less than sexual ones, must activate libidinal interest before the organism is motivated to satisfy them in the world. There is no obvious motive for us to engage in any behavior at all (self-preservative no less than sexual) other than the yield of pleasure attaching to it. This conclusion led Freud (1920) to collapse his previous dichotomy between self-preservative and sexual drives into a unified concept called "Eros." What distinguished Eros from other motive forces in the mind was its tendency to *increase* the level of arousal and tension, which not only contradicted the law of entropy but also the associated "pleasure principle" that Freud had always considered the primary regulatory principle of the mind. This caused him all sorts of theoretical trouble, as pleasure (for Freud) was nothing but the conscious experience of reduced drive tension. Indeed, according to Freud, this is what consciousness was for; it informs the organism how well or badly it is doing in relation to its drive demands (Freud, 1911).

In fact, he had recognized this contradiction of his pleasure principle from the outset (Freud, 1905). As anyone would know from his or her own experience, the behaviors that normally precede the sexual act—generally known as "foreplay"—increase levels of arousal and tension in the mind, and yet they are experienced as pleasurable, so much so that one seeks to prolong them. Freud initially dealt with this problem by conceptualizing such (oral, anal, clitoral, etc.) "foreplay" activities as immature forms of sexual activity, which prepared the way for copulation—the mature sexual act. In other words, they constituted preliminary forms of pleasure that primed the mental apparatus for a full discharge of genital pleasure. Failures to subsume such activities into the preparatory phases of genital copulation constituted the class of psychopathology known as "perversion."

But this solution did not cover the problems introduced by Freud's broader conception of Eros, which now included self-preservative behaviors too, like eating and drinking, the anticipatory aspects of which seemed to display similar characteristics to foreplay. This ultimately led him to conclude that his direct

[1] This is ironic considering the widespread criticism of Strachey's translation of Freud's term *Trieb* as "instinct," which led to it being retranslated as "drive" in the new edition of Freud's complete works (Solms, in press).

equation of pleasure with reduced drive tension was mistaken:

> It cannot be doubted that there are pleasurable tensions and unpleasurable relaxations of tension. The state of sexual excitation is the most striking example of a pleasurable increase of stimulus of this sort, but it is certainly not the only one. Pleasure and unpleasure, therefore, cannot be referred to an increase or decrease of a quantity (which we describe as "tension due to stimulus"), although they obviously have a great deal to do with that factor. It appears that they depend, not on this quantitative factor, but on some characteristic of it which we can only describe as a qualitative one. If we were able to say what this qualitative characteristic is, we should be much further advanced in psychology. Perhaps it is the rhythm, the temporal sequence of changes, rises and falls in the quantity of stimulus. We do not know. [Freud 1924, p. 160]

The SEEKING concept, perhaps, and the general theoretical framework within which it is embedded, provides the long-sought solution to the problem of appetitive pleasure. Wright & Panksepp suggest on the basis of their review of the neuroscientific evidence that activation of the SEEKING system does not merely pave the way for LUSTful pleasure, it is intrinsically pleasurable in itself; the (appetitive) pleasure attaching to it is simply *a different quality of pleasure* from that attaching to the various (consummatory) acts it facilitates. Within the instinctual taxonomy of Panksepp (1998), there are multiple qualities of pleasure (and unpleasure), each attaching to a different instinctual, sensory, or homeostatic mechanism within the brain. In each different case, the specific affects motivate the organism to execute the appropriate behaviors (the instinctual actions that are "adequate" to the currently active biological situation). Indeed, the specific affect aroused by each situation is how the organism recognizes what the situation *means* biologically speaking. That, according to Wright & Panksepp, is what affects are for; they not only motivate us to do anything at all, they also motivate us to do the most appropriate thing in the circumstances, within a biological system of values.

The quality of the specific affective state aroused by SEEKING activity is variously described by Wright & Panksepp as "curiosity," "interest," "exploratory engagement," "optimistic expectation," "anticipatory excitement," and "eager euphoria":

> Our view is premised on the robust discovery that, to our knowledge, all mammals tested (including humans) show increased interaction with and exploration of the environment when the SEEKING system is chemically or electrically aroused, and the psychological urge evoked is one of positive euphoria accompanied by increased engagement with all of the life-supporting "affordances" of the world. People have reported increased planning, sexual arousal, energy, agitation, curiosity, increased general motivation, a pressure to act, and euphoric states when this system is stimulated.

The bottom line is that this type of feeling "rewards" SEEKING behavior in and of itself. "Exploratory engagement" just feels good. The pleasures attaching to the consummatory acts that such engagement facilitates are a different matter; they feel good too, but in qualitatively different ways. One quality of consummatory pleasure attaches to quenching hunger or thirst, another to finding warmth, another to copulating, etc. Panksepp groups the multiplicity of such consummatory pleasures under the headings of "homeostatic" and "sensory" affects. Freud's mistake, on this view, was to assume that there was only one fundamental type of pleasure, that only one underlying algorithm for pleasure existed.[2]

If Wright & Panksepp's view is correct, the question arises as to whether the oral, anal, and phallic pleasures that Freud classically conceptualized under the conjoined headings of "infantile sexuality," "foreplay," and "perversion" should be considered appetitive or consummatory pleasures (albeit autoerotic ones). Given what we now know about the endogenous sources of primary SEEKING arousal—and particularly considering the fact that the postpubertal sexual hormonal imbalances that constitute the sexual drive in Panksepp's homeostatic sense would only be corrected by *genital* sexual discharge (which means that the "generating" of SEEKING would only cease following genital orgasm)—speaks much for the view that Freud's "erogenous zones" were, in fact, consummatory *objects* rather than appetitive *sources* of libidinal drive. At most it seems that stimulation of these parts of the body might qualify as external "incentive" stimuli (see Figure 3 in the Target Article). This, in turn, would imply that the important role of these bodily zones in the libidinal economy is not innate but *learned*.[3] Given the central role they play in Freudian drive theory (where they are conceived of as *the* sources of libidinal drive), and given everything else that pivots around them in Freud's classical theory of psychosexual development,

[2] On the other hand, my reading of Panksepp (1998) suggests that he might consider the periaqueductal grey to be an equivalent common denominator, providing an affective "keynote" to all the qualities of hedonic tone generated by the various instinctual systems.

[3] In this respect, the fact that the erogenous zones are exteroceptive may be very important (see Solms & Panksepp, 2012).

the revisions suggested by SEEKING theory are quite radical for psychoanalysis.

I would therefore very much like to know what Wright & Panksepp think about these issues. In addressing them, I am aware they would also have to explain why Panksepp (1998) differentiated the sexual LUST system (in his taxonomy) from SEEKING on the one hand and from the broad classes of "homeostatic" and "sensory" affects on the other. The considerations outlined above make me wonder whether the LUST system might not be partly reducible to one or both of the latter two categories, and partly to a more general (not narrowly sexual) opioid-mediated "pleasure" or "liking" system. And might the testosterone-mediated aspect of it even be relegated to a "dominance" or "power/assertion" system?

I am aware that many psychoanalysts today do not think about such apparently arcane theoretical questions. They tend to disregard the theoretical history of their discipline and rely instead on a purely clinical form of theorizing. For my part, I do not see how the clinical theories that underpin such "dentistry of the mind" can be upheld if the basic assumptions upon which they are based (from which they were derived) are incorrect.

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Evolution of Emotionality: Lineal Heritability or Sui Generis Emergence?

Commentary by Daniel R. Wilson (Jacksonville, FL)

The Target Article traces the rise of neuromental substrates by which animal experience came to be under increasingly sophisticated means of hermeneutical interpretation. It also traces how this rise was largely in line with mammalian and even earlier animal heuristics. This contribution also would correct the behaviorist paradigm that Wright & Panksepp and others have argued ought to be deposed from its long reign. Their efforts have faced a variety of critical appraisals that are ultimately unpersuasive. They also address a persistent polemic commonly used to misconstrue and attack evolutionary psychology and the related straw-man that science must be synonymous with logical positivism and empirical reductionism. It is true that the ties that the Target Article have to psychoanalysis are more gestural than overt or substantive. But, really, there is no alternative—at least no alternative that is both logical and intuitive—to the naturalistic phylogeny invoked by the authors.

Keywords: evolution; phylogeny; hermeneutics; psychoanalysis; ethology; behaviorism

Jason Wright and Jaak Panksepp have, with their article, "An Evolutionary Framework to Understand Foraging, Wanting, and Desire: The Neuropsychology of the SEEKING System," made a significant contribution toward a more integrated formulation as to how human experience arises as a higher level of hermeneutics that are, nevertheless, largely in continuity with more general mammalian and even earlier animal heuristics.

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This contribution is no small feat that sustains progress toward a view of humanity that heeds the phylogenetic naturalistic roots of emotionality and rationality. This contribution also corrects a long-dominant behaviorist tradition.

Indeed, their article lives up to its main purpose, which, it states, is to provide a "coherent understanding of this emotional urge in generating *joie de vivre* as well as many psychiatrically relevant vicissitudes of excessive motivational 'drive'."

The authors' cardinal success is the close parsing of the varied continuities that thread through phylogenetic hierarchies by which human anticipatory hunger in even its most sublime forms can be seen to share ineluctable kinship with remarkably primitive neuromental foundations. A related success is the invocation of the phases of a material metaphor (e.g., water can be solid, liquid, or gaseous); though not an original invention, this metaphor aptly parries the thrusts of some critics who insist that there is little if any conservation of substance as consciousness is said to emerge—seemingly as did Athena from the head of Zeus—in a form and manner wholly unique and free of phylogenetic strands (Barrett et al., 2007).

Can only the blind admire the mysterious beauty of a Nature in which, for example, dopamine is first found as a primordial intracellular bioergic sensor of vital resources more than 1.5 billion years ago in the Archeozoic and even now affects the mentation of millions of mentally ill humans, notably including Nobel Laureate John Nash (Wilson, 2008)? Of course there is back- and rewiring of brain circuits, but why deny the profound common strands in the biology and spirit of life and consciousness?

More about their other salutary scientific points will follow in due course. Yet even with so much to the good in this contribution, a few miscues must be noted.

The resonance with psychoanalysis *qua* psychoanalysis is tenuous. This is certainly true not only of any mainstream psychoanalytic theory or practice in the Freudian train, but even of psychoanalysis washed, rinsed, and ironed in the bathing waters of affective neuroscience that may yet—finally and at long last—cleanse psychoanalysis of its dogmatism, hagiography, and echoic insularity. So, one might say, if the present work enjoys only fragile conceptual linkages with psychoanalysis, the problem lays more with the faults of the psychoanalytic academy than with the authors of this essay.

Or, to put it differently, the authors' themselves break things out beyond traditional zones of intellectual comfort. With these moieties of affective neuroscience they catalyze the reformation of what may be called *classical* psychoanalytic theory and practice. A more trenchant critic might claim that there is really very little of psychoanalysis in this contribution (putting on a psychoanalytic book cover does not a psychoanalytic book make!). In all, even if their article has much stronger affinities to biological psychiatry than to psychoanalysis—at least that psychoanalysis practiced by psychoanalysts—it a welcome effort to urge psychoanalysis onto the status of science that Freud himself very much wished it to eventually have. Still, it seems meant more to draw the attention of psychoanalysts to key concepts in evolutionary neuroscience than to draw psychoanalytic formulations into the Darwinian arena.

The promised clinical applications resonate well enough and are logical too, but neither thorough nor robust enough to provide more than gestural outlines. With respect to clinical applications, the authors—or someone, anyway—are well advised to consider how this knowledge might enhance psychiatric nosology. This is especially true as the official *Apparatchiki* of the American Psychiatric Association are promulgating the fifth edition of their *Diagnostic and Statistical Manual* (DSM–V) and, in so doing, continue to struggle in the muck and mire of an enterprise that conflates all manner of phenomenological hierarchies and putative causal explanations all in an intellectually agnostic *Weltanschauung*. Wright & Panksepp do not fully deliver on their stated aim to substantially advance clinical understanding. Still, they have painstakingly elaborated such implications in other papers (Panksepp, 1985, 1998, 2000, 2005). Moreover, their broad concepts are proximal enough for most of the consequential dots to readily be connected.

The deconstruction (to use that politically correct phrase so beloved of social constructivists and moribund others in the moldering left-wing halls of the academy) of the "reward system" phraseology is a strong stone upon which the authors rightfully step. That affective anticipation traces directly from simple learning (perhaps even before, in the "flocking" of bacteria, etc.) to sophisticated human mentation is a point well taken. So too, that both horizontal and vertical aspects of phylogenetic evolution must be taken together in order to form a more perfect sense of how emotions—and, eventually, rationality—exfoliate in evolutionary space and time. Likewise, the means by which the *generation* of motive behavioral force is *coupled* with hedonic arousal is, indeed, not only a "natural kind," but a natural kind that shrinks the gap between neurology and psychology and, for that matter, phenomenological hermeneutics.

One could not help but admire the historical *cum* courant references to Hess and RAGE (Hess, 1957), to Olds and Milner with their REWARD (Olds & Milner, 1954), or to Delgado and his PUNISHMENT (Delgado, Roberts, & Miller, 1954)—indeed, even Le Gros Clark from 1938! This is, after all, an era in which applicants for funding (in the U.S. federal health research system, at least) are not to reference any citation more than five years old!

In a similar vein to this, one also could only read the authors' defenestration of (crypto- ?) social constructivists and their ideas and wonder anew how it is that deeply instinctual biopatterns that move a creature from gorging on food to gnawing on incomestible objects can continue to be overlooked by some who, in myopic examination of leaves, miss whole trees and, indeed, forests of behavioral biology and sociophysiology.

Indeed, sensate response is not to be confused with internal states of euphoria. Indeed, appetites are not slaked at all but are, in fact, whetted. All as the authors cogently say.

Yet some misread if not this particular essay then its kin. One simple example (Barnett et al., 2007) would have it believed that cortical evanescence is so strong and complete that lower centers and prior evolutionary assemblages are, essentially, bypassed or rendered somehow irrelevant. By way of explication, it is implicated that in a work closely related to the present review, Panksepp's egregious error is evident with his reference to how in humans severe impairment is typically the sequellum of subcortical injury. This inarguable point of fact is meant to be cast down with the rebuttal observation that injuries to the cortex can and often do entail even greater impairment. Ergo, there is no continuity—Cortex *Über Alles* and, it would seem, as a *Novus ordo seclorum*!

But what is this purported alternative to the naturalism of Wright & Panksepp, really? The notion that the accumulated phylogenetic heritage subserving emotion (especially) and logic (more recently) is somehow obviated by new cross-sectional capacities that have little to no continuity to their evolutionary *Anlage* is, well, both emotionally unsatisfactory and logically implausible. All this is something of a rehash of the strong (even purposeful) misreadings with which Paul MacLean and his vast contributions were almost entirely dismissed for falsely attributed atavistic and recapitulatorical tendencies *à la* Ernst Haeckel (see Cory & Gardner, 2002).

Of course, new tiers of evolved capacities endow new ranges of affect and reason even as they modify—at the margins—assemblages that arose in earlier phylogeny. But Wright & Panksepp have it right. There is a deep ethology that limns modes of seeking, lust, rage, sadness, and, somewhat more recently, attachment and its envoy—play.

In closing, I must simply say it has ever seemed, to me at least, that people who cannot see the clear degrees of both sentience and sentiments in other animals simply are not—themselves—very sentient or sensitive.

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Response to Commentaries

Jaak Panksepp & Jason S. Wright

Keywords: SEEKING; desire; drive; motivation; consciousness; theory; behavior; depression; addiction; neuropsychoanalysis

ON SEEKING: A FOUNDATIONAL SOURCE OF AFFECTIVE. BEHAVIORAL, AND COGNITIVE ENTHUSIASM, VOLITION, AND WILL-POWER

We thank all commentators for their enthusiastic reception of the affective neuroscience view of "the brain reward system" and the broadening of implications for understanding this preeminently important emotional–motivational system in the governance of human and other animals' behaviors and psychological lives. We realize that in the short space available for our Target Article, many issues could not be developed. We are happy that so many chose to provide constructive and forward-looking perspectives to elaborate on themes that we did not.

A vastly multidimensional system such as SEEKING—a foundational ingredient in the efficient functioning of all of the other primary-process emotional systems—deserves book-length treatment, as more and more people become dissatisfied with the traditional behaviorism-derived conceptualization of this powerful rewarding system. It is clear that SEEKING figures heavily in the positive as well as negative outlooks of our daily lives. The system becomes depleted in depression, and it can all to easily be captivated by various addictions, from drugs to sex and even music.

We minimized our own clinical intuitions about this emotional system, leaving much room for discussion about issues that are barely on the radar of behavioral neuroscience, biological psychiatry, and perhaps certain psychotherapeutic schools of thought. We also avoided making excessive alignments with traditional psychoanalytic thought, for we believe that the blending of affective neuroscience and long-standing therapeutic traditions will, for the time being, have to be an excessively creative, generous, and risky enterprise. It might also generate confusions because of our own limited experience with human clinical issues and, even more, the vagaries of human languages, where the vernacular is a sure road to ambiguities that have long plagued fields in both psychological sciences and therapeutics. However, we note that our ideas, and identification of directly relevant affective measures in animals (e.g., 50-kHz ultrasonic vocalizations), have already yielded a potential new antidepressant (code named GLYX-13) that is currently in Phase 2 FDA approved clinical testing in the United States (see Burgdorf, Panksepp, & Moskal, 2011; Burgdorf et al., 2011; Moskal, Burgdorf, Kroes, Brudzynski, & Panksepp, 2011).

Thus, our major goal here is to focus on extending the fine thinking and work represented in these commentaries. In doing so, we hope to avoid the common academic posture of talking past each other, especially when arguments are based on different databases. This is especially easy when a system has to be discussed at many levels of organization—from primary to tertiary, in evolutionary and functional hierarchical terms.

Our responses to our commentators are in alphabetic order. This also approximately organizes our conversation from the most constructively "critical" reflections to the most enthusiastically "supportive" ones. So we are delighted to start with the most provocative of the several critical comments and thereby take an "unfair" part of our limited response-space to co-reflect with this most well-developed challenge to our overall views. It also helps to contextualize many of the issues historically.

Burghardt & Cooper's commentary: "Forgive us for our sins" since we all know so little about what we are hoping to understand

We most certainly agree with Gordon Burghardt and Matthew Cooper! The "missteps of desire" are common currency in *Homo sapiens,* wise and otherwise. Just look at the SEEKING-promoted incidence of drug addictions, food and sex cravings, not to mention gambling—scientific and otherwise—as well as the sins of everyday power-politics (in the academy, as well, of course, in the world at large). We were delighted, and not in the least chagrined, for Burghardt and Cooper (henceforth B&C) to contextualize their important points so clearly and succinctly, emulating our own attempt to steer evolutionary psychology onto more scientifically sound paths (Panksepp & Panksepp, 2000, 2001, both in a fine journal no longer published). Also, would confess our sins if we indulged a bit too lavishly in our goal to project thinking further into the scientifically and clinically unknown territories. In any event, B&C raise important and sound concerns with which we heartily agree. Their seven sins deserve much attention by all who seek to penetrate the foundations of mind. But short of writing a desperately needed book on these topics, let us share just a few modest reflections on their carefully selected seven.

The lack of a credible phylogenetic approach.

We agree that our shorthand approach to such Mind-Brain evolutionary problems was by no means sufficient for the task at hand and that rather than getting down to the nitty-gritty of endless details, emerging more rapidly from modern genetics and neuroscience than anyone can digest, we painted with a broad brush. But in psychobiology, that is still needed to get the general principles and useful didactics right. Despite endless cross-species differences, it is noteworthy that the brain is the only organ where one can truly see the marks of evolution within the internal structures. Although Paul MacLean surely knew his "triune brain" was a simplification, and in so doing often highlighted background principles as opposed to foreground details (although his 1990 opus was brimming with them), we would put in a few positive words for joint sins. All levels of brain organization are highly interpenetrant and interactive, with as many differences in details across species as are evident from a visual scan of their bodies.

We would submit that our conception of nested hierarchies as depicted here in Figure 1 (Northoff, Wiebking, Feinberg, & Panksepp, 2011; Panksepp, 2011a, 2011b, 2011c) may be a slight improvement on MacLean's triune vision. Aside from implying that

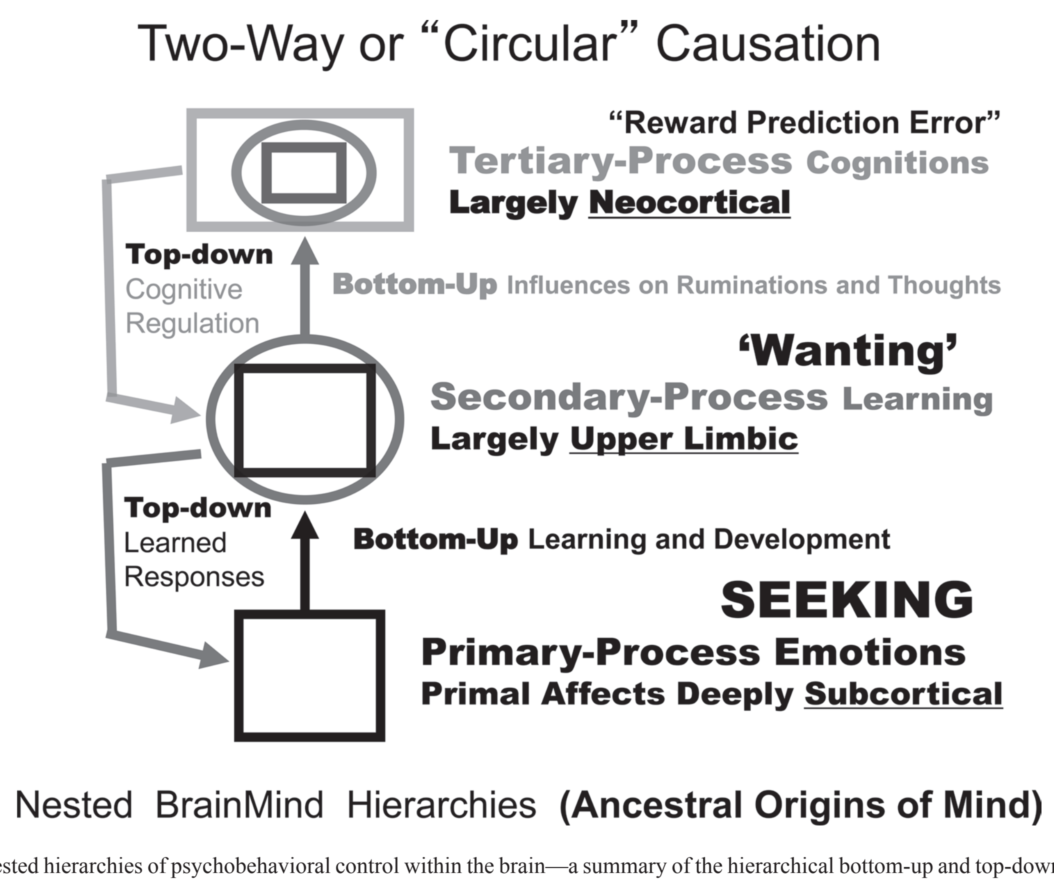

Figure 1. Nested hierarchies of psychobehavioral control within the brain—a summary of the hierarchical bottom-up and top-down (circular) causation that is proposed to operate in every primal emotional system of the brain. The schematic summarizes the hypothesis that in order for higher MindBrain functions to mature and function (via bottom-up control), they have to be integrated with the lower BrainMind functions, with primary processes being depicted as squares (SEEKING level), secondary-process learning as circles ("wanting" level of analysis), and tertiary processes ("reward prediction level of analysis,") by rectangles. This aims to convey the manner in which bottom-up evolution of nested hierarchies can integrate lower brain functions with higher brain functions to eventually exert top-down regulatory control. Bottom-up controls prevail in early-infancy and early-childhood development. Top-down control is optimized in adolescence and in especially adulthood.

parts of our human minds are "reptilian," the nested-hierarchy conceptualization explicitly addresses some critical dimension of the perennial problem in psychology and the neural analysis of behavior: All too many of the controversies in the area, especially discussions of emotions, arise from the failure of scientists to distinguish the various levels of analysis that they are pursuing:

1. Most psychological work is focused on neocortical refined-perception, thought, and other cognition-related tertiary processes.
2. Most behavioral neuroscience work illuminates learning and memory mechanisms, which are really secondary processes of great importance for us to have any foundational materials for tertiary-process mind functions.
3. Regrettably few biological psychologists or ethologists work at the primary-process neural level, trying to illuminate the foundational processes that Mother Nature built into our minds quite early in brain evolution.

Hence, the true nature of the unconditioned emotional stimuli and even more importantly the unconditioned *primary* emotional responses—a neural scaffolding whence affective feelings arise—has receive general neglect if not gentle derision (LeDoux, 2012). In fact, the foundational level of analysis deserves more attention than it has received in any of the approaches to psychologically relevant mammalian brain functions.

Evolutionary visions of the primary processes of the BrainMind are essential for psychologists, of all stripes, to construct better understanding of those evolved mind functions that undergird our various local areas of interests. This has yet to be successfully achieved by anyone—that is, to the point where it is generally accepted in neuroscience and psychology—but we keep trying (Panksepp & Biven, 2012). One would hope that neuroethologists would have achieved that a long time ago, but they could not. A clear vision simply cannot be had without brain research. And, regrettably, one needs a somewhat oversimplified *Bauplan* to make any coherent progress at all—namely, one that generates predictions that can be empirically evaluated. That was our goal.

We must reaffirm that the brain is the only organ of the body where one can see the layering of evolutionary solutions. For instance, the midline brain structures as well as those lower in the brain are evolutionarily more ancient than the more lateral and rostral structures. One cannot understand the roof of the mind without solid knowledge about the foundation. Without an appropriate neuroevolutionary analysis, an understanding of the whole cannot be had—ruthless empiricism, without guiding principles, will lead to a land of endless empirical rubble, the so-called "chaos in the brickyard," as opposed to a stately cathedral of knowledge (Forscher, 1963).

With an appreciation of a solid cross-mammalian (i.e., genetically controlled) subcortical neuromental foundation, laid down early in brain evolution (varying in many details across living species—see Weinberger, 2012), a principled understanding of the higher functions may be had. And as one ascends along the diverging branches in the evolution of species, differences will expand to such an extent (both in vertical as well as horizontal organizations) that guiding principles may too easily be abandoned, simply because of data overload. As Weinberger (2012) noted, there may be some scientific topics that are beyond our understanding.

Our position is that one needs a judicious balance between the recognition of general-purpose foundational principles and the massive diversification of details, which at a fine empirical level, permitted by modern technologies, can lead to that chaos of the brickyard where "Topics have no boundaries, and nobody agrees on anything" (as the description on Amazon of Weinberger's book noted). We full well recognize that B&C also realize this, and we are just seeking to be synergistic with their complaint. All readers can rest assured that we are on the same page for the need for "due diligence" on these issues, and we look forward to some scholar of the future who will write the hefty book that does justice to the topic. We fear that the data for a theoretically cogent neurofunctional level of analysis, highlighting general BrainMind principles, are currently too sparse for anything that might approximate a definitive treatise(our most recent effort being in Panksepp & Biven, 2012). But along with B&C, we see this as a holy grail of the field.

Use of an outmoded conception of reward and learning systems

These are very important issues, and ones we have partially addressed elsewhere (Alcaro & Panksepp, 2011; Ikemoto & Panksepp, 1999; Panksepp & Moskal, 2008). First, if the suggestion is that reverting to affective concepts to explain "reward" and "punishment" (as was evident in Thorndike's original version of the "Law of Effect," 1911) is on the wrong track, we disagree with B&C. We think that reinforcement does operate through currently neglected "Laws of Affect"—namely, an understanding of how affect-generating neural circuits promote learning and memory processes of the brain. In this monistic vision, raw affects *are* certain types of subcortical neural activities, rather than being *caused* by some kind of cognitive read-out in the cortex. Of course, abundant details remain to be gathered under this dual-aspect theoretical umbrella (Panksepp & Solms, 2012), and if B&C simply mean that, then we are on the same page. If they think instrumental learning can proceed effectively without brain affective-circuit functions, we suspect they are fundamentally wrong.

If their point is that most investigators do not believe in a unitary "reward system" where we see the "SEEKING" urge, we would simply note that the "reward system concept" is by no means dead in neuroscience and is still the most widely used concept, without much further conceptual analysis (even one of JP's postdocs has become accustomed to avoiding the SEEKING concept, because he says it is hard to publish papers using that concept). In some fields of neuroscience, such as feeding research, the use of the "reward system" concept to explain structures along the trajectory of the medial forebrain bundle has led to many fragmented and overly complicated explanations of feeding behavior. In this context, the "reward system" view inevitably seems to lead to the supposition that it mediates *consummatory rewards* (the pleasures of sensation), when in actuality these structures are involved in *appetitive reward*—an enthusiastic/euphoric psychologically and behaviorally forward-looking anticipatory–expectancy SEEKING response. This concept, as does "wanting," constitutes a complete reversal in understanding what this brain reward is all about!

But let us consider specifics: Kent Berridge's (1996) "wanting" concept is derivative of the SEEKING/EXPECTANCY one (Panksepp, 1981, 1982, 1998a), but Berridge has resisted crafting a fundamental connection to experienced affective processes, since in his estimation, as in LeDoux's (2012), that is scientifically unknowable. Accordingly, those approaches marginalize the affective experiences of other animals as being fundamentally unworkable. We do not agree, because the "reinforcing" effects, in simple learning situations, tell us that; for if they do not, we should be able to specify "rewards" in humans that are not affectively experienced. To do otherwise, is to put a major evolutionary barrier between us and the other animals, and our capacity for language and complex thinking suffices for that, if one really needs to believe in the uniqueness of human mammals.

Yes, the similarities of Berridge's views to ours are striking, but largely unacknowledged and undiscussed[1] by him, especially ever since "wanting" became a *meme* in psychology. In our estimation, "wanting" is truly a secondary-process concept that is tightly linked to learning and memory functions of the brain, without a clear recognition of primary-process emotional systems concepts, where affect is a critical evolutionary solution to certain problems of living/survival. By taking affect seriously, one can envision how such processes control learning. Without that, a meaningful synthesis is hard to achieve. In any event, Berridge probably "needs" an unconditional SEEKING emotion concept for his level of analysis, much more than we need the "wanting" concept for ours: Ours is a primary-process concept, and we see the excellent work of Berridge and LeDoux analyzing learning issues without clarifying the primary processes they will eventually need to understand. Berridge is also analyzing facial actions to intraoral pleasant and unpleasant stimuli in primary-process ways, but it remains unclear on what type of primary emotional processes his "wanting" concept is premised. It seems there is none, but there should be for conceptual coherence. In any event, the SEEKING/EXPECTANCY conception preceded the "wanting" one by a dozen years.

The critical point is that organismic urges to "seek" rewards is intrinsic to brain organization; their desire to "want" specific reward is a derived associative function. In other words, to "want" implies an object of "intent"—an animal actually desires *something* that has been already experienced. In contrast, primary-process SEEKING is initially objectless—it requires no learning. It is only at the secondary-process level of SEEKING that cravings for specific objects—a vast variety of distinct ones—arise. How could we ever hope to understand the workings of the BrainMind if we conceptually skip over the foundational, primary-process, level? Thus, while our work is directed more to the fundamental *unconditioned-response* aspects of brain emotional organization, Berridge's is more aligned with traditional sensory-perceptual-centered learning and memory functions, with no recognition that neural action-based emotional circuits generate raw affective experiences. It is important for someone to determine if his or her "taste plumes," based on

[1] About a dozen years ago, Fred Toates, Kent Berridge, and JP had an e-mail discussion about the differences in the "wanting" and SEEKING perspectives. The bottom line was that JP asked KB to suggest some differential predictions. He could not. JP could. It boils down to the fact that SEEKING is unabashedly a primary-process construct that incorporates some notion of an instinctual action apparatus, while "wanting" is largely a secondary-process concept, based largely on sensory-perceptual changes (e.g., "incentive salience") based on the study of learning functions.

correlative behavioral data, truly elaborate affective properties. A similar analysis can be made of Wolfram Schultz's (2006) "reward prediction error" concept, which in our estimation is a tertiary-process cognitive concept. Parenthetically, both Berridge and Schultz were invited to comment on the Target Article but declined.

How a synthesis between these three useful concepts can be forged seems straightforward to us—for example, SEEKING arousal provides the primal foundation for all varieties of addictive urges and, when "tuned down" by the harsher vicissitudes of life, is a source of the amotivational despair of depression (Panksepp & Watt, 2011; Watt & Panksepp, 2009). By focusing on emotional affective states, we may be in a better position to contribute to psychiatric drug development (Moskal et al., 2011; Panksepp, 2012). Our mode of thinking has led to new antidepressant molecular target concepts (Burgdorf, Kroes, Beinfeld, Panksepp, & Moskal, 2010; Burgdorf, Panksepp, & Moskal, 2011; Burgdorf et al., 2011) and novel "self-report" ways to study drug addictions in preclinical models (Browning et al., 2011; Panksepp, Knutson, & Burgdorf, 2002), with direct implications for related human clinical issues (Zellner, Watt, Solms, & Panksepp, 2011).

No comparable psychiatric relations have emerged from the "wanting" perspective, nor has the "reward prediction error" view been linked to practical clinical concerns. Berridge's model has also strongly impacted addiction research conceptually, perhaps because most investigators are working at secondary- and tertiary-process levels, while we are focused one evolutionary step below. Of course, for a complete understanding, all can work together synergistically (see Figure 1). However, without a sound *unconditional* evolutionary foundation, which we believe is provided by our view, we suspect that the secondary- and tertiary-process views are missing a key ingredient, although that is not adequately recognized by most investigators. Indeed, when we begin to recognize that the primary-process "id" is not deeply unconscious, but engenders various affective experiences, learning theory should be able to craft new "Laws of Affect" to replace the old behaviorist standby—Thorndike's "Law of Effect."

The need to acknowledge conceptual forerunners

We appreciate B&C highlighting these classic theoretical issues and articles, much ignored by neuroscientists. And there are others. We only neglected those antecedents because of space limitation. Of course, seeing the historical conceptual insights that anticipated (while some retarded) progressive neuroscientific endeavors is didactically useful. However, they rarely contributed much to the empirically based neuroscientific breakthroughs that have followed. Still, there is much intellectual utility to accurately acknowledge and situate such conceptual forerunners, and philosophical ones as well, in the intellectual landscape. Thus, we especially admire David Hume's and Baruch Spinoza's prescient views (*conatus* for instance), and Schopenhauer's discussion of "the will," not to omit Schneirla's (1959) appetitive motivation view, but those are better reserved for a full, book-length historical treatment, which this topic deserve.

Of course, before citing, we all need to read or reread the originals. The same should go for Freud's seminal approach to very similar issues (see Otto Kernberg's commentary). We have not yet integrated all these strands of thinking into our preclinical perspectives, but we thank B&C for refreshing our persistent wish to again dive into them. And we especially look forward to the forthcoming new and more accurate full translation of Freud's work by Mark Solms to get a more accurate understanding of what Freud actually said (as compared to Strachey's less than perfect effort). We also note that the commentaries by both Solms and Kernberg should be consulted to facilitate thinking about clinical connections and implications, which are of great interest for most readers of this journal.

Utilizing imprecise or misleading terminology

Yes, terminological issues haunt psychology. Indeed, there are no generally accepted verbal labels available for primary-process emotional functions of the brain. In psychology, the closest we have are "unconditioned stimuli" and "unconditioned responses," which are necessary for fundamental forms of learning. Thus, to maintain as much precision as possible, our primary-process terminology was selected as a specialized nomenclature for a well-studied and operationalized emotional system—namely, one must be able to evoke a characteristic emotional attitude, both with respect to actions and feelings, with electrical stimulation of distinct subcortical regions of the brain. The presence of phenomenal consciousness, as difficult to study as B&C maintain, is again operationalized in our view by the ability of such artificially aroused central states (i.e., brought under superb "stimulus control") to maintain "rewarding" and "punishing" behavioral effects (Panksepp, 1982, 1998a, 2011a; Panksepp & Biven, 2012). By this maneuver we have validated the affective tone of many simple emotional responses, such as vocalizations, as mediating negative and positive social affective states (e.g., Burgdorf, Wood, Kroes, Moskal, & Panksepp, 2007), while freezing and flight (e.g., Panksepp, 1990) and affective attack (Panksepp, 1971) mediate negative feelings.

This provides a useful guide—indeed, an empirically robust bridge—to studying human emotional feeling states (Panksepp, 1985) and also offers a vision of key psychologically meaningful endophenotypes for psychiatric science (Panksepp, 2006). How this relates to classical psychoanalytic concepts is a very debatable and interesting issue, already well represented in Kernberg's commentary, which highlights various possible relationships, setting the stage for richer interdisciplinary conversations.

Need more compelling justification for a hierarchy of drives

We again recognize the conceptual antecedents in psychology, but we continue to be surprised and puzzled by the fact there is no consistent use of "drives" in behavioral science and psychoanalysis. Across time and different schools of thought, "drive" has become one of those words that has expanded—pregnant with both ambiguous and excessive meanings—to such a degree that agreement will be hard to nail down. Just like so many other global historical concepts in psychology, no one is quite sure what others mean, because of the lack of generally accepted definitions.

Having scientifically been bred on regulatory physiology, we still use the concept of "drive" in the limited sense—measureable deviations from bodily homeostasis, especially in energy, thermal, and fluid-balance regulations. And we suspect that because of the history of conflicting terminologies, this delimited usage is most likely to be used consistently. Of course, we do not deny there are antecedents to our primary–tertiary terminology, with Freud having substantial priority (see Kernberg's commentary), but since our major interest has been in establishing the first neuroscience-based terminology for primary-process emotions, we offer the "solution" of using capitalization as a nomenclature for primary processes, otherwise confusion will prevail. Obviously these systems "motivate behavior," and some might even consider them "drives." We do not.

In line with our nomenclature convention, we thank B&C for consistently capitalizing SEEKING, but regret their lower-case usages for so many of the other emotional primes, which can lead to semantic and conceptual ambiguities; these were also evident in several other commentaries. Once one disregards the specialized nomenclature and reverts to the vernacular, one is no longer clearly talking about the primary level of control.

The evolutionary levels of brain controls, which developmentally operate in a bottom-up matter—namely, primary levels of control establish the possibility of secondary levels of control, etc.—is based on evidence from extensive decortication experiments (which highlight loss of tertiary processes). Likewise, damage to various basal ganglia (e.g., amygdala) more selectively disrupts learning abilities that arise from intermediate (basal-ganglia) levels of controls. Although neocortical damage severely disrupts cognitive processes, when those highest brain strata are eliminated, we still have animals and humans (as long as damage occurred in youth) (for summaries, see Merker, 2007 along with commentaries). In contrast, the top-down controls that emerge during BrainMind maturation have been a focus of modern human brain-imaging for well over a dozen years, but there is no assurance that those changes reflect feelings, unless one runs very good controls (e.g., Northoff et al., 2009).

The need to seriously accommodate individual differences

We most certainly agree with the need to understand the diverse temperamental traits that animals exhibit. We have developed new measures of such differential affective proclivities in humans (Davis & Panksepp, 2011; Davis, Panksepp, & Normansell, 2003). Selective breeding indicates that any of the primary-process traits can be strengthened or weakened, as the work of Scott and Fuller (1965) first demonstrated in dogs. We have been especially interested in behavior genetics, having bred for the first time happy and not-so-happy animals, using our behaviorally validated rodent vocal measures of brain affective-circuit dynamics (Burgdorf, Panksepp, Brudzynski, & Moskal, 2005; Panksepp, 2000). Our genetic analyzes of such systems have led to the development of potential new antidepressants (Burgdorf, Panksepp, & Moskal, 2011; Burgdorf et al., 2011) and other targets for psychiatric medicinal development (Burgdorf et al., 2010; Moskal et al., 2011).

We could have expanded on such issues, except for the limited space available, but concur completely with a need for more attention to such issues in behavioral neuroscience. Of course, the problem is in getting first-rate measures of affective differences in primary-process emotionality. We think this can be achieved with rigorous assays such as our standard tickling procedures and measures of positive affective (~50-kHz) and negative affective (~22-kHz) ultrasonic vocalizations in rats, which allowed us to affectively phenotype animals and to pursue selective breeding for "happy" and "dysphoric" animals (Burgdorf et al., 2005). And others have used these procedures effectively in randomly bred populations to effectively identify depression susceptibility (Mällo et al., 2007).

Need for treatment options actually derived from the framework proposed

Again, we thank B&C for focusing on a key issue in which we are intensely interested (e.g., Panksepp, 2004; Panksepp & Biven, 2012) and have contributed our share to the positive-psychology movement (see Sheldon, Kashdan & Steger, 2011). Unfortunately, issues such as primal play and laughter do not figure clearly or explicitly in modern psychoanalytic practice, for either adults or children. For children, play therapy is still carried out largely with toys and structured games rather than positive playful human interactions. When one of our friends, child psychoanalysts Mark Smaller of Chicago (who we were pleased to congratulate for being selected as the next President of the American Psychoanalytic Association), heard about "real" play from us, he discarded many of the toys and games he had relied upon and engaged the children more directly with playful attitudes and interactions. He found (no doubt substantially because of personal qualities) that therapeutic progress moved forward more efficiently and solidly (JP, personal communication). We expect this would also be the case in many adults also, especially if one uses the power of memory reconsolidation to de-fang and de-sting painful memories through the power of social joy (see Panksepp & Biven, 2012).

Of course, Gordon Burghardt (2005) is well versed in the ways of play. However, we have done our share of preclinical work evaluating the efficacy of play in counteracting ADHD and depression (Panksepp, Burgdorf, Gordon, & Turner, 2002). We also did the first formal experimental study of play in our species using ethological observations (Scott & Panksepp, 2003) and have done a feasibility study of the benefits of extra play in a public school system (Panksepp & Scott, in press). We have sought multiple sources of funding, including three applications to the NIMH, to implement a "play sanctuary" concept for young children with ADHD to examine whether we can see beneficial effects comparable to those we have seen in an animal model. We have been turned down each time, for no good scientific reasons as far as we could perceive. All these efforts have been premised on our understanding of the synergistic functions of the SEEKING and PLAY systems of the brain. (For an overview, see Panksepp, 2007a, 2007b, 2008.)

B&C are correct that our current Target Article does not explicitly offer "fundamental advances in treatment options," but we have promoted work that is doing that (see next commentary). And across the year we have done our share: Beside the ADHD work noted above, for a long time we have advocated the use of safe opioid agonists such a buprenorphine, most recently in Panksepp and Watt (2011) and Watt and Panksepp (2009). And, as noted earlier, we have new antidepressants, such as GLYX-13, in Phase II human testing (Burgdorf, Panksepp, & Moskal, 2011), with clear preclinical indications for autism (Moskal et al., 2011). Parenthetically, we developed the first animal model for autism based on our work on the social-attachment/PANIC system (Panksepp, 1979), yielding the low-dose opioid antagonist (naltrexone) strategy, which has garnered positive evidence in several double-blind studies (Bouvard et al., 1995; Kolmen, Feldman, Handen, & Janosky, 1997).

In conclusion, we appreciate the friendly challenges posed by B&C and appreciate the opportunity to reflect on their critically important concerns. We thank them for drawing out our perspectives on these topics, if ever so briefly, and to share our deep conviction that preclinical models of psychiatric disorders have to focus on validated affective emotional-network functions. Instead of just focusing on behavioral endpoints, in preclinical analyses of disorders such as depression, we have advocated using brain affective-network endpoints for both evoking affective imbalances and also monitoring them (Panksepp, 2012; Wright & Panksepp, 2011). And, most surely, we deeply appreciate B&C's willingness to highlight key topics that need attention didactically, so all need to consider their own research in the context of those admirable ideals. Perhaps our biggest "misstep" so far (according to colleagues in behavioral neuroscience) is standing up for the emotional feelings of animals (most recently, Panksepp, 2011a, 2011b, 2011c), a view that has clearly irritated many of our colleagues across the decades, which helped assure that our revolutionary work has never received the funding it deserves. Of course, all too often the pursuit of research dollars these days requires finding out more and more about less and less (see Weinberger, 2012), if not outright deception (such as eliminating the concept of "emotion" from their animal research programs). Still, we are happy to have caught the imagination of psychiatrists and psychotherapists who recognize the value of truly understanding how affective states, and their disorders, may arise from brain activities.

Coenen & Schlaepfer's remarkable data: the impact of SEEKING in biological psychiatry

We first would like to express our excitement about the ongoing work in Bonn. An 87% success rate in the treatment of depression is remarkable enough—but that deep-brain stimulation (DBS) in circuits implicated in SEEKING generates this success rate in those with treatment-resistant depression (TRD), where all other treatments have failed, makes this one of the most promising discoveries and accomplishments in neurology.

Thomas Schlaepfer and colleagues (2008) have demonstrated how DBS of the "brain reward" system within the terminal regions of the nucleus accumbens can alleviate depressive affect (also, for evidence of long-term sustained efficacy for such affective brain "pace-making," see Bewernick et al., 2010). Volker Coenen and his colleagues (Schoene-Bake, et al., 2010) proceeded to demonstrate, using modern neural-tract tracing in living human brains, that highly localized brain lesions of the late-psychosurgery era, in four varieties (bilateral anterior capsulotomy, anterior cingulotomy, subcaudate tractotomy, and stereotactic limbic leucotomy (which is a combination of the last two lesion sites), that produced significant remissions in depression could have converging influences on vast subcortical emotional systems that mediate SEEKING and PANIC.

The neuroanatomical understanding of these systems with diffusion tensor imaging (DTI)—along with the new vision of what kind of "rewardingness" the SEEKING system, which is confluent with the medial forebrain bundle (MFB), actually generates—has revealed another target for DBS-facilitated alleviation of treatment-resistant depression (Coenen, Schlaepfer, Maedler, & Panksepp,, 2011; Coenen et al., in press). Indeed, through their courage to test an idea that many others have been scared to consider, their preliminary cohort of 7 patients with MFB-DBS pacemakers have shown heightened appetitive states characterized by increased exploration and motivation.

The therapeutic potential of the psychological changes seen so far bodes well for further inquiry into the utility of this robust new medical intervention to reduce levels of human suffering that have not been assuaged with standard treatments. This modality of treatment will need a great deal more evaluation, especially through psychoanalytic depth interviews designed to probe the patterns of the affective changes. However, we are impressed by the new gateway to clinical progress that is being opened. If future work bears out the preliminary findings,[2] we will be as amazed as everyone else, but especially pleased since this is a critical and natural prediction of the perspective that the SEEKING system has become pathologically underactive or dysregulated in certain depressive disorders (e.g., Coenen et al., 2011; Panksepp & Watt, 2011).

Kashdan reflections: a state of the heart perspective

Todd Kashdan has an enticing vision of how the fully developed human mind's "desire to find meaning" and "progress toward personally meaningful goals" can be best understood from a "functional contextual" perspective. His well-developed "tertiary-process" approach, in our terms, can synergize well with the vision of SEEKING that we share. Of course, with our bottom-up approach, we spent little time at the tertiary-process level of analysis, in anticipation that several commentators would spend much time on the subject. Kashdan provides a superb view of that, with enough tension to provoke us to reconsider how well our primary-process rendering of the affective mind, based heavily on data from other mammals, can synergize with his tertiary-process vision of the human mind, which has historically sought to free itself from its animal past. We do suspect that a harmonious synthesis can be achieved between these poles of knowledge, as many clinicians already realize.

We remain fully open to the complexities of human mind that the massive expanses of human neocortical functions, aided by the linguistic abstractions and semiotics of our capacity to learn how to speak, open up for us. Within the vast cathedrals of thinking permitted by language, we humans have created totally new ways of looking at the world, unique values, including scientific skepticism, that make many feel that we have crossed a cognitive Rubicon that truly separates us from the other animals. Indeed, he highlights how the primal powers of SEEKING can be transformed by the existential virtues and vicissitudes of high-level mental existence. With regard to emotional feelings, we suspect that Kashdan has not gone that far, but perhaps he is not quite giving the ancestral powers of mammalian minds their proper due. By pursuing this analysis from

[2] Work supported by the Hope for Depression Research Foundation (NYC) and the Institute of Affective Neuroscience (University of Haifa).

a top-down perspective (Figure 1), he does "increase the precision of what" might be "meant by a seeking or exploratory system," especially as it relates to uniquely human aspirations.

However, perhaps from a bottom-up perspective, he is not fully recognizing the absolute power that the SEEKING system has over the human mental apparatus. One need go no further than the remarkable data shared here by Coenen & Schlaepfer (*vide supra*), for the first time, indicating that direct therapeutic arousal of SEEKING urges, via DBS pacemakers, may counteract depressive affect. Kashdan would surely understand that such effects would require a very different view of the SEEKING system than he is advocating. This, in no way, would diminish Kashdan's important view for understanding the existential aspirations of human "hearts," but our hope is to gradually coax scholars to view human mental life from other than traditional human cognitive perspectives and to become more open to the powers of the primal affective faculties of human brains (for one example, see Davies, 2011).

Even though those powers in well-"trained" (bred?) humans are under the control of "Aristotelian *phronesis*"—they are often under superb top-town regulation—that does not mean that a great deal of chaos in human lives does not emerge from the bottom-up affective powers of our animalian minds. That chaos is not just from our human "pursuit of meaning," but from the fact that we are inheritors of robust subcortical emotional systems that academic psychology has yet to fully acknowledge.

The biggest challenge will be integrating the bottom-up approaches that are most rigorously implemented in preclinical (animal) research, and the top-down approaches where human investigations provide a much richer framework than either one alone can produce (Figure 1). This dilemma is richly addressed by Kashdan, who considers SEEKING from "a functional contextual approach" that helps individuals "make progress toward personally meaningful goals." Thus, he pursues the ramifications of a SEEKING system at the highest (tertiary-process) levels of human aspirations and how the powers of this primary-process system can go awry. We enthusiastically agree with the need to fully recognize the impact of our primal mental "energies" within the highest levels of human intentionality and subjectivity.

It is important to fully recognize how such primal psychic "energies" create higher order mentalities and entangle human minds in the networks and webs of individual lives—namely, how important they are for the highest positive aspirations of humans as well as the creation of mental agitations and miseries, full of deeply self-referential thinking and maladaptive living patterns. However, at present there is no clear way to scientifically envision how SEEKING urges shared by all mammals create everyday happiness and madness in our own species. This requires much more neuropsychoanalytic research on how simple stimuli that arouse this system, from psychostimulants such as amphetamines to DBS along the MFB, work (see Coenen & Schlaepfer's commentary). Still, besides energizing positive creative ideations, it is increasingly clear that this system can promote idiographic mentally addictive obsession and maladaptive delusions. At extreme levels of dysregulation, the SEEKING system can promote personally harmful patterns of mentation such as those that characterize the paranoid symptoms of schizophrenia. As Kashdan emphasizes, from a positive psychology perspective, it can also promote the capacity to conceptualize and instantiate vast arrays of life-affirming "meaningful goals." In short, the end result of this mental energy is preordained not by the primary-process nature of SEEKING, but by the way individuals use this mental force to create themselves and to navigate the world.

Of course, we were dismayed that Kashdan "believes the evidence is less than compelling for describing the SEEKING system as a primal positive emotional system," since we long ago gave our first full description of the concept, and supporting evidence, in a 100+-page, data-guided, chapter (Panksepp, 1981), persisting with extensive documentation (Panksepp, 1998a) and periodic studies to the present day (most recently Alcaro & Panksepp, 2011; Panksepp & Biven, 2012). We realize that some of our views are very difficult for psychologists to grasp, especially those whose thinking is so deeply immersed in the full tertiary-process complexities of the human mind, where there is, to this day, no agreed-upon definition of emotional systems nor any disciplined discussion or understanding of the primary processes we share with other animals.

Of course the main problem here may be the difficulty of defining emotional systems (ours is a neurally based definition). And SEEKING is not just intended to be "a positive emotional descriptor" but one that is based on solid ethological descriptions that can also be used effectively to illuminate negative situations such as "the seeking of safety" (Panksepp, Fuchs, & Iacabucci, 2011)). Since it is our contention that primary SEEKING is required for the higher mind to function, it is no surprise that SEEKING needs to be conceptualized as playing a prominent role in an enormous spectrum of cognitive activities. This includes primary-process animalian PANIC and the oft-unpleasant ruminations of human life—a tertiary process. However, at the highest level of analysis, psychodynamics in the BrainMind become increasingly complex and blended together so that it becomes difficult, if not impossible, to make inferences about the bottom from the top-down view.

Although SEEKING might be involved in negative rumination, arising from the midline default networks of the cortex (Alcaro, Panksepp, Witczak, Hayes, & Northoff, 2010), it does not mean that we can attribute any of these emotions to the SEEKING system alone. However, we can speculate about the evolutionary emotional roots that energize and sustain rumination. When an animal is starving, it makes sense that SEEKING leads to an obsessed highly focused search for food. It is perhaps this aspect of SEEKING that plays a prominent role in rumination. It is, of course, interesting to speculate about how the different layers of the BrainMind, from primary to tertiary, interact with one another, but, at this time, all we can comfortably suggest is that the higher mind cannot achieve anything without the lower mind. Indeed, the higher mind "dissolves" when the lower mind is extensively damaged.

We agree that context plays a powerful modulatory role on the emotions and perceptions of all mammals. At the primary -level, it is only through context that the naked SEEKING urge learns and couples to specific objects in the environment. However, any sort of context that would dramatically alter the quality of the raw experience of SEEKING is likely a tertiary phenomenon. Indeed, DBS of the SEEKING system that is not controlled by a subject is often aversive (Steiner, Beer, & Schaffer, 1969) Likewise, being placed in a cultural context where the SEEKING system must be utilized despite one's will is often negative. A child forced to take out the trash or do homework might find it unpleasant, but the same child performing the same actions according to his or her own free will and impulse might find the tasks exciting. This simply further illustrates the complexity of the BrainMind when the total package is operating, and it highlights the importance for researchers and clinicians to be aware of what they are studying and/or how far other research and experience can be interpreted. This is why vernacular terms will never suffice for clear communication about the primary-process level.

This said, let us affirm that we agree with the vision of human cognitive life, with its many forms of everyday "madness" precipitated by our emotional storms, that Kashdan shares in his sharp analysis. We are pleased to hear that "There is a lack of evidence that altering the balance of negative to positive cognitions is what mediates client improvement in therapy," but we would be surprised to hear that altering the balance of positive and negative emotional *affects* would not have enormous impact on the quality of human lives, for better or worse. One aspiration of affective neuroscience is to bring that neglected dimension of mental life back into academic psychology as well as into new conversations about how we can improve the lives of clients seeking psychological help.

We may be on the same page on this, but the top-down and bottom-up views need to be integrated better for the most useful conversations to emerge. Indeed, Kernberg's commentary well highlights these issues, by understanding that "psychic functioning at that symbolic level" is based very much on the "integrating organization of secondary affect systems under the influence of the primary process . . . neurobiological level." Once we appreciate such levels of control in both directions, there will be fewer reasons for disagreements between scholars situating their arguments at different levels of BrainMind organization.

Reflections on Kernberg's commentary: interlevel integrations conceived more fully than we could have

Otto Kernberg has "proposed that affect systems are the primary, biologically motivational systems and that the developmental integration of affects and internalized object relations leads, on the one hand, to the development of the tripartite structure (ego, superego, and id), and, on the other, to the coalescence of positive affective systems into a hierarchically supraordinate integration as libido, and the corresponding hierarchically supraordinate integration of negative affect systems into aggression." We resonate very much with this sentiment.

Kernberg provides a useful counterpoint to the commentary by Kashdan. Kernberg's is a clear and important statement on how our primary-process analysis of SEEKING and the other fundamental emotions of mammalian minds relate to Freudian dual-drive—libido and aggression—perspectives on the human mind. As we pondered this possible synthesis, one troublesome feature also became clear to us—that these two lines of understanding, although not incommensurate, are not capable of being robustly (at least empirically) reconciled at the present time. Whether this reflects inadequate existing methodologies, or more fundamental ontological problems, is difficult to say. Probably both are relevant, since many conceptual analyses of the past, before neuroscience was able to tackle the complex infrastructure of the mind, can be synthesized in the realm of words, but not necessarily primary-process neurobehavioral facts that have a genetic origin. They can be better coordinated at tertiary-process levels, where clinical and symbolic visions, before neuroscientific ones, ripened to guide important human considerations. Now clinical insights need to be crafted into novel neurophenomenological studies that will need to be increasingly represented in neuropsychoanalytic science (see Kaplan-Solms & Solms, 2000; see also many previous contributions to this journal).

It is important to realize, as Kernberg makes clear, that libido and aggression of Freud's dual-drive theory were fundamentally higher order mental concepts, linked to imagined genetic substrates. Since Freud assumed, as did neuroscientists of his day, that consciousness was a higher cortical function (our tertiary-process level of analysis), it will be interesting to see how our views could be reconciled and/or synthesized now that we know that affective experiential feelings are tightly linked to subcortical primary-process neural mechanisms that have no capacity to think. At this juncture, it is also important to note that our use of primary-to-tertiary BrainMind processing is vastly different from the way Freud used primary and secondary concepts in his theorizing.

The way Freud originally developed primary and secondary processes in *The Interpretation of Dreams* (1900) was fundamentally a form of thinking (see Holt, 2009, who applied empirical techniques to such issues). We use this same terminology in a different way, for two reasons: (1) As a consequence of evolutionary theory and modern neuroscience advances, the optimal way to restructure primary-process concepts needs to be renegotiated. (2) It may be important to view the *dynamic unconscious* to be largely a mix of basic learning as well as automatized cortical thinking processes. For instance, the subcortical basal ganglia (e.g., amygdala and nucleus accumbens) promote secondary-process temporospatial parsing of affects into the wishful thinking (a tertiary cortical process) that causes such psychiatrically relevant havoc in clients' lives. But we hold out the hope that they may be ameliorated by more direct affective interventions, even ones as extreme as DBS (see the Coenen & Schlaepfer commentary).

With our view of fundamental phenomenal affective consciousness, which already exists at the primary-process level of emotional processing (Panksepp, 1998b, 2007c), the dynamic unconscious, taken as a higher brain function energized by raw affects, may take on a distinctly new meaning in the mental economy. Although raw primal emotions are affectively experienced, the further integration of related input from the world through basic learning and memory mechanisms may indeed be "profoundly unconscious processes," in Kernberg's words, promoting "the development of unconscious fantasy" at the cortical level, as each emotion "plays out the relationship between libido and aggression" within higher brain regions. Thus Heather Berlin's recent analysis of the dynamic unconscious in this journal (Berlin, 2011), now well studied with various cognitive tasks, may shed light on subtle dynamic aspects of the unexperienced secondary-process mind that promotes decision-making without being explicitly expressed in the experienced aspects of the cognitive mind. However, those unacknowledged thoughts may still be accompanied by shifts in the experienced affective tone of the mind, but often without clearly being acknowledged in language. In other words, a great deal of the dynamic unconscious may be experienced but typically unacknowledged.

In this way, the body often behaves in certain ways, as in skilled sportsmen, without any explicit experience of decision-making. Indeed, we see this dichotomy between felt experience and habitual behaving, based on learning, operating even in basal-ganglia regions: The more ancient and more ventrally and medially situated SEEKING urges of the mesolimbic and ventral striatal systems have euphoric rewarding properties. In contrast, the more recently evolved, more rostral and lateral dorsal striatal systems mediate habit formation, and the corresponding nigrostratal dopamine systems are much less capable of promoting reward effects, a pattern that is seen in the ventral tegmental area itself (Ikemoto, 2007). The role of the more lateral systems in the patterning of behavior is better described by the concept of unconscious "habit strength" (Everitt & Robbins, 2005; Graybiel, 1998; Ikemoto & Panksepp, 1999; Yin & Knowlton, 2006). The fact that the more ancient unconditional SEEKING urge is experienced positively, while the more recently evolved secondary structures are not, is a challenge for traditional modes of thinking about the origins of consciousness, especially when it comes to affective qualia. This may arise since the SEEKING urge also participates in many affectively negative behavioral and psychological patterns. We are now confronted by an internal structure of mind that could hardly have been recognized in Freud's time. Still, Freud was struggling with the right issues.

In sum, the brain contains no singular "motivational" process in its infrastructure. Thus, *motivational* structures should be recognized as higher order concepts that subsume the many factors that coalesce to guide directed actions. Some of them are very ancient, and deeply affective. Some of them are more recent and deeply habitual, and thereby cognitively unconscious. And some of them are very recent BrainMind acquisitions, based completely on individual learning and the resulting realms of thought, which are explicitly cognitive but are still fired by the affective energies deep in the brain. How we will ever speak clearly about such interacting levels of complexity is a challenging task that has not yet been linguistically, or neuroscientifically, solved. Our capitalized nomenclature for emotional primes, regrettably ignored by many commentators, highlights the difficulties that still exist at mere linguistic levels. But as Kernberg highlights, Freud pointed us in productive directions. Although his ideas could not have been scientifically precise without the neuroscience revolution, he shared intellectual territory (as does Kernberg) that can guide productive discussions about the neural nature of the mind.

Reflections on Solms's synthesis: without a coherent neuropsychoanalysis, mind science is lost in an impenetrable wilderness

Mark Solms provided a vivid synopsis of how Freud approached the concept of "libido." This is remarkably useful not only to envision how similar our ideas are to some of Freud's, but also to note the kinds of conceptual difficulties that can emerge when the modern era continues to use vernacular terms to describe the now neuroscientifically illuminated underbelly of mind. Still, the inside and outside views are bound to often lead to conceptualizing key BrainMind processes in slightly different ways. Considering that a key goal of science is to progressively promote our ability to differentiate aspects of complex issues that were not differentiable in earlier eras, we must continually pay attention to different levels of analysis. Thus, by necessity, global earlier concepts begin to be parsed into subconcepts, while the necessarily excess meanings of earlier conceptual usages may stand in the way of clearly communicating subsequent parsings. Indeed, scientific technologies have now progressed to a point where the collection of data is proceeding more rapidly, driven by spectacular technologies, compared to earlier eras, to the point where high-tech science is beginning to resemble a chaotic brickyard (Forscher, 1963).

Here, we have attempted to avoid such chaotic end-results while, at the same time, sustaining our conviction that Freud was prescient about the overall framework of the neuromental apparatus that needed to be understood in ever-greater detail. We have now reached a time where stacks of relevant details often outweigh our ability to synthesize them into the greater whole (Weinberger, 2012). Thus, a middle road has to be found that does not discard Freud's conceptual babies in the complexity of the neuroscientifically detailed bathwater. In the following reflections, all quotes are to Solms's commentary as opposed to any direct quotes from Freud.

As Solms notes, Freud envisioned that "the human mind was possessed of a drive to seek pleasure in and of itself. He termed this drive 'libidinal,' saying that libido was the appetitive dimension of sexuality—analogous to hunger in relation to nutrition." In fact, hunger utilizes the SEEKING system as much as sexual urges and certain types of aggression. This could not have been known in Freud's era. Indeed, without a neutrally based vision of the layering of emotional processes (Figure 1), what seems perfectly sensible at a tertiary-process level become semantically confusing at the primary-process level, about which Freud knew nothing neuroscientifically.

Part of the current problem in discussing all relevant conceptual issues is that the meanings of terms such as "drives" and "motivation" have changed implicitly during the past century. So, all too often people are using the same terms to discuss somewhat different issues. Although we suspect that "Freud conceived of libido as an appetitive drive. It was synonymous with 'desire'," we are tempted to envision "desire" as the proper term at the tertiary-process level of mentation, "wanting" at the secondary-process level. And from our primary-process SEEKING vantage, "desire" remains largely a generalized force that can be used for a great variety of life-sustaining goals. And at present, each of the homeostatic "drives" needs to be conceptualized as body-state receptive fields for hunger, thirst, etc. concentrated mostly within the most medial regions of the brain (see Fig. 4 in the Target Article). Of course, the connectivity of these "homeostats" to lateral hypothalamus concentrated appetitive urges probably also means that our vernacular "hunger" and "thirst" do obtain some of their remarkable psychic "energy" from the SEEKING system, partitioned in time and space by secondary-process learning mechanisms to fit in, ever better, with worldly demands.

Freud's realization that "there was no obvious (self-preservative) motive for us to engage in reproductive behavior, other than the large yield of pleasure" attaching to it" was clearly a critical affective insight, since "without the pleasure we simply would not reproduce." Indeed! However, this still coaxes us to consider that the actual pleasures of copulation may be largely sensory-based affects, quite distinct from the raw SEEKING urge, which is exciting and euphoric in ways that are hard to describe in words, but not at all synonymous with the feelings that typically go under the concept of pleasure. And to make it more complex, this does not mean that the SEEKING system has no role in male copulatory pleasure, but we envision that to be the end component of the SEEKING urge, as appetitive drive toward pleasure mounts toward orgasm. It is amazing that the female orgasm does not have the rapid undoing of pleasure, as consummated by orgasm, as in males. A neuropsychological puzzle! In any event, we suspect that a more disciplined distinction between the various "pleasurable" feelings (perhaps sharing related neural substrates) and those more ineffable and obsessively persistent ones that arise from SEEKING is needed. The two, in our higher minds, seem to be coordinated into an overall sexually libidinous urge, but a neuropsychoanalytic scientific analysis will be needed to pry apart the component underlying several distinct affective processes, which are commonly conflated in traditional psychological analyses

Reflections on Wilson's dessert: a fine ending to an interesting conversation

We savored Daniel Wilson's resonant reflections on the need for an evolutionarily integrated view of the human mind, from our ancestral psychological roots to our cerebral canopies. We agree that understanding such complexities cannot be achieved simply from the incisive thrusts of "empirical reductionism," especially in its most ruthless modern forms where overriding general questions are often buried, and lost, within an avalanche of data. Clearly, lasting answers to the questions we humans have had forever will require finding the middle road. But we also do not regret that some are willing to devote their lives to smaller and smaller pieces of the overall puzzle, but that descent into the particulate level of biology often becomes disengaged from the levels that are most important for the understanding of human beings.

Perhaps the biggest stumbling block to a reasonable integration of neuroscience and depth psychology is the failure of our current *Zeitgeist* to have robust visions of the BrainMind based on "network doctrines," as most studies of brain function are currently based on the prevailing "neuron doctrine." This fault can be placed very much at the door of the funding agencies, which seem to agree more on the critical importance of the use of the most modern technologies in modern science, often at the expense of the human importance of the questions being addressed. Useful knowledge will rarely float to the top, like cream in full milk. That is not just a matter of new technologies. It must also be created by repeated iterations of testable hypotheses to allow useful translations at each phase of our cultural and scientific evolution. For instance, currently new psychiatric drug development research needs to be targeted at affective rather than just behavioral levels of understanding (Panksepp, 2012).

We have reached an era where we can surely measure the activities of single neurons more precisely than the actions of massive interacting networks that weave together this thing called mind, but ultimately an understanding of the latter will have more impact on psychology and psychiatry than the former. For ourselves, we are motivated by the following Freudian insight: "No knowledge would have been more valuable as a foundation for true psychological science than an approximate grasp of the common characteristics and possible distinctive features of the instincts. But in no region of psychology were we groping more in the dark" (1920, p. 61).

It is within the dynamically flexible natural emotional behavior patterns that mammalian brains generate in response to simply being stimulated in certain deep subcortical reaches of the brain that we will have a scientific understanding of how our affective experiences are constituted from brain activities. Indeed, although the study of sensory-perceptual systems currently prevails in our search for the mechanisms of consciousness, we suspect that the coherent action systems within the trajectories of our core-SELFs (Panksepp, 1998b), concentrated in centromedial strata of the brainstem, will be the place where we begin to understand the neural nature of our emotional affects—and perhaps the primordial origins of consciousness itself. The foundation of the mammalian mind may be fundamentally affective.

Concluding, converging, and diverging historical perspective

What might Freud have said about these psychodynamic primary-process issues that have now been enriched with brain research, after he abandoned his "Project for a Scientific Psychology" (1950 [1895]) almost 120 years ago? Is his concept of "Id" still needed to help clarify the foundations of mind? Would he agree that his dynamic unconscious is actually experienced affectively? Of course, there is no way to know.

But it is worth noting that concurrently in America William James was crafting an equally compelling but rather different vision of the mental apparatus, and it is noteworthy that in his longer (original) version of *Principles of Psychology* (1890), he covered the topics addressed here in three successive chapters—"Instinct," "Emotions," and "Will." Also, among others, social psychologist William McDougall (1908) was advancing a vision of the emotional mind where he recognized seven basic instincts that are not all that different conceptually from those in *Affective Neuroscience* (Panksepp, 1998a). And, of course, these three great scholars of the mind were in no position to cite each other's ideas.

How wonderful it would have been for these pioneers to have shared and debated their ideas at a roundtable, with all of modern functional neuroscience at their fingertips (as it is for us with PubMed) and at the front of their minds and the tips of their tongues for us to savor. And what would Descartes and Schopenhauer, and countless others add to the conversation if all the modern data were at their disposal? Might Descartes indicate that Panksepp's vision of the passions is not all that different from his own, if Panksepp simply read his original ideas closely enough and with sympathy? Would Schopenhauer indicate to Freud how much in his own footsteps Freud had trod? Each of us and each of the noted eminent scholars above had deep roots in earlier visions—for instance, the linkage of Freudian thought to the ideas of Schopenhauer, which was left quite unacknowledged (see Young & Brook, 1994), and so forth.

All modern thinkers are now confronted by how extensively their ideas are linked to the many preempirical, as well as contemplative, philosophically, and clinically inspired past conceptualizations of human mental life. We should probably recognize that they are all conceptually vastly important and, all too often, empirically quite irrelevant to the ongoing scientific analysis of topics of shared interest. In a sense, many old ideas are being rediscovered, but framed with new scientific casts of mind. Thus, even as we need to recognize and appreciate so many antecedents, at the same time we need not be constrained by some of the conceptual and empirical limits that guided earlier visions.

We should also recognize that so many modern investigations of emotions continue to be implicitly guided by diverse prescientific conceptions and misconceptions. One of the most important in the former class may be the recognition that much of our higher mental life emerges from a dynamic affective "subconscious" that may lie at the roots of our capacity to experience the higher cognitive forms of mental life. One in the latter class is that a close study of our fellow animals will not dramatically illuminate the sources of our own minds. In closing, we would again show our appreciation of this forum for the sharing of ideas, especially with so many esteemed commentators.[3]

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[3] As the time that this response to the commentaries was being proofed, an article of great relevance to our discussions about the nature of consciousness appeared (Solms & Panksepp, 2012), as well as a synopsis of the affective neuroscience perspective on cognitive, philosophical, and legal issues (Panksepp, Asma, Gabriel, & Greif, 2012).

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