The Neural Basis of the Dynamic Unconscious

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A great deal of complex cognitive processing occurs at the unconscious level and affects how humans behave, think, and feel. Scientists are only now beginning to understand how this occurs on the neural level. Understanding the neural basis of consciousness requires an account of the neural mechanisms that underlie both conscious and unconscious thought, and their dynamic interaction. For example, how do *conscious* impulses, thoughts, or desires become *unconscious* (e.g., repression) or, conversely, how do *unconscious* impulses, desires, or motives become *conscious* (e.g., Freudian slips)? Research taking advantage of advances in technologies, like functional magnetic resonance imaging, has led to a revival and re-conceptualization of some of the key concepts of psychoanalytic theory, but steps toward understanding their neural basis have only just commenced. According to psychoanalytic theory, unconscious dynamic processes defensively remove anxiety-provoking thoughts and impulses from consciousness in response to one's conflicting attitudes. The processes that keep unwanted thoughts from entering consciousness include repression, suppression, and dissociation. In this literature review, studies from psychology and cognitive neuroscience in both healthy and patient populations that are beginning to elucidate the neural basis of these phenomena are discussed and organized within a conceptual framework. Further studies in this emerging field at the intersection of psychoanalytic theory and neuroscience are needed.

Keywords: unconscious; psychodynamic; repression; suppression; dissociation; neural

"Nothing is so difficult as *not* deceiving oneself."

Ludwig Wittgenstein [1889–1951]

Cognitive unconscious processing

The intricate relationship between conscious and unconscious processes is one of the many mysteries that continue to perplex our understanding of ourselves.[1] How much of our subjective conscious experience is influenced by unconscious processes? There is a distinction, however, between unconscious processes, which neuroscience is more likely to explore, and the unconscious mind with its psychoanalytic contents (Kihlstrom, 1994, 1999; Macmillan, 1996; Westen, 1998a). Early psychodynamic theorists attempted to explain phenomena observed in the clinic, but later cognitive scientists used computational models of the mind to explain empirical data. By using models based mostly on nonclinical data, cognitive science (in branches like neuroscience, cognitive psychology, neural modeling, and neural linguistics) departed from the older psychoanalytic theories, heading into new areas involving neural processes (Ekstrom, 2004). For example, recent imaging, psychophysical, and neuropsychological findings suggest that unconscious processes take place hundreds of milliseconds before conscious awareness.

It is largely accepted that lower levels of processing (e.g., motor reflexes, sensory analysis) can operate outside of perceptual awareness (implicitly) (e.g., Castiello, Paulignan, & Jeannerod, 1991). And although the existence of nonconscious computations at higher levels (e.g., semantic or inferential processing) has been controversial (Dixon, 1971; Eriksen, 1960; Greenwald, 1992; Holender, 1986), a range of empirical find-

[1] The terms consciousness and awareness (or conscious and aware) are used in this article synonymously and anything outside of awareness/consciousness is referred to as nonconscious (a term used more in cognitive psychology that emphasizes the descriptive and empirical nature of the phenomenon) or unconscious (traditionally used in the psychoanalytic tradition to reflect more dynamic unconscious processes).

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ings on the unconscious over the last several decades has led most cognitive neuroscientists today to believe that mental activity can occur outside of conscious awareness (Hassin, Uleman, & Bargh, 2005). Some have argued that all information processing can, at least in principle, operate without conscious experience, and that consciousness (C) may thus be of a different nature (Chalmers, 1996). This view goes along with the hypothesis that nonconscious processes can achieve the highest levels of representation (Marcel, 1983). A large amount of complex cognitive processing appears to occur at the unconscious level in both healthy and psychiatric and neurological populations. For example, evidence from patients with blindsight (Goebel, Muckli, Zanella, Singer, & Stoerig, 2001; Weiskrantz, 1986), prosopagnosia (Renault, Signoret, Debruille, Breton, & Bolgert, 1989), implicit awareness in hemineglect (Cappelletti & Cipolotti, 2006; Marshall & Halligan, 1988; Vuilleumier et al., 2002), nondeclarative learning even in amnesia (Knowlton, Mangels, & Squire, 1996; Knowlton, Squire & Gluck, 1994; Turnbull & Evans, 2006), and the "split-brain" syndrome (Gazzaniga, 1995) supports the idea that unconsciously processed stimuli can activate high-level cortical regions.

Subliminal perception

Kouider and Dehaene (2007) suggest that in order to reach C, a stimulus must have sufficient strength (which can be hindered by masking)[2] and receive top-down attention (which can be thwarted by drawing attention to another task or stimulus). Subliminal perception (aka perception without awareness) occurs when stimuli are processed by our sensory systems, but do not reach the "threshold" of entering into C because they are presented below the limen for conscious perception. This is usually demonstrated by presenting stimuli that are "masked" or presented in a subtle form or too briefly to be consciously perceived, but are sufficient to prime or bias a subject's performance in tasks like lexical decision-making. Subliminal perception studies have shown that unconscious processing can influence awareness. Subliminal priming can occur in a range of sensory modalities and with a range of different stimuli (visual, verbal, auditory etc.) and is inferred when a stimulus is not perceived, yet still influences actions, thoughts, feelings, learning, or memory.

Evidence shows that subliminal stimuli can still be highly processed and can even activate motor responses (e.g., Dehaene et al., 1998, 2001, 2004; Marcel, 1983; Naccache et al., 2005; Nakamura, Dehaene, Jobert, Le Bihan, & Kouider, 2005; Nakamura et al., 2007). Subliminal priming studies indicate that a masked word or digit can have an influence on perceptual, lexical, and semantic levels (Allport, 1977; Kouider & Dehaene, 2007; Marcel, 1974, 1980, 1983; Nisbett & Wilson, 1977). These studies suggest that the subliminal words activate cognitive processes associated with the meanings of words, even though there was no conscious awareness of such an effect. Semantic priming from masked stimuli has been shown not only with words (Balota, 1983; Fowler, Wolford, Slade, & Tassinary, 1981) but also with auditory stimuli (Holender, 1986; Nisbett & Wilson, 1977; Schacter, 1992) and pictures (Carr, McCauley, Sperber, & Parmelee, 1982; McCauley, Parmelee, Sperber, & Carr, 1980; Nisbett & Ross, 1980). Even associative learning, as measured by event-related brain potentials, can occur without awareness (Wong, Bernat, Bunce, & Shevrin, 1997). Thus, it seems as though some stimuli that are sensed by our sensory organs, but do not reach the "threshold" of conscious awareness, are still processed by our neural network and can influence higher level cognitive processing and behavior.

Neuroimaging studies show that subliminal priming evokes activation in several cortical areas (see Kouider & Dehaene, 2007). Compared to supraliminal stimuli, cortical activation to subliminal stimuli is often weaker, but there are many exceptions (e.g., attentional blink) that show that high activation is not a sufficient condition for conscious access (Kouider & Dehaene, 2007). Studies using intracranial recordings with electrodes in humans provide the first direct evidence that subliminal words perceived unconsciously can have long-lasting effects on neuronal signals and can trigger long-lasting cerebral processes (Gaillard et al., 2007; Naccache et al., 2005). Nakamura et al. (2006) show that the subliminal priming effects in lexical decision and pronunciation tasks can be selectively disrupted by transcranial magnetic stimulation (TMS) to distinct sites, suggesting that task set influences subliminal processing. And evidence from event-related potentials (ERPs) shows that goal-driven, task-set dependent attention can be captured by visual stimuli that are not consciously perceived (Ansorge, Kiss, & Eimer, 2009).

Based on studies that show that inhibition is present when stimuli are presented superluminally but not when

[2] When presenting a visual stimulus (the "mask") directly before and/or after another briefly presented (≤ 50 ms) visual stimulus (the "target") leads to a failure to consciously perceive the target stimulus (Breitmeyer & Ogmen, 2007).

presented subliminally (e.g., Allport, Tipper, & Chmiel, 1985; Marcel, 1980; McCormick, 1997; Merikle, Joordens, & Stolz, 1995; Neill, Valdes, & Terry, 1995; Tsushima, Sasaki, & Watanabe, 2006), some contend that inhibitory control is restricted to stimuli that are accessible to C. They assert that while subliminal stimuli can trigger passive activation, only supraliminal stimuli can elicit active inhibitory control. However, Eimer and Schlaghecken (2003) review studies that challenge this view. These experiments show that inhibitory processes can take place even when response predispositions are activated by subliminal stimuli. Results from subliminal priming experiments have shown that masked stimuli, which are not perceived consciously, can still trigger response activations, and that these response activations can subsequently be inhibited (Eimer, 1999; Eimer & Schlaghecken, 2002), perhaps to prevent behavior from being controlled by extraneous stimuli (Eimer, 1999). Early response facilitation produced by consciously perceived information may in fact counteract the automatic effects of self-inhibitory motor control (Eimer & Schlaghecken, 2002).

Schlaghecken, Münchau, Bloem, Rothwell, and Eimer (2003) found that repetitive TMS (rTMS) over left premotor or motor cortex during a masked prime task did not affect reaction times triggered by subliminal primes. So subliminal priming effects do not appear to be caused by activation of premotor or motor cortex. Subsequent data suggest that motor control in a masked prime task is influenced by low-level, automatic processes mediated by subcortical (presumably basal ganglia–thalamic) control circuits (Schlaghecken, Bowman, & Eimer, 2006). Thus, inhibitory motor control processes can be decomposed into separate mechanisms that operate at different levels within the motor response system (Schlaghecken et al., 2006). "*Endogenous*" inhibition, which occurs when stimuli are presented supraliminally, is voluntary, optional, dependent on the conscious detection of task-relevant signals, and thought to be controlled by executive mechanisms mediated by the prefrontal cortex (PFC) (Band & van Boxtel, 1999; Berlin, Rolls, & Iversen, 2005; Berlin, Rolls, & Kischka, 2004; Konishi, Nakajima, Uchida, Sekihara, & Miyashita, 1998; Liddle, Kiehl, & Smith, 2001; Menon, Adleman, White, Glover, & Reiss, 2001; Rubia et al., 2001; Tsushima, Sasaki, & Watanabe, 2006). In contrast, "*exogenous*" inhibition (i.e., inhibitory response control to subliminally presented stimuli) appears to be reflexive and nondependent on the conscious detection of task-relevant signals and is believed to be mediated by corticostriate circuits (involving subcortical structures like the thalamus and caudate nucleus, and perhaps posterior parietal cortex) (Eimer & Schlaghecken, 2003) and may not engage the PFC at all (Aron et al., 2003).

Affective and motivational unconscious processing

Despite the surge of empirical studies of unconsciousness and cognitive processes (e.g., see Greenwald, 1992; Hassin, Uleman, & Bargh, 2005; Kihlstrom, 1987; Schacter & Buckner, 1998), few cite current psychodynamic work or theories (Robins & Craik, 1994). The unconscious of cognitive scientists is automatic, cold, and cognitive, and many are skeptical of extending the notion of unconscious processes to affect and motivation and of the idea that affect can bias how thought is constructed outside of awareness ("defense"). Phenomena of the kind described above, where sophisticated *cognitive* processes can occur without subjective experience of them, support Sigmund Freud's [1856–1939] general claim of omnipresent unconscious mental activity (Turnbull, 2001). But they do not support the more specific facets of his model, described by psychodynamic theorists and clinicians for a century—for example, that unconscious *emotional* and *motivational* factors can mold the conscious mind (Turnbull & Solms, 2007). Attention to the affective and motivational aspects of the unconscious would give a more comprehensive, balanced, and valid depiction of the workings of the human mind (Westen, 1998a).

A vast amount of data supports the proposition that much of mental life, including thoughts, feelings, and motives, is unconscious (Westen, 1998b). Researchers are beginning to discover that the same principles that apply to cognition operate with unconscious (implicit) affective and motivational processes as well. So the *cognitive unconscious* (Kihlstrom, 1987, 1990) is now becoming the *cognitive–affective–motivational unconscious* (Brenner, 1982; Sandler, 1987; Westen, 1998a). Due in part to advances in functional imaging, we now have incomparable access to the neurobiological bases of instinctual drives and basic emotions (Canli, Sivers, Whitfield, Gotlib, & Gabrieli, 2002; Etkin et al., 2004; Jackson et al., 2003; Sander, Roth, & Scheich, 2003; Yoshino, Kimura, Yoshida, Takahashi, & Nomura, 2005), and evidence for their importance in mental life (Damasio, 1994, 1999; LeDoux, 1998a; Panksepp, 1998; Rolls, 1995). Recent findings support Freud's claim that mental activity is rooted in phylogenetically old emotion and motivation systems that influence early mental development (LeDoux, 1998a; Panksepp, 1998; Pfaff, 1999).

Unconscious emotional processes

Studies on unconscious affect provide persuasive evidence that people can feel things without knowing they feel them and can act on feelings of which they are unaware (e.g., see Westen, 1998a, 1998b)—an idea that has guided psychoanalytic clinical practice for a century. The studies presented thus far on unconscious affect provide particularly compelling evidence for a central hypothesis that has been propounded only by psychoanalytic theory and has guided psychoanalytic clinical work for a century: People can feel things without knowing they feel them, and they can act on feelings of which they are unaware—for example, subtly hostile, indifferent, or defensive treatment of members of ethnic minority groups. A cognitive–affective neuroscience of the unconscious has recently emerged, focusing on laboratory paradigms like subliminal perception, implicit cognition, and directed forgetting and proving new insights into the neural basis of unconsciousness and cognition and affect (Stein, Solms, & van Honk, 2006). Evidence suggests that emotion processing is initiated and can proceed without conscious awareness (Balconi & Lucchiari, 2008; Bunce, Bernat, Wong, & Shevrin, 1999; LeDoux, 1998a; Phelps et al., 2000; Wiens, 2006; Wong et al., 1994,). This makes sense since emotional input is highly adaptive and thus preferentially processed with or without capacity-limited C. Behavioral and physiological measures reveal that unconscious stimulation is sensitive to the emotional content of the stimuli (Lang et al., 1998).

Craig's (2002, 2009) theory of the neural basis of interoceptive conscious perception ties emotions to body states. Consistent with the theories of William James (1890) and Antonio Damasio (1994), Craig (2002, 2009) suggests that subjective human emotion is based on an abstracted meta-representation of the physiological state of the body in the right anterior insular cortex, which provides the foundation for the volitional modulation of feelings, emotion, and efferent activity affecting the state of the body. So feelings may have their basis in body representations, but we do not have conscious access to the neuronal processes that underlie bodily homeostasis and emotion states (Craig, 2002, 2009).

Tsuchiya and Adolphs (2007) review the evidence for unconscious emotions. Emotional responses can occur without awareness of the stimuli that triggers them—for example, in studies of fear conditioning to subliminal stimuli (Wong, Bernat, Snodgrass, & Shevrin, 2004). "Invisible" visual stimuli can affect judgments of visible stimuli (Murphy, Monahan, & Zajonc, 1995; Murphy & Zajonc, 1993; Tamietto & de Gelder, 2008), and emotional visual stimuli can elicit affective somatic responses even when cortical processing of the stimuli is diminished by backward masking (Macknik & Livingstone, 1998). Evidence for the unconscious perception of masked faces in humans has been shown in studies using subjective reports (Esteves, Parra, Dimberg, & Öhman, 1994), autonomic reaction (Morris, Buchel, & Dolan, 2001a), ERPs (Kiefer & Spitzer, 2000), and brain imaging (Whalen et al., 1998). Subjects show increased skin-conductance responses to masked fear-conditioned visual stimuli (Esteves et al., 1994) and covert facial mimicry to masked fearful faces (Dimberg, Thunberg, & Elmehed, 2000). ERPs also show subliminal processing of fearful faces, providing further evidence of emotional processing without conscious awareness (Kiss & Eimer, 2008).

Brain lesion patients also provide evidence that nonconscious stimuli can, in fact, elicit emotion states. In a phenomenon known as "affective blindsight,"[3] patients with lesions in the primary visual cortex (V1) can have affective responses to emotional visual stimuli presented in their blind visual field, without early cortical processing (e.g., in V1) or conscious awareness (i.e., they deny consciously seeing anything in the blind field) of the stimuli. These responses include behavioral responses (e.g., above chance discrimination of gestures and emotional facial expressions in forced-choice paradigms) (de Gelder & Hadjikhani, 2006; de Gelder, Vroomen, Pourtois, & Weiskrantz, 1999; Pegna, Khateb, Lazeyras, & Seghier, 2005), judgments of visible stimuli presented simultaneously (de Gelder, Morris, & Dolan, 2005; de Gelder, Pourtois, van Raamsdonk, Vroomen, & Weiskrantz, 2001), and somatic responses (e.g., startle reflex potentiation) (Anders et al., 2004; Hamm et al., 2003). Some patients with V1 lesions can reliably discriminate the affective valence of facial expressions presented to their blind fields by guessing, or by using techniques like reaction times, despite having no conscious awareness of the stimuli (Anders et al., 2004; de Gelder, Haan, & Heywood, 2001; de Gelder, Pourtois, & Weiskrantz, 2002; de Gelder, Vroomen, Pourtois, & Weiskrantz, 2000; de

[3] Blindsight (Cowey & Stoerig, 1991; Weiskrantz, 1986) is a phenomenon where patients with primary visual cortex (V1) lesions, but intact retina and retino-tectal projections, maintain that they are blind, but have accurate (above chance) behavioral responses to visual tracking and other select visual tasks, which are thought to be mediated by extrageniculostriate retinofugal pathways (Cowey & Stoerig, 1991). Thus, they can perceive visual stimuli in some way even though they are not conscious of doing so. Similar phenomena have been observed in other sensory modalities, such as blindsmell (Schwartz, 1996; Schwartz et al., 1994) and blindtouch (Paillard, Michel, & Stelmach, 1983), where patients are not consciously aware of the stimuli due to lesions in or near the corresponding primary sensory cortex but have appropriate behavioral responses to them.

Gelder et al., 1999, 2001; Hamm et al., 2003; Pegna et al., 2005; Tamietto & de Gelder, 2008).

These "unconscious emotion" effects (e.g., affective somatic responses to visual stimuli presented in a V1 lesion patient's blind visual field) are thought to be mediated by a subcortical visual pathway that includes the superior colliculus, pulvinar thalamus, and amygdala (aka a subcortical retino–tecto–thalamic route to the amygdala) (e.g., Berman & Wurtz, 2010; Diamond & Hall, 1969; Lyon, Nassi, & Callaway, 2010). However, recent work by Schmid et al. (2010) shows that in the monkey, the thalamic lateral geniculate nucleus (LGN) is critical in the processing of visual information independent of V1 (i.e., blindsight), via direct LGN projections to extrastriate cortex (e.g.V2, V3, V4, and V5). In either case, there appears to be an "alternative" pathway that bypasses neocortical processing routes thought to be necessary for conscious detection, discrimination, and identification of stimuli (Andino, Menendez, Khateb, Landis, & Pegna, 2009; Johnson, 2005; Linke, De Lima, Schwegler, & Pape, 1999; Morris, Buchel, C., & Dolan, 2001; Morris, Friston, & Dolan, 1997; Morris, Ohman, & Dolan, 1999; Pegna et al., 2005; Rosen et al., 1992).

Emotional influences on conscious perception may be related to automatic activation of emotional circuits including, but not limited to, the amygdala. Animal studies suggest that fear-related responses occur via a direct subcortical pathway from the thalamus to the amygdala, allowing emotional (specifically threatening) stimuli to be processed automatically and outside awareness (LeDoux, 1998a). Imaging studies reveal that while implicit cognitive learning is mediated by regions including the striatum (Rauch et al., 1997), unconscious emotional responses are mediated by regions including somatosensory association areas (Anders et al., 2004) and the amygdala (de Gelder, Morris, & Dolan, 2005; Morris, Ohman, & Dolan, 1998; Stein, Solms, & van Honk, 2006; Vuilleumier et al., 2002; Whalen et al., 1998). For example, individual differences in trait anxiety predict basolateral amygdala response to unconsciously processed fearful faces (Etkin et al., 2004), and amygdala activation correlates with indirect/unconscious measures of race evaluation (Implicit Association Test and potentiated startle), but not with the direct/conscious expression of race attitudes (Phelps et al., 2000). Naccache et al. (2005), using intracranial electrodes, recorded brain potentials in three epileptic patients. Emotional words presented subliminally modulated amygdala activity at a long latency (>800 ms), implying that subliminal words can trigger long-lasting cerebral processes, like semantic access to emotional valence.

Threatening (fearful, angry) as well as nonthreatening (happy) emotional pictures and faces result in increased amygdala activity even when they are unattended (Anderson, Christoff, Panitz, De Rosa, & Gabrieli, 2003; Vuilleumier et al., 2001), presented briefly, masked from awareness (Morris, Ohman, & Dolan, 1998; Whalen et al., 1998), or suppressed during binocular rivalry (Pasley, Mayes, & Schultz, 2004; Williams, Morris, McGlone, Abbott, & Mattingley, 2004). In accordance with this, blindsight patients show modulation of amygdala activity in response to the emotional meaning of stimuli that they cannot see consciously (Andino et al., 2009; Morris, de Gelder, Weiskrantz, & Dolan, 2001; Penga et al., 2005). Other neuroimaging studies have found substantial activation in the amygdala (as well as the fusiform gyrus and superior temporal sulcus) and emotional responses to objectively invisible emotional stimuli (see Tsuchiya & Adolphs, 2007). For example, Jiang and He (2006) found that bilateral amygdala responses to fearful faces occurred independent of objective visibility, but the responses to neutral faces were modulated by visibility. The increased amygdala activity for suppressed affective faces, regardless of valence, may be driven by inputs via the rapid, phylogenetically older, subcortical pathway that assists in prompt detection of potential danger (Vuilleumier, Mohr, Valenza, Wetzel, & Landis, 2003; Williams et al., 2004). Back projections linking the amygdala to the visual cortex via the thalamus (Amaral & Price, 1984; Amaral, Price, Pitkanen, & Carmichael, 1992) may provide a route by which emotion can influence perceptual dominance of rivaling images during visual cortex processing (Alpers, Ruhleder, Walz, Mühlberger, & Pauli, 2005). This "low road" of visual processing may prime and modulate the visual cortex for preferential processing of emotional material (especially fearful) (Davis & Whalen, 2001; LeDoux, 1998b, 2000). However, although the amygdala is believed to process fear-related stimuli nonconsciously and rapidly, a woman (SM) with complete bilateral amygdala lesions,[4] who could not recognize fear from faces, still showed normal nonconscious processing and rapid detection of those same fearful faces (Tsuchiya, Moradi, Felsen, Yamazaki, & Adolphs, 2009). Thus, the authors suggest that the amygdala may not be essential for early stages of fear processing, but may modulate social judgment and recognition.

[4] Note that this was not a conventional lesion that took place suddenly. SM suffers from Urbach–Wiethe disease, a rare recessive genetic disorder that causes bilateral symmetrical calcification of the amygdala, which most likely took place very early in her life.

Visual stimuli presented to fully sighted people, and in the sighted visual field of blindsight patients, are thought to be processed via the subcortical/"alternative" pathway described above (i.e., the retino–tecto–thalamic route, or via direct LGN projections to extrastriate cortex (Schmid et al., 2010), and simultaneously by the retino–geniculo–cortical pathway directly to V1 involved with in-depth, conscious cortical visual processing. And some studies suggest that the level of this parallel cortical processing determines the degree to which information from subcortical processing modulates emotional responses and reaches awareness. For example, Jolij and Lamme (2005) induced affective blindsight in healthy people by applying TMS to their visual cortex. Interestingly, subjects could report the valence of the affective face only when TMS interfered with cortical processing. Access to the affective content of the stimuli disappeared after prolonged task training or when the stimulus visibility increased. Thus, it seems that conscious processing of information can actually *repress* unconsciously processed information, lending credence to the idea that conscious processes can repress unconscious tendencies.

In line with this, using functional magnetic resonance imaging (fMRI) in 9 cortically blind patients, Anders et al. (2009) found that despite similar startle reflex potentiation in their blind and sighted visual fields in response to a threatening visual stimulus, patients reported significantly *less* negative affect when the stimulus was presented to their sighted visual field. In other words, when the affective visual stimulus was visible and received full cortical processing, the patients' conscious phenomenal experience of affect was reduced and did not reflect their unconscious somatic response. The results also implied that this "decoupling" of somatic responses and consciously experienced affect might occur via left ventrolateral PFC activity inhibiting affect-related somatosensory cortex, resulting in the reduction of negative phenomenal experience when the negative stimulus is consciously seen. However, this "repression" mechanism may be bypassed when the stimulus is not consciously seen, and in such cases the subjective negative affective experiences may counterintuitively be enhanced. Thus, the left PFC appears to play a role in the passive control of negative affect. In accordance with this, Tsushima, Sasaki, and Watanabe (2006) using fMRI and a very well controlled paradigm found that supraliminal inhibition is mediated by dorsolateral PFC activity.

It is also interesting to note that studies using pharmacological administration together with cognitive–affective paradigms or fMRI (Harmer, Hill, Taylor, Cowen, & Goodwin, 2003; Harmer, Shelley, Cowen, & Goodwin, 2004) have suggested that monoamine neurotransmitters and steroid hormones (Hermans, Putman, Baas, Koppeschaar, & van Honk, 2006; van Honk, Peper, & Schutter, 2005) play a key role in mediating implicit cognitive–affective processes as well (Stein, Solms, & van Honk, 2006).

In sum, studies in both healthy and brain lesion subjects have demonstrated that, under certain circumstances, stimuli that are not experienced consciously still can modulate neural activity and generate emotional responses. Further evidence demonstrates that subliminally presented stimuli, if sufficiently weak, can lead to autonomic responses, without the subject experiencing the emotional responses themselves—that is, when subjects are completely unaware of their own emotional reaction (Dimberg, Thunberg, & Elmehed, 2000; Tsuchiya & Adolphs, 2007). For example, two studies show that emotional states that are not experienced consciously at all can still motivate behavior (Adolphs, Tranel, Koenigs, & Damasio, 2005; Winkielman, Berridge, & Wilbarger, 2005). Winkielman, Berridge, and Wilbarger (2005) found that subliminally presented (masked) happy or angry faces, for which participants reported no subjective change in affect, could still influence their subsequent drinking behavior. Subjects placed more value on beverages (via pleasantness ratings and willingness to pay) and consumed more of the beverage after subliminally presented happy faces, while their beverage value and consumption decreased after subliminally presented angry faces. So nonconscious stimuli can influence motivation, value judgment, and goal-directed behavior without affecting conscious feeling. Further support comes from a bilateral insula lesion patient who could not perceive taste (Adolphs et al., 2005). He described solutions of lime juice, saline, and sugar as all tasting "like pop" and drank them arbitrarily. But he preferred the sugar solution when given a choice between solutions presented simultaneously, showing a motivational preference based on the affective value of the taste, without an emotional response to, or conscious experience of, the tastes. These studies demonstrate that the affective value of stimuli that are not consciously perceived and do not produce any conscious affective feelings can still motivate behavior.

Unconscious motivational processes and decision-making

Motives, like skills, may be activated unconsciously. Some claim that the majority of the motives that drive our behavior occur outside of awareness (e.g., Bargh

& Chartrand, 1999; Solms, 1997), so a person may be unable to report the goals or rewards that underlie their behavior (Bargh, 1997). A recent review paper by Custers and Aarts (2010) summarizes studies that demonstrate how the pursuit of goals can operate outside of conscious awareness, a phenomenon they call "unconscious will." Studies show that under certain circumstances, actions can be initiated without conscious awareness of the goals to be attained or their motivating effect on one's behavior. However, we still do not understand exactly how unconscious goals control behavior at the neural level, and as such, this should be explored in future research.

There are many examples that show that people are often not aware of the countless different things that affect their decisions about what they do and say (Bargh & Ferguson, 2000; Ferguson & Bargh, 2004; Hassin, Ferguson, Shidlovski, & Gross, 2007). Nisbett and Wilson (1977) review evidence suggesting that people have little or no direct introspective access, and have only *inferential* access, to their higher order cognitive processes and causal links of their mental states. Studies show that when people act on the basis of motives or preferences for which they cannot access reasons, they tend to make up sensible, often incorrect, explanations about their behaviors after the fact, based on intuitive theories about themselves and psychological causality.

Unconscious motivation in humans is often inferred but is rarely demonstrated empirically. However, Bargh (1997; Bargh & Barndollar, 1996) produced research showing the existence of unconscious motivational processes. Extending findings on automatization of cognitive processes (Anderson, 1995) to motives, Bargh claims that well-learned goals can be activated by environmental stimuli, and related behaviors can occur without conscious awareness. Disagreeing with the idea of a simple, irrational unconscious (e.g., Greenwald, 1992), he thinks an individual's history of learning in a given situation is embodied in automatic and habitual motives, which are often better guides to behavior than a conscious, seemingly rational analysis of a single event, which may be ignorant of base rates and previous automatic actions (Westen, 1998a). Accordingly, "gut" feelings are often better guides to action and produce more postdecisional satisfaction than reasoned thoughts, which may interfere with emotion-based judgments (Damasio, 1996; Wilson & Schooler, 1991; Wilson et al., 1993). Furthermore, ventromedial PFC lesion patients, whose reasoning processes are mostly intact, cannot use prior affective associative learning to adaptively guide their behavior, and consequently they make poor decisions (Bechara, Tranel, Damasio, & Damasio, 1996).

According to the "theory of unconscious thought" (Dijksterhuis & Nordgren, 2006; see also Dijksterhuis, Bos, Nordgren, & van Baaren, 2006), conscious thought, due to its precision (it can strictly follow self-generated rules), may lead to good choices in simple matters, but to worse choices in more complex matters because of its limited capacity. Unconscious thought ("deliberation without attention") can conform to rules but has a higher capacity, but due to its relative imprecision it may lead to lower quality choices. However, quality of choice does not deteriorate with increased complexity, so unconscious thought may lead to better choices under complex conditions, since large amounts of information can be integrated into the evaluation. Dijksterhuis et al. (2006) confirmed in four studies on consumer choice, in the laboratory and in actual shoppers, that purchases of complex products were viewed more favorably when decisions were made without attentive deliberation, while choices about simple products produced better and more favorable results after conscious deliberation. This suggests that complex cognitive processes like decision-making occur at the unconscious level and that it may be better to think consciously about simple matters, and unconsciously about complex ones.

However, in contrast to the predictions made by the "unconscious thought theory" (i.e., that complex decisions are best made following an interval of distraction presumed to generate "unconscious thought"), the findings of Waroquier, Marchiori, Klein, and Cleeremans (2009, 2010) suggest that decisions made after distraction are better because conscious deliberation/rumination can deteriorate decisions that have already been made on first impressions that were formed "online" during information acquisition. But conscious deliberation can improve decisions when a high-quality first impression is not available, because conscious thinking can help improve performance when alternatives have not been properly compared and a decision has not yet been made. In sum, they suggest that rather than "thinking unconsciously" about a decision, "if you have a clear first impression, stick with it; if not, keep thinking" (Waroquier et al., 2010). Waroquier et al. (2010) do not, however, assert that decisions are always best when made consciously, or that decision-making involves only conscious processes, but simply that certain types of information processing, in particular those that involve symbol manipulation and propositional reasoning, can only take place in conscious thought.

Still, substantial evidence from recent studies suggests that conscious thought does not always lead to the best choices and that, in accordance with Benjamin

Libet's classic studies (Libet, 1985; Libet, Gleason, Wright, & Pearl, 1983) and Wegner's (2003) theory that "conscious will is an illusion," simple decisions can be predicted by brain activation well before a person becomes consciously aware of his or her intent to take a certain course of action. For example, using probabilistic population codes for Bayesian decision-making, Beck et al.'s (2008) evidence suggests that our "unconscious" brain makes the best decisions; similarly, using fMRI, Soon, Brass, Heinze, and Haynes (2008) found that unconscious brain activity in prefrontal and parietal cortices predicts decisions made by as much as 7 seconds before the subject is consciously aware of his or her decision (although some argue that these studies do not adequately manipulate C (e.g., by masking) or test for explicit conscious awareness (C. Koch, personal communication). Furthermore, by recording electroencephalography (EEG) signals while participants solved verbal puzzles, Sheth, Sandkühler, and Bhattacharya (2009) found that unconscious brain activity (posterior beta and anterior gamma oscillations) predicts the moment of cognitive insight. Finally, Zhong, Dijksterhuis, and Galinsky (2008) showed that distractions facilitate creative problem-solving, demonstrating the importance of unconscious thought in creativity, and Zhaoping and Guyader. (2007) found that people performed feature-detection tasks better when they simply "trusted their instincts."

The term "defense" describes processes whereby people adjust their cognitions to avoid aversive feelings like guilt and anxiety (Freud, 1933). Emotion systems (and their governing drives) may distort cognitive representations of reality by seizing executive resources via "defenses." Freud argued that humans are often irrational, holding false beliefs, because their consequences are subjectively advantageous (Turnbull & Solms, 2007). Emotion-biased, or motivated, reasoning, biased to produce emotionally preferable conclusions, is a form of implicit affect regulation where the brain comes to solutions that simultaneously satisfy cognitive constraints that maximize goodness of fit to the data and emotional constraints that maximize positive and minimize negative affect states associated with threat to or attainment of motives (Thagard, 2003; Westen, 1994, 1998a; Westen & Blagov, 2007). Research has begun to examine explicit (conscious) processes used to regulate emotion (e.g., suppression and distraction; Anderson et al., 2004; Hariri, Mattay, Tessitore, Fera, & Weinberger, 2003; Ochsner, Bunge, Gross, & Gabrieli, 2002), but studies examining the neural basis of motivated reasoning or implicit affect regulation are rare.

In the first study to describe the neural correlates of motivated reasoning (and related concepts of psychological defense, implicit affect regulation, confirmatory biases, and cognitive dissonance; Westen, 1994), during the 2004 U.S. Presidential election, Westen, Blagov, Harenski, Kilts, and Hamann (2006) gave 30 committed partisans reasoning tasks involving judgments about information threatening to their own candidate, the opposing candidate, or neutral targets. Motivated reasoning, measured during fMRI, was associated with activation of ventromedial PFC, lateral orbitofrontal cortex, anterior and posterior cingulate, and insular cortices, and not with activation in regions (dorsolateral PFC) previously linked to conscious/explicit emotion regulation (e.g., suppression) and "unemotional" reasoning. Thus, motivated reasoning appears to be qualitatively different from reasoning when there is no strong emotional investment in the outcome. But the extent to which motivated reasoning engages neural circuits involved in "unemotional" reasoning and conscious emotion regulation is unknown.

Pessiglione (2007) imaged unconscious motivational processes in a paradigm where the tighter subjects squeezed a handgrip when an image of money was presented, the more of it they could win. The presentation duration, and thus reportability, of the images varied from 17 and 50 ms, which were determined to be subliminal from a preliminary behavioral test, to 100 ms, which was consistently associated with conscious perception. Subjects squeezed harder when larger sums of money appeared, regardless of whether they were consciously perceived or not. The ventral pallidum (of the basal ganglia) was activated whenever participants responded, and it may be part of a circuit underlying both unconscious and conscious motivation, enabling expected rewards to invigorate behavior. The results suggest a "bottom-up" decision-making process, where the ventral pallidum is part of a circuit that first weighs the reward and decides, and then interacts with the higher level, conscious regions, like the PFC, if at all. In line with this, experiments by Libet and colleagues (Libet, 1985; Libet et al., 1983,) suggest that cerebral activity (readiness potentials) precede the conscious intent to perform a motor act by as much as 500 ms, implicating unconscious processes in decision-making. It appears as if our self-sufficient brains can evaluate a situation and select adaptive action before they (i.e., we) are aware of it or of the initial input, if at all (Kinsbourne, 1998). Thus, although decisions probably involve a complicated mix of unconscious and conscious processes, evidence suggests that they are largely predetermined and biased by unconscious processes, perhaps much more than we would like to believe.

Brain lesion patients with disorders of awareness such as anosognosia (apparent unawareness of their disorder) provide further support for "cognition beyond conscious awareness" and a unique window into the nature of self-deception (Trivers, 2000). Evidence suggests that patients with anosognosia (in particular for hemiplegia) have "implicit" awareness of their deficit, and that their lack of explicit awareness is driven by the emotionally aversive consequences of bringing deficit-related thoughts into C—that is, they appear to be engaged in a "defensive" emotion-based denial of their deficit (Bisiach & Geminiani, 1991; Fotopoulou, Pernigo, Maeda, Rudd, & Kopelman, 2010; Fotopoulou, Rudd, Holmes, & Kopelman, 2009; Fotopoulou et al., 2008; Kaplan-Solms & Solms, 2000; Nardone, Ward, Fotopoulou, & Turnbull, 2007; Ramachandran, 1996a; Turnbull, Jones, & Reed-Screen, 2002; Turnbull, Owen, & Evans, 2005; Vuilleumier, 2004). It has been suggested that anosognosia might result from a lesion of a right-lateralized emotion-regulation system, such that these patients are less able to tolerate aversive stimuli (Kaplan-Solms & Solms, 2000; Nardone et al., 2007; Turnbull, Jones, & Reed-Screen, 2002; Turnbull, Owen, & Evans, 2005). In line with this and with Craig's (2002, 2009) theory (described above), findings from Fotopoulou et al. (2010) suggest that the delusional features of anosognosia for hemiplegia can be explained by a failure to "re-represent" sensorimotor information in the right insular cortex (and possibly limbic areas and basal ganglia circuits), which is thought to be required for explicit, affectively personalized sensorimotor awareness.

Using an attentional-capture paradigm with hemiplegia-deficit-related words, Nardone et al. (2007) found that non-anosognosics showed reduced latencies (i.e., facilitation) for emotionally threatening words, while anosognosics (most with hemiplegia) showed increased latencies (i.e., interference). This indicates some degree of "implicit" knowledge of their deficit, which may be kept outside of C by a process akin to repression, in that they seem to be avoiding thoughts related to their deficits (i.e., despite explicit indifference to their motor impairment, anosognosic patients show interference for disability-related words). Along similar lines, nonlesion individuals classified as repressors show slowed responses to threatening objects, while highly anxious participants show speeded-up responses to the same objects (Calvo & Eysenck, 2000).

Interestingly, anosognosic patients can temporarily acquire conscious awareness of their disability subsequent to certain psychological manipulations (Kaplan-Solms & Solms, 2000; Ramachandran, 1995; Weinstein & Kahn, 1953), such as interventions that change the affective consequences of their motor disability, manipulate a first- versus third-person perspective (Fotopolou et al., 2009; Marcel, Tegner, & Nimmo-Smith, 2004), or offer a nonaversive explanation for their paralysis (Ramachandran, 1996b). These occasional episodes of transient awareness, when knowledge of their deficit reaches C, often cause the patient a great deal of distress and negative affect such as sadness (Kaplan-Solms & Solms, 2000; Moss & Turnbull, 1996; Turnbull, Jones, & Reed-Screen, 2002; Turnbull, Owen, & Evans, 2005). These findings exemplify the importance of motivation and emotion in the generation and maintenance of self-deception.

The neural basis of unconscious dynamic processes

There has been recent interest in scientific data relevant to analytic theory (Bilder & LeFever, 1998; Solms & Turnbull, 2002; Westen, 1999) and in the reformulation of its concepts using advances in cognitive science (Erdelyi, 1985; Horowitz, 1988; Kihlstrom, 1987; Stein, 1992, 1997; Stein, Solms, & van Honk, 2006; Turnbull & Solms, 2007). Psychodynamic theories emphasize unconscious dynamic processes, which are mental processes and contents that are defensively removed from C as a result of conflicting attitudes. Empirical studies in healthy and patient populations are beginning to elucidate the neural basis of the classical psychodynamic concepts of repression, suppression, and dissociation.

Repression

Freud (1892–93) proposed that much of human behavior is influenced by unconscious processes, and that the unconscious contains socially unacceptable ideas, motives, desires, and memories associated with conflict, anxiety, and emotional pain, which are put out of mind, so as to not be easily retrieved, to protect the person from distress. Defense mechanisms are unconscious mental strategies used to protect the mind from conflict and distress. One such mechanism proposed by Freud (1915) is repression—the *unconscious* process of pulling thoughts into the unconscious, to keep unwanted, anxiety-provoking, painful memories, thoughts, desires, and impulses from entering C. But these "forgotten" thoughts, memories, and urges can still influence conscious thoughts and feelings and express themselves as symptoms. Freud believed that mental illness arises when these unconscious forces, wishes, and motives, which influence behavior, are in conflict.

Research suggests a link between physical illness and people with repressive personality style (usually measured by questionnaires and/or psychological tests), who tend to avoid feeling emotions to manage distress and defensively renounce their affects, particularly anger (Jensen, 1987; Schwartz, 1990; Weinberger, 1992, 1995). The inhibition of conscious access to emotions puts the body, especially the heart and immune system, under significant stress (Westen, 1998a). These memories and emotions do not just disappear; they continue to influence behavior (e.g., a person with repressed memories of childhood abuse may later have difficulty forming relationships). Repression may express itself through symptoms (e.g., a repressed sexual desire may resurface as a nervous cough or slip of the tongue; Freud, 1895). So, the body can articulate unconscious desires via symptoms that one cannot verbalize. This information can also leak into C via a Freudian slip (accidentally revealing a hidden motive), free association, or dreams.

The majority of studies show that while people who repress report healthy coping and adaptation, objective physiological or cognitive measures indicate that they are hypersensitive to anxiety-provoking information, especially when it is personally relevant (Furnham, Petrides, Sisterson, & Baluch, 2003). One study found that while heterosexual men exhibited increases in penile circumference to heterosexual and female homosexual videos, only the homophobic men showed an increase to male homosexual stimuli (Adams, Wright, & Lohr, 1996). Homophobia was associated with homosexual arousal that the homophobic individual was unaware of or denied. Homophobia may thus be a response to a threat to an individual's own homosexual impulses causing repression, denial, or reaction formation to such impulses (West, 1977).

The neural mechanisms underlying repression are unknown. People with a repressive personality style were found to have smaller evoked potentials to subliminal stimuli and gave significantly fewer verbal associations to the stimuli (Shevrin, 1973; Shevrin, Smith, & Fritzler, 1969, 1970). Repressiveness was also related to the presence of unconscious conflict reflected in differential brain responses to subliminal- and supraliminal-conflict-related words (Shevrin, Bond, Brakel, Hertel, & Williams, 1996). There is some evidence that subliminal conflicts are resolved without a significant contribution from the anterior cingulate cortex, which instead participates, along with the PFC, in a distributed network for conscious self-regulation (Dehaene et al., 2003).

Although some have technical objections to his account (e.g., see Koch, 2004), Libet (Libet, 1966, 1973, 1978; Libet et al., 1964) found that a critical time period for neural activation is needed for a stimulus to become conscious. During neurosurgical treatment for dyskinesias, primary somatosensory cortex (S1) was stimulated with an electrode and elicited a sensation in a portion of the contralateral hand, wrist, or forearm. A train of repetitive 0.5-ms pulses of liminal intensity had to persist for about 500 ms to elicit a sensation. This was known as the minimum "utilization train duration" (UTD). UTD values varied little over time within subjects, but they varied between subjects from 200–750 ms. Subjects with a longer UTD exhibited a greater tendency to repression, as measured by a battery of psychological tests (Shevrin, Ghannam, & Libet, 2002). So, people who need a longer time period of neural activation in order to develop a conscious experience of a stimulus may be prone to develop repression as a defense against unacceptable unconscious wishes (for instance, people with high intelligence may be prone to develop intellectualization as a defense). This suggests that this neurophysiological time factor is necessary, but not sufficient, for the development of repression and that it may be possible to explore the neurophysiological processes involved in repression itself.

Using a very clever paradigm and technique called "continuous flash suppression" (Tsuchiya & Koch, 2005; Tsuchiya, Koch, Gilroy, & Blake, 2006), Jiang, Costello, Fang, Huang, and He (2006) demonstrated that interocularly suppressed ("invisible") images of naked men and women, which do not enter the subjects' C, can attract or repel subjects' spatial attention based on their gender and sexual orientation. Despite being unaware of the suppressed images, heterosexual males' attention was attracted to invisible female nudes, heterosexual females' and homosexual males' attention was attracted to invisible male nudes, and homosexual/bisexual females performed in-between heterosexual males and females. What was particularly interesting was that *heterosexual* males were actually *repelled* by pictures of naked men in that their attention was diverted away from areas of their visual field where invisible naked men were presented. None of the other groups showed this repulsion effect. This appears to be an example of the Freudian concept of repression—that is, the unconscious prevention of anxiety-provoking thoughts or desires (in this case, perhaps latent homosexual desires in heterosexual men) from entering C. Another controversial implication of this experiment is that it suggests that an individuals' sexual orientation can be statistically inferred from their unconscious attentional biases (Koch, 2008). Although these results are only behavioral and do not uncover the neural pathways that enable such unconscious attentional modulation, the authors suggest that because the stimuli were arousing erotic images, the amygdala is likely to play a critical role.

Despite the evidence described above, the existence of repression remains contentious, due in part to its association with trauma and to the practical and ethical problems of studying it in controlled animal and human experiments. Therefore, creative paradigms with which to study the mechanism underlying repression in the laboratory are needed.

Suppression

Suppression—the voluntary form of repression proposed by Freud (1892–93)[5]—is the *conscious* process of pushing unwanted information (thoughts, emotions) out of awareness, and it is thus more amenable to controlled experiments than repression. While some claim that memory repression or suppression is a clinical myth with no scientific support (Kihlstrom, 2002), others have provided initial evidence for memory suppression (Anderson & Green, 2001; Anderson et al., 2004). Memory suppression requires people to override or stop the retrieval process of an unwanted memory, and this impairs its later retention (Anderson & Green, 2001). Executive control processes can be recruited to prevent unwanted declarative memories (provoked by cues) from entering awareness, and this cognitive operation makes later recall of the rejected memory harder (Anderson & Green, 2001). If suppression by executive control processes becomes habitual over time, inhibition may be maintained without any intention of avoiding the unwanted memory, evolving from an intentional to an unintentional process (i.e., repression).

Anderson et al. (2004) used a "think/no-think paradigm" where participants first learned word pairs (e.g., Ordeal–Roach), and then, during fMRI, were shown one member of a pair (e.g., Ordeal) and told to recall and think about the associated response (e.g., Roach) (respond condition) or to prevent the associated word from entering C for the entire 4-s stimulus presentation (suppression condition). Suppression impaired memory. After scanning, cued recall for Suppression items, when given the originally trained cue, was inferior to recall of Baseline items that did not appear during scanning. So, suppression during scanning made subjects unable to recollect memories that had been formed prescanning, and this memory deficit was beyond what was measured for simple forgetting over time. Furthermore, controlling unwanted memories (suppression) was associated with increased dorsolateral PFC activation and reduced hippocampal activation. Also, the magnitude of forgetting was predicted by both PFC and right hippocampal activations. So people can actively suppress unwanted memories by recruiting dorsolateral PFC involved in executive control (e.g., stopping prepotent motor responses [inhibition], switching task sets, overcoming interference in cognitive tasks) to disengage hippocampal processing (important for declarative memory formation and retrieval). These results establish a neurobiological model for guiding research on motivated forgetting (suppression) and integrate it with fundamental and widely accepted mechanisms of behavior control.

Depue, Curran, and Banich (2007) employed Anderson's think/no-think paradigm (Anderson & Green, 2001; Anderson et al., 2004), but instead used neutral faces as cues and negative pictures as targets. The behavioral evidence showed that subjects effectively suppressed memory. Using fMRI, they found that emotional memories are suppressed by two neural mechanisms: (1) initial suppression by the right inferior frontal gyrus over areas that support sensory elements of the memory representation (e.g., thalamus, visual cortex), preceded by (2) right medial frontal gyrus control over areas that support emotional and multimodal elements of the memory representation (e.g., amygdala, hippocampus), both of which are influenced by frontopolar areas (Figure 1). This implies that memory suppression does in fact occur and is under the control of prefrontal regions, at least in healthy populations.

Another form of "suppression" worth mentioning here is visual perceptual suppression (Blake & Logothetis, 2002; Kim & Blake, 2005; Tsuchiya & Koch, 2005), which occurs when an image—or part of one—is not accessible to conscious perception (i.e., not seen), even though the stimulus is present on the retina. Various paradigms that elicit this type of perceptual suppression are used widely, as they allow the experimental manipulation of the relationship between physical, objective stimuli and subjective, conscious content and therefore the isolation of the neuronal correlates of C.

The best-known form of perceptual rivalry is "binocular rivalry" (BR) (Alais & Blake, 2004), where perceptual content (conscious experience) oscillates, despite constant, if ambiguous, sensory input. In BR,

[5] Some (Erdelyi, 2001) suggest that this distinction in terminology is a distortion of Freud's view by Anna Freud, and that Freud used the term "repression" to refer to both conscious and nonconscious acts (Anderson et al., 2004).

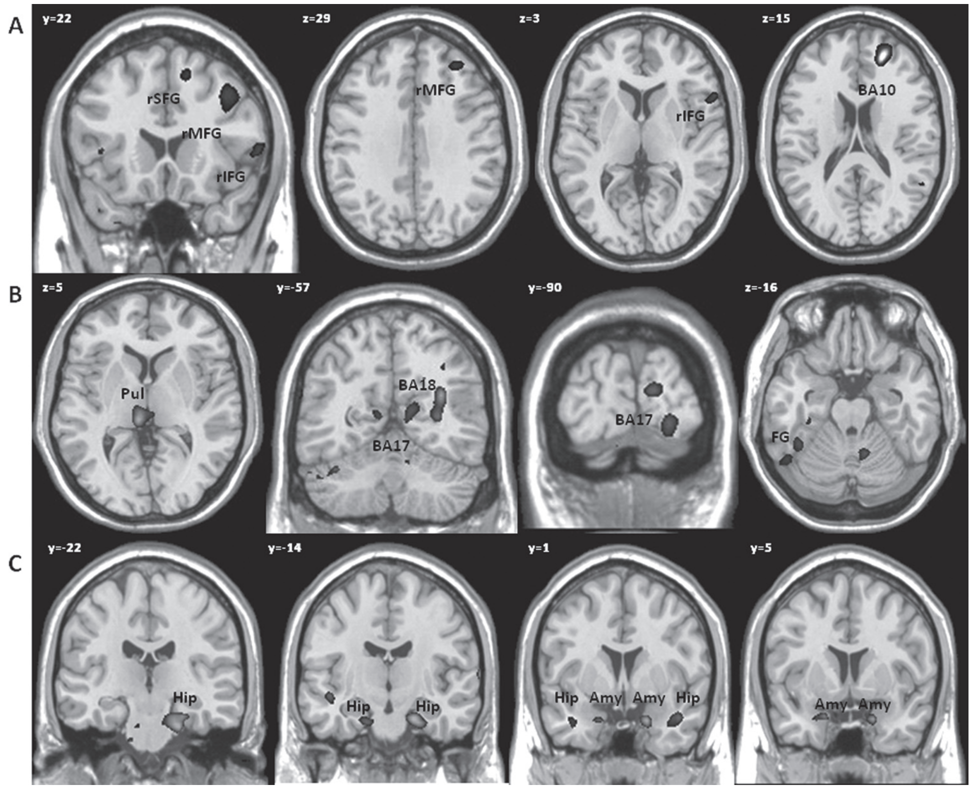

Figure 1. Functional activation of brain areas involved in (A) cognitive control, (B) sensory representations of memory, and (C) memory processes and emotional components of memory (rSFG, right superior frontal gyrus; rMFG, right middle frontal gyrus; rIFG, right inferior frontal gyrus; Pul, pulvinar; FG, fusiform gyrus; Hip, hippocampus; Amy, amygdala) (courtesy of Brendan E. Depue).

two different images are presented simultaneously, one to each eye; rather than perceiving a binocularly fused image, perception alternates between the two images, usually every few seconds, in a seemingly random way, indefinitely. Each "rivaling" image (monocular view) undergoes a period of dominance and of suppression from awareness. The proportion of time each dominates depends on attributes of both images (i.e., their contrast, spatial frequency, content, size, etc.) as well as characteristics of the individual viewer. Selective attention can influence the dominance duration of an image, but whether BR can be controlled by attention is debated. Voluntary, "endogenous" attention appears to be effective only during dominance, but not during suppression (Blake & Logothetis, 2002). Therefore, a more apt description of "perceptual suppression" would be "perceptual repression" due to the lack of conscious control over which stimulus enters awareness and for how long. However, remains to be determined whether the neural mechanisms underlying this form of suppression are related to those underlying psychodynamic suppression and repression.

Dissociation

The concept of "dissociation" was originally put forward by the French psychiatrist Pierre Janet [1859–1947] to describe the "dual consciousness" characteristic of hysteria (Ellenberger, 1970). Dissociation is currently described as a psychological state in which certain thoughts, emotions, sensations, or memories are separated from the rest of the psyche (aka "splitting"), which is not inherently pathological but is more prevalent in people with mental illness (APA, 2000). The DSM-IV-TR (APA, 2000) defines dissociation as "a disruption in the usually integrated functions of consciousness, memory, identity or perception," and specifies five dissociative disorders: dissociative amnesia, dissociative fugue, depersonalization disorder (DPD; Simeon & Abugel, 2006), dissociative identity disorder (DID; formerly multiple personality disorder), and dissociative disorder not otherwise specified (Kihlstrom, 2005). Dissociation may also present as a symptom in other psychiatric disorders (Sar & Ross, 2006).

DPD is a dissociative disorder characterized by a persistent or recurrent feeling of being detached from one's mental processes or body, accompanied by a sense of unfamiliarity/unreality and hypoemotionality, but with intact reality testing (APA, 2000). People with DPD have difficulties with information processing in relation to the dissociative detachment feature of depersonalization, especially in early perceptual and attentional processes, and with effortful control of the focus of attention (Guralnik, Giesbrecht, Knutelska, Sirroff, & Simeon, 2007; Guralnick, Schmeidler, & Simeon, 2000; Stein & Simeon, 2009). They have also been shown to have attenuated emotional perception, disrupted emotional memory, and a difficulty in identifying feelings (Medford et al., 2006; Montagne et al., 2007; Simeon, Giesbrecht, Knutelska, Smith, & Smith, 2009).

Sierra and Berrios (1998) put forward a "corticolimbic disconnection hypothesis," which is supported by functional neuroimaging and psychophysiological studies. The hypothesis suggests that depersonalization occurs via a fronto-limbic suppressive mechanism, which is mediated by attention, and generates a state of subjective emotional numbing and disables the process by which perception (including that of one's own body) and cognition become emotionally colored. This emotional "decoloring" results in a qualitative change of conscious awareness and feelings of "unreality" or detachment, which become persistent and dysfunctional in people with DPD (Sierra, 2009; Sierra & Berrios, 1998). More specifically, the authors suggest that hyperactivity of the right PFC (in particular the right dorsolateral PFC) increases alertness, while left PFC activation inhibits the amygdala and other limbic structures (in particular the anterior insula), causing chronic hypoemotionality in DPD (Phillips & Sierra, 2003; Sierra, 2009; Sierra & Berrios, 1998). Understanding the neural basis of C requires an account of the neurocognitive and neurobiological mechanisms that underlie distortions of self-perception such as those seen in the context of DPD.

To further examine the neural basis of dissociation, the next section focuses on DID since it is the most complex, chronic, and severe of the dissociative disorders, and it presents as a symptom in the other dissociative disorders. Challenging the notion of a unitary self-consciousness, DID is characterized by identity fragmentation, rather than proliferation, and is usually associated with a history of severe childhood trauma (Putnam, 1997). DID involves the presence of two or more distinct dissociative identity states, characterized by different emotional responses, cognitions, moods, and perceived self-images, that recurrently and alternately take control of one's behavior and C. Clinical data suggest that the "traumatic identity state" (TIS) has access to traumatic autobiographical memories and intense emotional responses to them. But when in the "neutral identity states" (NIS), patients claim amnesia for traumatic memories (coinciding with the notion of suppression) too extensive to be explained by normal forgetfulness. In the NIS they appear to inhibit access and responses to traumatic memories, processing and responding to trauma-related information as if it pertains to neutral and/or nonautobiographical information, thus enabling daily life function.

Neurobiological studies support the validity of the diagnosis of DID and provide clues to the neural basis of dissociation. In the first controlled structural MRI study of DID, Vermetten, Schmahl, Lindner, Loewenstein, and Bremner (2006) found that compared to healthy controls, DID patients had 19.2% smaller hippocampal and 31.6% smaller amygdalar volumes. Ehling, Nijenhuis, and Krikke (2008) also found that DID patients had smaller hippocampal (25–26%) and amygdala (10–12%) volumes than healthy controls, and those who recovered from DID had more hippocampal volume than those who did not. Stress acting via *N*-methyl-D-aspartic acid (NMDA) receptors in the hippocampus may mediate symptoms of dissociation (Chambers et al., 1999). Early life exposure to elevated glucocorticoid levels, released during stress, may result in progressive hippocampal (a target for glucocorticoids) atrophy (Bremner et al., 2003; Stein, Koverola, Hanna, Torchia, & McClarty, 1997). However, stress may not cause hippocampus damage; rather, those born with a small hippocampus and/or amygdala, perhaps owing to genetics, may be at greater risk for DID. In fact, abused subjects without DID had larger hippocampal and amygdalar volumes than nonabused subjects without DID (Vermetten et al., 2006), perhaps helping protect against early trauma. Psycho- and/or pharmacotherapy for dissociative disorders may increase hippocampal volume (Vermetten, Vythilingam, Southwick, Charney, & Bremner, 2003), but longitudinal studies are needed. Coincidently, electrical stimulation of the hippocampus in epilepsy patients resulted in dissociative-like symptoms, including feelings of *déjà vu*, depersonalization, derealization, and memory alterations (Halgren, Walter, Cherlow, & Crandall, 1978; Penfield & Perot, 1963). And ketamine, an NMDA receptor (concentrated in the hippocampus) antagonist, resulted in dissociative symptoms in healthy subjects, including feelings of being out of body, of time standing still, perceptions of body distortions, and amnesia (Krystal et al., 1994).

In relation to an orbitofrontal hypothesis of DID (Forrest, 2001), using single photon emission computed tomography, Sar et al. (Sar, Unal, Kiziltan, Kundakci, & Ozturk, 2001; Sar, Unal, & Ozturk, 2007) found that compared to healthy controls, DID patients had decreased perfusion (regional cerebral blood flow [rCBF] ratio) in the orbitofrontal cortex bilaterally, and increased perfusion in median and superior frontal and occipital regions bilaterally, and in the left lateral temporal region. Dysfunctional interaction between anterior and posterior brain areas may contribute to the neurophysiology of dissociation. Reinders et al. (2003) found specific changes in localized brain activity (via positron emission tomography [PET]) consistent with DID patients' ability to generate at least two distinct mental states of self-awareness, each with its own access to trauma-related memories. The rCBF patterns showed involvement of medial PFC and posterior associative cortices (including parietal areas) in the representation of the different states of C. Based on findings with other "disorders" of C (e.g., see Laureys, 2005; Laureys, Lemaire, Maquet, Phillips, & Franck, 1999; Laureys, Owen, & Schiff, 2004; Laureys et al., 1999, 2000), these highly connected areas have been suggested to be part of the neural network for C.

Data suggest that one brain can generate at least two distinct states of self-awareness, each with its own pattern of perception, reaction, and cognition (Dorahy, 2001; Nijenhuis, van der Hart, & Steele, 2002) and displaying different psychobiological traits that are generally not reproducible in DID-simulating controls (e.g., Miller & Triggiano, 1992; Putnam, 1997). Differential responses in DID patients have been reported in electrodermal activity (Larmore, Ludwig, & Cain, 1977; Ludwig, Brandsma, Wilbur, Bendfeldt, & Jameson, 1972), autonomic nervous system variables (Putnam, Zahn, & Post, 1990), arousal (Putnam, Zahn, & Post, 1990), EEG (Coons, Milstein, & Marley, 1982; Hughes, Kuhlman, Fichtner, & Gruenfeld, 1990; Mesulam, 1981; Putnam, 1993), visual evoked potentials (Putnam, 1992), and rCBF (Mathew, Jack, & West, 1985; Saxe, Vasile, Hill, Bloomingdale, & Van der Kolk, 1992; Tsai, Condie, Wu, & Chang, 1999). Brain areas directly or indirectly involved in emotional and memory processing are most consistently reported as being affected in DID (Dorahy, 2001; Nijenhuis, van der Hart, & Steele, 2002).

Physiologic differences across identity states in DID also include differences in dominant handedness (which may indicate opposing hemispheric control of different identity states), response to the same medication, allergic sensitivities, endocrine function, and optical variables such as variability in visual acuity, refraction, oculomotor status, visual field, color vision, corneal curvature, pupil size, and intraocular pressure in the various DID identity states, compared to healthy controls (Birnbaum & Thomann, 1996). One patient (BT) with DID in response to trauma, gradually regained sight during psychotherapy, after 15 years of diagnosed cortical blindness by neuro-ophthalmic examination (Waldvogel, Ullrich, & Strasburger, 2007). Initially only a few personality states regained vision, while others remained blind. Amazingly, visual evoked potentials were absent in the blind personality states, but normal and stable in the sighted ones. This case shows that, in response to personality changes, the brain has the ability to prevent early visual processing and consequently obstruct conscious visual processing at the cortical level. The neural basis of this ability is being explored (Strasburger et al., 2010). Top-down modulation/suppression of activity in the early stages of visual processing, perhaps at the level of the thalamus or primary visual cortex, may be the neural basis of psychogenic blindness (Berlin & Koch, 2009).

Reinders et al. (2006) were the first to compare the response to trauma-related stimuli in the same DID patients in different dissociative identity states. Differences were found between the NIS and TIS, in response to a trauma-related versus neutral memory, in subjective reactions (emotional and sensorimotor ratings), cardiovascular responses (heart rate, blood pressure, heart-rate variability), and cerebral activation patterns (rCBF via PET). When exposed to identical trauma-related stimuli, the two dissociative identity states exhibited different autonomic and subjective reactions and rCBF patterns, implicating different neural networks. This extends findings in healthy subjects (Anderson et al., 2004) that memory suppression can be transferred to unrelated memories, which Reinders et al. (2006) suggests may result in psychopathology.

So there seems to be a type of "splitting" of C in DID patients. But how does this relate to the neural correlates of C? By what mechanism can multiple selves coexist or alternate in the same brain? There is remarkable similarity between psychiatric and neurological dissociation syndromes, but the main difference is that the former are conceived as a disconnection between psychic functions such as seeing and acting, while the latter are defined in terms of physical disconnection between specialized brain regions such as vision and motor areas. But both types of disorders can be considered disorders of integration, the former because of a "functional" or dynamic impairment of connectivity and the latter because of a neuroanatomical lesion.

Thus, what appears to be altered in both neurological disconnection syndromes and dissociative disorders is not so much the degree of *activity* of a brain area or psychic function, but the degree of *interactiv-*

ity between such areas or functions. Integration of various cortical and subcortical areas appears to be necessary for cohesive conscious experience (Laureys et al., 1999a, 1999b, 2000; Tononi, 2004, 2005). Dissociation may involve disruption of cortico–cortical, thalamo–cortical, amygdalo–cortical, or hippocampo–cortical connectivity (Krystal, Bremner, Southwick, & Charney, 1998). Many of these connections are excitatory NMDA receptor mediated and are blocked by the NMDA antagonist ketamine, which results in dissociative symptoms in healthy subjects. Psychopathologies, like dissociative disorders, that defy the apparent unity of the self, may be failures of coordination or integration of the distributed neural circuitry that represents subjective self-awareness (Kinsbourne, 1998).

The French neurologist Jean-Martin Charcot [1825–1893] believed that the transient effects of hypnosis and the inexplicable neurological symptoms of "hysteria," currently known as "dissociative (conversion) disorder," involved similar brain mechanisms. In line with this, recent studies in cognitive neuroscience reveal that the brain processes involved in symptoms of "hysteria" are in fact similar to those seen in hypnotic phenomena (see Bell, Oakley, Halligan, & Deeley, 2010). Studies also indicate that hypnotizability is associated with a tendency to develop dissociative symptoms, particularly in the area of sensorimotor function, and that suggestions in highly hypnotizable people can replicate dissociative symptoms (Bell et al., 2010). Interestingly, converging evidence indicates that dissociative "symptoms," whether simulated through hypnosis or diagnosed clinically, are linked to increased PFC activation. This implies that interference by the prefrontal/executive system in voluntary and automatic cognitive processes is a shared neural feature of both dissociation and hypnosis. However, systematic, well-controlled, and well-designed experiments investigating the neurocognitive basis of dissociation and hypnosis are needed.

The neural basis of conscious vs. unconscious processes

The evidence described thus far suggests that complex cognition can proceed in the absence of C and that the unconscious brain is active, purposeful, and independent and can selectively access and activate implicit goals and motives. However, exactly how unconscious emotions and evaluations help shape the dynamics of the neural coalitions that give rise to conscious perception is still unknown. Studies suggest that subliminal stimuli produce enough neural activity at a relatively high level of complexity to trigger an appropriate behavioral response. But something in this neural activation is inadequate for conscious experience to arise. So, what is missing?

One possibility is suggested by experiments that show that various cognitive tasks that require awareness are accompanied by short-term temporal correlations among distributed populations of neurons in the thalamocortical system. A coalition of neurons is a collection of mono- or polysynaptically coupled forebrain neurons that dynamically assemble over a fraction of a second to encode a percept, memory, or thought (Koch, 2004). Coalition members reinforce each other and suppress competing coalition members. These competitive interactions can be biased by attention (Koch, 2004). Oscillatory and synchronized neural firing may play a key role in strengthening one coalition over others and in determining which percept enters C (Cosmelli et al., 2004; Engle & Singer, 2001; Gross et al., 2004; Koch, 2004; Rodriguez et al., 1999; Srinivasan, Russell, Edelman, & Tononi, 1999; Swindale, 2003; Thompson & Varela, 2001; Varela, Lachaux, Rodriguez, & Martinerie, 2001). When we become conscious of an event, there is evidence of synchronized activity between widely separated brain regions, particularly within the thalamocortical system (Rodriguez et al., 1999; Srinivasan et al., 1999; Tononi, 2004, 2005). Brief periods of synchronization of oscillating neuronal firing in the gamma range (30–80 Hz) may be an integrative mechanism that brings together a widely distributed group of neurons into a coherent assembly that underlies a cognitive act (Balconi & Lucchiari, 2008; Engle & Singer, 2001; Gross et al., 2004; Meador, Ray, Echauz, Loring, & Vachtsevanos, 2002; Melloni et al., 2007; Nakatani, Ito, Nikolaev, Gong, & van Leeuwen, 2005; Palva, Linkenkaer-Hansen, Naatanen, & Palva, 2005; Rodriguez et al., 1999) and correlates with conscious perception (Doesburg, Kitajo, & Ward, 2005; Fries, Roelfsema, Engel, Konig, & Singer, 1997; Fries, Schroeder, Roelfsema, Singer, & Engel, 2002; Srinivasan et al., 1999).

So, rather than activation of specific brain regions, conscious perception appears to depend on coordinated dynamic states of the cortical network and on transient synchronization of widely distributed neural assemblies (Engel, Fries, Konig, Brecht, & Singer, 1999; Engel & Singer, 2001; Fries et al., 1997, 2002; Lamme, 2006; Melloni et al., 2007; Singer, 2002; Thompson & Varela, 2001). Some evidence suggests the need for a critical level of activation and complexity of widely distributed neuronal assemblies (Greenfield & Collins, 2005) to enable them to be included in the "dominant focus" of C, where information is integrated into the currently dominant pattern of neuronal activity (Kinsbourne, 1988, 1993, 1997, 1998, 2006).

In general, some (e.g., Greenfield & Collins, 2005; Singer, 2002) argue for more holistic/global properties where activation of many neurons are needed for C. They believe that neurons across the brain synchronize into coordinated assemblies, and then disband, for each conscious experience. So, C is generated by a quantitative increase in holistic brain functioning (e.g., the more neuronal activity the more C) and is not a qualitatively distinct property of the brain. Others argue for more specific local properties of a very specific subset of neurons interacting in a very specific way (e.g., Crick & Koch, 2003; Koch, 2004). They believe that a unique set of neurons in particular brain regions fire in a specific manner for each conscious experience. So, qualitative, not quantitative, differences in neuronal activity give rise to C. Although this is not a theory, it implicates specific mechanisms in space or time or in the brain (e.g., 40-Hz oscillations, temporal synchrony, the PFC, the claustrum, not V1, etc.) that are testable. It implies that the neural basis for specific forms of C perception (e.g., color, motion, faces, familiarity) is restricted to part of the cerebral cortex; so a particular region is an essential node for the particular perceptual trait. However, a combination of both qualitative and quantitative properties of neural firing may be required for conscious experience to arise. For a summary of this debate, see Koch and Greenfield (2007).

Koch (2004; Crick & Koch, 2003) suggests that for conscious visual perception to emerge, neurons at the essential areas in the back of the cortex must receive reciprocal feedback from the planning centers in the front of the brain. He proposes that unless a visual area directly projects into the frontal cortex, activity in that region cannot enter awareness directly, because frontal activity is needed to help establish the dominant coalition of cortical neurons needed for conscious visual perception. Sustained spiking activity that circulates between select neurons in inferotemporal and/or medial temporal cortex and the PFC may constitute the neural basis for object perception (Quiroga, Mukamel, Isham, Malach, & Fried, 2008; Quiroga, Reddy, Kreiman, Koch, & Fried, 2005). The PFC may modulate the competition between sensory networks in the temporal lobe related to conscious perception (Kreiman, Fried, & Koch, 2002). Studies implicate the PFC in top-down control of visual processing in extrastriate cortex and of perceptual transitions during perceptual rivalry (Leopold & Logothetis, 1999; Lumer, Friston, & Rees, 1998). Using ERPs, Del Cul et al. (2007) found that subliminal processing can occur early on in the occipito–temporal pathway (<250 ms poststimulus), but that conscious perception of masked stimuli corresponds to later activity (~300 ms poststimulus) in a broadly distributed fronto–parieto–temporal network. They suggest that this late and highly distributed fronto–parieto–temporal activation may be a marker of C.

Awareness appears to take place hundreds of milliseconds after stimulus presentation, and after the cortical processing that determines the significance and nature of the stimulus (Velmans, 1991). But both conscious and unconscious mental processes are thought to be widespread in, or coextensive with, forebrain function and thus must represent different functional states of that same substrate (Kinsbourne, 1998). Unconscious processes may reflect the neural network in its modular state—that is, relatively isolated loops of action and reaction (Kinsbourne, 1998)—and/or local coordination of neural activity and propagation along sensory processing pathways (Dehaene, Changeux, Naccache, Sackur, & Sergent, 2006). Conscious processes may be the same processes but in some form of global coordination of widely distributed neural activity by long-distance synchronization (Dehaene et al., 2006; Kinsbourne, 1988). Unconscious activity may be mediated by a rapid, feedforward netwave of activity that can trigger neurons, and ultimately behavior, but that is not sufficient to establish a robust coalition for the 500 ms or longer that is necessary for conscious awareness (Koch, 2004).[6]

Conclusion

Since a large part of our mental lives occurs outside of C, with a great deal of it being exceedingly adaptive and advanced, it impels one to question what function (if any) does C actually serve. Unconscious processes appear capable of doing many things previously thought to require deliberation, intention, and conscious awareness, such as processing complex information and emotions, goal pursuit, self-regulation, and cognitive control (Hassin, Uleman, & Bargh, 2005). There have been significant advances from cognitive, neuroscientific, and social perspectives in the empirical study of unconscious mental processes (cognitive, emotional, and motivational), and in understanding their structural and functional neural correlates. This research reveals a new vision of the mind and questions traditional concepts of the self, control of action, and free will.

[6] There has also been some progress in studies on the molecular pathways involved in mediating unconscious processes, e.g. exploring the neurochemistry underlying explicit vs. implicit memory (Nissen, Knopman, & Schacter, 1987; Rammsayer, Rodewald, S., & Groh, 2000).

It is not known how much control an individual (i.e., his or her brain) has over the intricate interaction between unconscious and conscious thought, and how this relates to our concept of free will (Wegner, 2003). We still do not understand exactly how or when *conscious* drives suddenly become *unconscious* (e.g., repression), or *unconscious* drives suddenly become *conscious* (e.g., Freudian slips), or how or when people are able to override hidden urges by force of will (e.g., not acting impulsively; Berlin, Rolls, & Kischka, 2004, 2005; Hollander & Berlin, 2008). To better understand the neural basis of C (Crick & Koch, 2003; Dehaene et al., 2006; Dennett & Kinsbourne, 1992; Humphrey, 2000; Tononi, 2004, 2005), we need to account for the complex, high-level dynamics that occur between unconscious and conscious thought and the neural mechanisms that underlie and distinguish these processes.

Many secrets of the human mind and brain can be revealed when we look to the "disordered" mind and brain for answers and integrate this information with results from animal, single-cell recording, genetic, and imaging studies. Freud had the foresight to look to the brain for answers (Figure 2), but his efforts were limited by the mechanistic understanding and technologies available at the time. New advances in neuroscience and technology are now enabling the neurobiology of the dynamic unconscious that Freud envisioned to come to fruition (e.g., Berti et al., 2005; de Gelder, Morris, & Dolan, 2005; Ramachandran, 1996a; Solms, 1995; Vuilleumier, 2004, 2005; Vuilleumier et al., 2001, 2003). In the process, a good deal of what Freud originally put forth based solely on clinical observations has been revised, refined, and enhanced (Guterl, 2002). But this is to be expected, as the initial insights of every discipline in its early stages require modification over time (Turnbull & Solms, 2007). Only by studying precisely how the human brain processes information will we fully comprehend the true nature of the dynamic unconscious (Tallis, 2002). Devising novel ways, using modern technology, to empirically test dynamic unconscious processes such as repression, suppression, and dissociation will help unveil their neural basis and ultimately lead to more effective treatment options for psychiatric patients, completing the task that Freud began over a century ago.

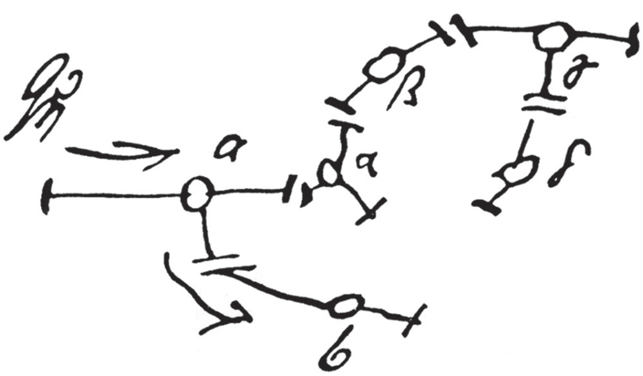

Figure 2. Freud's (1950 [1895]) own sketch of neurons and the flow of neural energy, illustrating his concept of diversion of neural energy via a "side-cathexis." The normal flow of energy (arrow on left labeled $Q'\eta$) is from neuron "a" to "b." Freud proposed that a side-cathexis of neuron "α" would attract the $Q'\eta$ and divert the flow from neuron "b." He believed this postsynaptic attraction of energy or side-cathexis was the neuronal mechanism underlying repression of forbidden wishes in both waking and dreaming (from McCarley, 1998).

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Levels of (Un)Consciousness

Commentary by Vaughan Bell (London)

Heather Berlin's review is an insightful analysis of the cognitive neuroscience behind unconscious processes at the level of "semantic or inferential processing," although there are some minor points that are worth re-evaluating. The article seems to conflate the concepts of dissociation put forward by Pierre Janet (the "unconscious compartmentalization of normally integrated mental functions"), the concept of "splitting" (presumably in the Freudian sense), and dissociative disorder as defined by the DSM-IV-TR, despite strong evidence that these are not unitary processes either conceptually and neuropsychologically. Furthermore, the championing of Freud as the figurehead of the dynamic unconscious is perhaps a little misplaced, as the main contribution of Freud was not the concept of unconscious processing, which had a long history before his work and has been well studied since, but the fact that these influences are supposedly interpretable at the level of personal meaning—something that is hard to reconcile with either the majority of evidence from cognitive neuroscience or indeed its conceptual basis. Despite these minor points of contention, the article remains a perceptive and revealing examination of the science of the unconscious.

Keywords: dissociation; hysteria; dynamic; unconscious; emotion; psychoanalysis

Heather Berlin's review "The Neural Basis of the Dynamic Unconscious" is an insightful analysis of the cognitive neuroscience behind unconscious processes at the level of "semantic or inferential processing," and, in fact, the overview is so complete and well conceived I feel a little like a sports commentator who has to resort to giving her opinion on the team's choice of footwear because there is little else to criticize. Along these lines, my commentary is largely one of style rather than substance.

I was most struck by the section on dissociation, not least because it is one of the areas I am most familiar with. In the introduction to the section, the article seems to conflate the concepts of dissociation put forward by Pierre Janet, the concept of "splitting" (presumably in the Freudian sense), and dissociative disorder as defined by DSM-IV-TR (APA, 2000). However, it is notable that these do not make comfortable bedfellows.

Janet's description of dissociation as the unconscious compartmentalization of normally integrated mental functions has largely defined the modern concept, and his idea, inherited from Jean-Martin Charcot, that "unresolved traumatic memories" are a fundamental cause is still highly influential (van der Hart & Horst, 1989). In *Studies on Hysteria* (Freud, 1895), Breuer and Freud described splitting[1] in similar terms, although it is notable that they suggested that the process and subsequent symptom can have a purely symbolic relationship to the precipitating event, something not present in Janet's original theory where dissociation was caused at a subpersonal level—something akin to the cognitive level of explanation in modern terms. Freud later placed greater emphasis on this symbolic connection, famously abandoning Breuer's need for a "hypnoid state" to facilitate dissociation, and included conflict, defense (Freud, 1894), and compromise formation (Freud, 1908) as causal mechanisms.

Berlin initially relies on the Janet-inspired definition that has found pride of place in the DSM, namely "disruption in the usually integrated functions of consciousness, memory, identity, or perception" although it is notable that the conditions described as DSM "dissociative disorders" are not the typical examples that would have characterized dissociation for Janet and Freud, whose cases of "hysteria" would now likely be diagnosed as one of the somatoform disorders, most likely conversion disorder or somatization disorder, where patients present with seemingly neurological symptoms that are not consistent with demonstrable function of the nervous system. To add further complexity, the term dissociation has more recently become associated with "depersonalization"—a general feeling of detachment from sensory input, lived experience, or "connectedness" with the world. This is the core experience in "depersonalization disorder," one of the DSM dissociative disorders, as well as peri- and posttraumatic dissociation in posttraumatic stress disorder (Brown, 2006).

Evidence suggests that "depersonalization" and conversion disorder, as well as being phenomenological distinct, are also neuropsychologically distinct and are unlikely to be explained by the same neurocognitive mechanisms (Brown, 2004; Holmes et al., 2005; Sierra & Berrios, 1999). However, it seems that these types

[1] Bearing in mind that Freud later substantially widened his definition of splitting to refer to splitting of the ego and objects.

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of dissociation (and, indeed, others) are conflated, with our own work on conversion-disorder-like syndromes (Bell, Oakley, Halligan, & Deeley, 2010), Jacksonian dreamy state phenomena during hippocampal stimulation, effects of the dissociative anesthetic ketamine, and dissociative identity disorder all considered under the same banner and subject to a single causal explanation, which is undoubtedly not the case.

I was also a little concerned that Berlin's discussion of a possible neurocognitive basis for dissociation largely focused on dissociative identity disorder (DID). Although it is considered by some to be the paradigmatic dissociative disorder (Gleaves, 1996), it has nonetheless garnered significant criticism for lack of conceptual coherence (Lilienfeld et al., 1999), equivocal evidence for dissociative memory impairments (Allen & Movius, 2000; Huntjens, Peters, Woertman, van der Hart, & Postma, 2007), and the marked influence of popular culture on its diagnosis and prevalence (Kihlstrom, 2005), making it a doubtful paradigm on which to base an analysis of dissociation. (On a conceptual note, Berlin's assertion that "neurobiological studies support the validity of the diagnosis of DID" reflect a category error, as psychopathology cannot be adequately validated on the basis of its neural substrates since by definition we base neuroscientific investigations on phenomenological categories associated with distress and impairment—mental and behavioral concepts that cannot be completely substituted by facts about the function of neurons and neurotransmitters.) These vagaries are less a fault of Berlin, more that of an indistinct literature that perpetuates the confusion in many cases and makes it difficult for the nonspecialist to see the wood for the trees. As someone who does consider herself a specialist, albeit a very minor one, I can only add my voice to the collective *mea culpa*.

The section on dissociation also highlights another theme that runs through the article: the championing of Freud as the "figurehead" of the dynamic unconscious, to the point where the concluding paragraph claims that "new advances in neuroscience and technology are now enabling the neurobiology of the dynamic unconscious that Freud envisioned to come to fruition." However, on several occasions, the ideas discussed are not a Freudian innovation, nor are they necessarily a good example of his version of the dynamic unconscious at work.

With this in mind, the aspect that makes the Freudian theory of hysteria and splitting distinctive is not the concept of dissociation (borrowed from Janet), nor the idea that dissociation was the result of the unconscious action of traumatic memories (borrowed from Charcot), but that the process had a symbolic link to the cause that was interpretable at the level of personal meaning. While the analysis provides a great deal of evidence for a neuroscience of a dynamic unconscious at work in dissociation, it provides virtually none with regard to its symbolic significance in the Freudian sense that assumes that these processes can be understood adequately, for example, at the level of jealousy for a specific person relating to specific personal events. The idea that the unconscious can be coherently interpreted at the level of symbolic meaning is central to many of Freud's theories, and yet an analysis at the level of cognitive neuroscience seems to be difficult to fully integrate with this by its very nature, owing to the fact that personal meaning, information processing, and neurobiology rely on different levels of explanation and may have to be integrated through a process of "patchy reductionism" (Kendler, 2005).

Clarity over which level of explanation we are addressing is therefore, essential, and this is not always clear in some aspects of the text. For example, in the discussion of unconscious emotional processes, one section notes that "people can feel things without knowing they feel them, and can act on feelings of which they are unaware," which would seem to lead to a logical contradiction because "feeling" is widely defined in the human sciences as the conscious subjective experience of emotion (e.g., Vandenbos, 2006). We can certainly be motivated or our behavior can be changed by things of which we are unaware, but to say that these influences are feelings is incoherent. It could be suggested that they are structurally identical to feelings but unconscious in nature, but this is an empirical point that still begs questions about the role of consciousness in our behavior and, indeed, the structure of our emotions themselves.

Of course, the great man himself was not shy of a bit of self-championing with regard to his "figurehead" status. When Freud (1940) wrote "The concept of the unconscious has long been knocking at the gates of psychology and asking to be let in. Philosophy and literature have often toyed with it, but science could find no use for it" (p. 286), he was clearly spinning us a line. We know from extensive histories (e.g., Claxton, 2006; Ellenberger, 1981) that the concept of the dynamic unconscious existed well before Freud, was central to many pre-existing theories of mind and behavior, and was consciously—and, dare we say, unconsciously—incorporated into the theories of psychoanalysis. History has shown us that psychological theories are almost invariably theories of the unconscious, however conceived, and it is much harder to find any that have rejected the importance of the unconscious mind than have accepted it.

Notwithstanding my comments on what are, at the end of the day, details in the bigger picture, Berlin's important and thought-provoking article is a remarkably comprehensive look at cognitive neuroscience of unconscious influences and a valuable resource for anyone wanting an insightful review of the relevant literature.

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The Anna Karenina Theory of the Unconscious

Commentary by Ned Block (New York)

The Anna Karenina theory says: all conscious states are alike; each unconscious state is unconscious in its own way. This paper argues that many components have to function properly to produce consciousness, but failure in any one of many different ones can yield an unconscious state in different ways. In that sense the Anna Karenina theory is true. But in another respect it is false: kinds of unconsciousness depend on kinds of consciousness.

Keywords: Anna Karenina; unconscious; phenomenal consciousness; access consciousness; dream; anosognosia

The Anna Karenina theory says: all conscious states are alike; each unconscious state is unconscious in its own way. What are those different ways in which states are unconscious? In her illuminating article, Heather Berlin describes a vast variety of ways unconscious states can occur. Here are some examples illustrating the variety of such processes even within the domain of perception:

1. Subliminal perception, in which the stimulus strength is below threshold and so too weak to

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produce conscious experience. Variants include degrading the stimulus or superimposing noise on it.

2. Masking, in which even a strong stimulus can excite early vision but interference at a later stage of processing prevents conscious experience.
3. Blindsight, in which subcortical pathways can lead to unconscious representation of a stimulus.
4. Attentional blink, in which a strong and unmasked stimulus can be prevented from reaching conscious experience by attention being drained away by another task. Variants: the emotional blink, the surprise blink.
5. Neglect, in which one side of space is not attended to, resulting in the perceptual representation of stimuli that the subject is unable to report.
6. Binocular rivalry, in which a stimulus presented to one eye inhibits the processing of a stimulus presented to the other eye. Adaptation in the dominant eye eventually weakens its hold, reversing the rivalry (Alais, Cass, O'Shea, & Blake, 2010).
7. Motion-induced blindness, another form of bistable perception
8. Crowding, in which spatial integration fields in the periphery are too large to isolate a single object, and so representations of properties of different objects interfere with one another (Pelli & Tillman, 2008).

These and other ways in which perception and perceptual priming can occur outside of consciousness are accepted by nearly everyone in this field. Unconscious semantic and cognitive processing are somewhat more controversial. Nonetheless, some of these semantic and cognitive unconscious effects withstand even the harshest scrutiny (Kouider & Dehaene, 2007). As Berlin mentions, there is ample evidence for unconscious decision processes, even inhibitory decision. (An impressive series of studies at the University of Amsterdam that she does not mention demonstrates unconscious inhibitory control: van Gaal, Ridderinkhof, Scholte, & Lamme, 2010.) Furthermore, as Berlin notes, there are a variety of ways in which motivational and affective states and processes can occur unconsciously. She mentions, for example, that invisible emotion-provoking stimuli (e.g., fearful faces) can evoke emotions that the subject does not know he has; affective blindsight; induced affective blindsight; repression (in which a representation is pulled out of consciousness by unconscious mechanisms); suppression (in which a representation is pushed out of consciousness); depersonalization disorder and various forms of dissociative identity disorder (DID).

By contrast with unconsciousness, consciousness is usually viewed as a more uniform phenomenon. One reason is that perceptions, emotions, and cognitions can all be co-conscious—experienced phenomenally in a single unified consciousness, so there must be something in common to the way in which these very different kinds of mental states are conscious. Our most widely accepted theories of consciousness appeal to something uniform among all consciousnesses, be it global broadcasting, phase-locked oscillations, reentrant processing, higher order monitoring, or high "phi."

It may seem obvious that the Anna Karenina theory is true. For any kind of complex machinery of success, everything has to work together properly to succeed, but any one of the many individual components of the process can fail, resulting in overall failure. An airplane can fall from the sky if the engines fail but also if there is a problem with the wings, the rudder, the ailerons, the control system, or the fuel lines. But there is only one kind of success, at least for a given type of airplane—if everything functions properly.

I mentioned many ways in which unconscious states and processes can be produced, but do these different ways produce genuinely different *kinds* of unconsciousness? In my view, genuinely different kinds of unconsciousness depend on genuinely different kinds of consciousness. I have distinguished between phenomenal consciousness—what it is like to have an experience—and what I call "access consciousness"—cognitive accessibility (Block, 2002). I also think there are various forms of monitoring consciousness and self-consciousness. (The co-consciousness I described that unites conscious perceptions, emotions, and cognitions is a matter of phenomenal consciousness.) So in my view, the Anna Karenina theory is true if understood to say that there are many ways of *producing* unconsciousness, but false if understood to claim that genuine kinds of unconsciousness float free of genuine kinds of consciousness.

Anyone who has had a vivid dream knows that dreams are phenomenally conscious. However, there is plenty of evidence that self-consciousness of the "autobiographical" sort that we typically have in waking life is severely reduced in dreaming. Activation in the dorsolateral prefrontal cortex is inhibited (Muzur, Pace-Schott, & Hobson, 2002), which is presumably responsible for the decreased volition, self-reflection, and insight people report in dreams. It is silly to say that dreams are unconscious, as Antonio Damasio (2010) does, and as Daniel Dennett (1976) and Norman Malcolm (1962) earlier suggested. But there is a grain of truth in this idea—namely that (except in lucid dreaming) dreaming involves inhibition of a kind of self-consciousness.

I believe that some of the cases of "unconsciousness" described in Berlin's article may be cases in which all of phenomenal and access and self-consciousness are missing, but others may be cases of mere failure of access consciousness—that is, cases of cognitive inaccessibility, possibly with preserved phenomenal consciousness. And this possibility is suggested by the way Berlin describes the cases.

As Berlin notes, in DID, patients in the "neutral identity state" claim amnesia for memories that they remember perfectly well when in the "traumatic identity state." She says that "they appear to inhibit access and responses to traumatic memories." Her description in terms of inhibition of *access* raises the possibility that those traumatic memories are represented in a form that is experienced phenomenally even though access to the neutral identity state is inhibited. The key to this speculation (and speculation is what this is) is the thought that the neutral and traumatic identities share some memory and imagery but differ in cognition.

Similar points apply to some cases of anosognosia—denial of deficit. Fotopoulou, Pernigo, Maeda, Rudd, and Kopelman (2010) describe what sounds like implicit knowledge of deficits in patients who explicitly deny them. For example, they describe one patient with anosognosia for paralysis on one side (hemiplegia) who "unceasingly complained about everyday difficulties with an emotional intensity that better fitted her devastating disability than these minor every-day disappointments." Using a task involving descriptions that in some cases were related to the deficits, Fotopoulou et al. found that anosognosic patients were significantly slower on tasks involving deficit-related descriptions than were controls, revealing "implicit" knowledge of the very deficits that they explicitly denied having. The task requires adding a missing word to a sentence that is supposed to be "completely unrelated to the theme of the sentence." For example, subjects might be asked to complete the following sentence with an unrelated word: "'A hoist is often used to lift paralyzed patients off the____'." Paralyzed patients who deny their paralysis were slow in completing such blanks compared to controls—paralyzed patients who did not deny their paralysis. On Fotopoulou's analysis, there is response competition between emotionally self-threatening information and what is needed to do the task. If the Fotopoulou analysis is right, the question arises as to how the emotionally self-threatening information is represented in these patients. If this emotionally self-threatening information is represented in the form of phenomenally conscious images of being unable to move, then these subjects would have phenomenal states that are cognitively inaccessible without a shift out of the anosognosic state.

Berlin describes repression in terms that suggest a similar account. She speaks of "inhibition of conscious access to emotions," noting that the emotions do not disappear in repression and that their inhibition puts the body under stress. One might wonder whether part of the explanation of this stress is that the emotions are actually experienced in phenomenal consciousness.

I started this paper with a discussion of the Anna Karenina theory, noting that fundamental kinds of unconsciousness must be based on fundamental kinds of consciousness. In particular, I argued, one kind of unconsciousness may involve impaired cognitive access (access consciousness) with preserved phenomenal consciousness. Whether the converse case of preserved access consciousness without phenomenal consciousness can occur is another matter (Block, 1996; Hartmann, Wolz, Roeltgen, & Loverso, 1991). But my main point has been that in Berlin's essay as in much of the literature on unconscious states, some kinds of unconscious states are described in the language of access, as if the author is leaving room for the possibility that what is missing is *just* access, opening up the possibility that a deeper form of consciousness may be preserved.

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Psychological Processes and Neural Correlates

Commentary by Morris N. Eagle (New York)

The wide range of studies and findings presented in Heather Berlin's paper supports Freud's claims regarding the descriptive unconscious, in particular the claim that unconscious mental processing is ubiquitous. However, what do the studies and findings show with regard to claims regarding repression and the dynamic unconscious? Dealing with that question is the focus of my commentary. I also discuss the question of unconscious affect, together with some general comments on the relationship between psychological processes and neural correlates.

Keywords: unconscious processes; neural processes; dynamic unconscious; repression; unconscious affect; neuroscience and psychoanalysis

Heather Berlin's article, "The Neural Basis of the Dynamic Unconscious," is a *tour de force* of information and the sheer number of studies and research areas covered. It provides a valuable and impressive overview of research findings on the neurophysiological underpinnings of unconscious processes. It would be a daunting task to discuss the wide range of studies and findings presented in her article, particularly given my lack of expertness in neurophysiology. Hence, my commentary will deal mainly with one central question: How are the studies covered relevant to psychoanalytic concepts, propositions, and formulations? In particular, I focus on repression, the "cornerstone" of psychoanalysis that is central to an understanding of the "dynamic unconscious."

I begin with a general comment, then focus on the implications of the findings reported in the article for the concept of repression, followed by a brief comment on the question of unconscious affect and ending with some general remarks on the relationship between neuroscience and psychoanalysis.

The dynamic vs. the descriptive unconscious

As is implicit in Berlin's article, one must first demonstrate the tenability of unconscious processing in general before one can even begin to refer to processes relevant to the dynamic unconscious. And indeed, despite the title of the paper—"The Neural Basis of the Dynamic Unconscious"—much of it is concerned with the former. However, although the existence of the former is a necessary condition for the latter, it is not a sufficient one. Indeed, there are many theorists (e.g., Kihlstrom, 1987) who accept the existence of ubiquitous unconscious processes, but reject the claims associated with the dynamic unconscious.

Still, recognition of the existence of unconscious processes and the identification of their neural correlates is of no small significance for psychoanalysis. It opens the door to the possibility of investigating dynamic unconscious processes. As the studies described by Berlin indicate, we have come a long way from the Cartesian equating of mind with conscious awareness. One needs to recall that the dominant philosophical position greeting Freud's concept of unconscious mental processes was the Cartesian equating of mental with conscious. From that perspective, the notion of unconscious *mental* processes was a contradiction in terms, a logical absurdity. Indeed, some philosophers reacted in precisely that way (e.g., Field, Averling, & Laird, 1922). And as late as 1968, in a primer entitled *Philosophy of Mind* (1968), written by the distinguished philosopher Jerome Shaffer, there is not a single reference to unconscious processes. Indeed, the author writes that "if we were asked to give a general characterization of the branch of philosophy of mind, we might say

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that it is the branch particularly concerned with the nature of consciousness . . .” (p. 4).

As Berlin notes, the findings presented in her article suggest not only that, as Freud (1915b) proposed, unconscious processing is ubiquitous, but also that such processing can occur at the complex level of semantic meaning. This conclusion, although still contested by some, is supported by the nature of the thoughts, feelings, and actions that subliminal stimuli can prime as well as the evidence that such priming entails cortical activation. As Berlin also notes, these studies are generally carried out without reference to psychoanalytic theories. They are mostly relevant to what has been referred to as the “cognitive unconscious” (Burston, 1986; Eagle, 1987; Kihlstrom, 1987)—or what Freud (1915b) referred to as the descriptive unconscious—rather than the “dynamic unconscious.”

Although many of the studies on the cognitive unconscious cited by Berlin support the assumption of ubiquitous unconscious processing, they do not speak directly to the hypothesis that unconscious affective and motivational factors can mold the unconscious mind. It is such factors that are especially relevant to the concept of the dynamic unconscious. In the latter context, Berlin has cited studies that show that autonomic and brain responses to emotional stimuli can occur when the latter are presented subliminally. There is also evidence that the much vaunted faculty of reason can be influenced by the aim of maximizing positive affect and minimizing negative affect. Although these studies come a bit closer to repression and the dynamic unconscious, they are not yet fully there.

Repression and the dynamic unconscious

What does one mean by the concept of the dynamic unconscious? Put very simply, the dynamic unconscious is conceptualized as a repository of repressed wishes and impulses, as a “cauldron full of seething excitations” (Freud, 1933, p. 73). It is called dynamic because these wishes and impulses are always striving for expression in consciousness and in motor action and are prevented from doing so by counterforces of defense. There is always a dynamic tension between these two sets of forces.

Given the centrality of the notion of dynamic unconscious, it is no wonder that Freud (1914, p. 16) referred to repression as the “cornerstone” of psychoanalysis. As he put it, “the theory of repression is the cornerstone on which the whole structure of psycho-analysis rests” (p. 16). At the core of repression is the banishment of anxiety-laden mental contents from consciousness.

There has been much discussion regarding the process or processes through which that banishment of anxiety-provoking mental contents occurs and the nature of the mental contents that are banished. In his early writings, Freud seemed to think of the repressive banishment process as a conscious one, which would make it indistinguishable from what we think of as suppression (Erdelyi, 2001). In his later writings, particularly once he supplanted or at least supplemented the topographical model with the structural model—which entailed the recognition that certain ego functions, such as defense, can be unconscious—Freud clearly thought of repression as an unconscious process.

Even if in not so many words, Freud essentially developed a homeostatic negative-feedback model for repression (as well as other defenses) that operated as follows:

1. Forbidden mental content (i.e., a thought, or a wish) elicits signal anxiety;
2. this automatically triggers repression—that is, the mental content is prohibited from entering consciousness or banished from consciousness;
3. the successful operation of repression reduces or eliminates the signal anxiety.

One can add two other implications of this model. First, insofar as successful repression serves to reduce anxiety, its repeated use serves to reinforce it to the point that it may become a habitual or characterological means of dealing with potentially anxiety-provoking material. Second, the failure of repression should lead to the outbreak of conscious anxiety. On this conceptualization, if a cognitive–affective process is to be understood as repression, it should include these components.

I make a point of delineating the components of repression because doing so may enable us to more accurately pinpoint which components are supported by empirical data and which are not, and which components the neural correlates are correlates of. As noted, according to the Freudian concept of repression, it is triggered mainly by an “inner” forbidden wish that is associated with anxiety rather than with an external percept. However, many of the investigations that attempt to study repression experimentally have to do with the question of how subjects respond to a particular set of presumably emotion-laden external stimuli, including subliminal stimuli. The assumption often made is that a wish or affect is elicited by the external stimulus, which then triggers signal-anxiety and, in turn, repression. However, quite often, no evidence is presented that either a forbidden wish or anxiety has been triggered. These studies are often interesting and inform us about what might be referred to as "something like repression" rather than Freud's concept of repression. Indeed, we may find that in the light of evidence, the Freudian concept of repression needs to be modified. And that, indeed, is just the sort of thing a consideration of the relationship between research evidence and theoretical formulations should accomplish. However, this process should be made explicit. Too often, a concept or formulation is left sufficiently vague or, at the opposite end, is operationalized in such a way that it loses all ecological validity with the consequence that it becomes difficult to evaluate its relationship to the data.

Unfortunately, the operationalization of repression in terms of such measures as poorer recall for material associated with experimentally induced failure (e.g., Zeller, 1951) or higher recognition thresholds for taboo words (e.g., Eriksen, 1963; see also MacKinnon & Dukes, 1964) had little conceptual or ecological validity—that is, had little to do with a psychoanalytic concept of repression (i.e., with the above components of repression) or with real-life expressions of repression. The result was more than fifty years of unsuccessful and unfruitful attempts to demonstrate repression in the experimental laboratory (Holmes, 1974, 1990).

Repression and neural processes

Through the years, different neural processes presumably underlying repression have been proposed. For example, during the period following the publication of research on split-brain patients (e.g., Gazzaniga, 1967; Sperry, 1968), Galin (1974) suggested that a functional disconnection between the two hemispheres (referred to as "functional commissurotomy" by Hoppe, 1977) might be the neural mechanism for repression. Galin wrote: "Mental events in the right hemisphere can become disconnected functionally (by inhibition of neuronal transmission across the cerebral comissures) and can continue a life of their own" (p. 572). (See also Levin, 2004.) Some support for Galin's proposal came from the finding that repressors show relative deficits in the transfer of information from the right to the left hemisphere (Davidson, 1984). It would be interesting to know whether more recent research findings provide any additional support and additional details in regard to the functional disconnection hypothesis. Given Berlin's description in terms of degree of interactivity and integration, the functional disconnection hypothesis seems more relevant to dissociation than to repression.

Berlin summarizes some fascinating findings that seem quite relevant to the psychoanalytic concept of repression. One such finding is the reduction of phenomenally experienced negative affect in cortically blind patients when threatening visual stimuli were present to their sighted field rather than blind field—that is, when full cortical processing was involved. This suggests some cortical mechanism that serves to dampen negative affect (see LeDoux, 1998). Another finding is the increased latencies that anosognosics show for emotionally threatening material relevant to their deficits despite conscious indifference to their impairment.

In contrast to experimental studies that focused entirely on repression as a specific mechanism triggered by certain external stimuli, the investigation of repression also took the form of viewing it as a personality variable and characterological style (see Shapiro, 1965, 1981, 1999). Berlin cites important research in this area. The finding that certain individuals who need a longer time period of neural activation for conscious experience of a stimulus to develop also show a greater tendency for repression on psychological tests supports the idea of proneness to the use of repression as a personality variable.

A great deal of research has been carried out on "repressive style," which includes the report by Weinberger, Schwartz, and Davidson (1979) of relatively low anxiety on a self-report anxiety scale, a relatively high level of physiological arousal (as measured by heart rate and skin conductance) in response to mild stress, and high scores on the Crowne–Marlowe Social Desirability Scale (Crowne & Marlowe, 1960). Taken together, these responses suggest a disjunction between conscious feelings of anxiety (at least conscious report) and bodily states as well as a tendency to limit one's self-image to socially desirable and conventional thoughts and feelings. As Berlin notes, a number of studies on "repressive style" suggest that while the benefits bestowed by this coping style include less likelihood of conscious experience of anxiety and distress, the costs include heightened susceptibility to certain physical symptoms and illnesses and compromised immune response under mild stress.

Which aspects or components of the Freudian concept of repression do these findings tend to support? Berlin interprets these results as suggesting that "The inhibition of conscious access to emotions puts the body, especially the heart and immune system, under significant stress" and also that "These memories and emotions do not just disappear; they influence behavior (e.g., a person with repressed memories of childhood abuse may later have difficulties forming relationships). Repression may express itself through symptoms (e.g., a repressed sexual desire may resurface as a nervous cough or slip of the tongue . . .).” The findings on greater susceptibility to somatic illness and compromised immune response do seem to support the hypothesis that “the inhibition of conscious access to emotions [at least of conscious anxiety] puts the body . . . under significant stress” and are congruent with Freud’s (1915a) claim that the “work” of repression entails a constant expenditure of energy. However, there is little or nothing in these findings that supports the conclusion that “a person with repressed memories of childhood abuse may later have difficulties forming relationships”—although that may be the case—or that “a repressed sexual desire may resurface as a nervous cough or slip of the tongue.” There is simply too much inferential weight placed on a limited set of data. Overinterpreting the data obscures the particular component of repression the evidence supports.

Moreover, one needs to note that there are mixed findings and a good deal of controversy regarding the relationship between repressive style and somatic as well as psychological distress. For example, Coifman, Bonanno, Ray, and Gross (2007) found that compared to those with a nonrepressive style, both bereaved and nonbereaved individuals with a repressive style showed fewer symptoms of psychopathology, reported fewer health problems and somatic symptoms, and were rated as better adjusted by close friends. And, one of my students failed to find a significant relationship between repressive style and report of physical symptoms (Bohlmann, 2008; see also Bonanno, Keltner, Holen, & Horowitz, 1995). However, Cosineau and Shedler (2006) conclude on the basis of their findings that “defensive denial of distress is itself a medical risk factor” (p. 427). One of the problems in this area that may at least partly account for inconsistent findings is that different measures of repressive style and defensive denial and different methods of obtaining information on somatic symptoms are employed. It is clear that much more work needs to be done to resolve these inconsistent findings.

Unconscious affect

Let me turn now to the question of unconscious affect.

Berlin writes that “studies on unconscious affect provide persuasive evidence that people can feel things without knowing they feel them . . . an idea that has guided psychoanalytic clinical practice for a century.” Studies are then cited suggesting that “emotional visual stimuli can elicit affective somatic responses.” However, the activation of “affective somatic responses” does not necessarily indicate that one is feeling something without knowing that one is feeling it. Not all physiological processes are accompanied by feelings.

This may be partly a semantic issue, but I think it is important to note that one of the main reasons that the evidence indicating that “affective somatic responses” can occur in the absence of conscious affect is of interest to psychoanalysis is precisely because such evidence suggests unconscious processing without phenomenal awareness. For example, the evidence that a masked emotional stimulus can activate the right amygdala without cortical activation (Jolij, 2005; Morris, Ohman, & Dolan, 1999) is of special interest because it suggests unconscious processing of emotional material without conscious feeling. There is a distinction between discriminating without awareness and the somatic responses such discrimination triggers, on the one hand, and consciously feeling of an emotion or sensation, on the other. For example, because the somatosensory-related brain areas that are activated when one is touched are also activated when observing someone being touched (Blakemore, Bristow, Bird, Frith, & Ward, 2005), this does not mean that one experiences being touched without knowing it.

As we know, Freud thought that although there was no harm in a loose use of the term, strictly speaking, there is no such thing as unconscious emotion. That is, according to Freud, in contrast to ideas, which partake of the property of representationality, feelings are, by definition, conscious (see Wakefield, 1992).

Concluding comments

It seems to me that if work on neural correlates of psychological processes are to further our understanding of them, these processes need to be clearly delineated and described. Otherwise, the meaning and significance of these neural correlates may not be clear. That is, one may not know what these neural correlates are correlates of. To borrow language from the domain of assessment and measurement, although the neural correlates may be reliable, we may not know enough about their validity, including their ecological validity.

It would also be useful to cite studies and findings that challenge cherished psychoanalytic concepts and formulations or point to the reasons and ways they need to be modified or made more precise or even relinquished in the light of available evidence. In the long run, it is the latter rather than supportive research that will contribute to the growth and vitality of psychoanalysis.

Although we may assume that repression is a unitary process, this may not be the case. If one examines the research literature on repression, it becomes apparent that it refers to a wide range of phenomena, including, for example, delayed recognition for taboo words (e.g., Eriksen, 1963), delayed formation of aggressive concepts (e.g., Szalai & Eagle, 1992), "momentary forgetting" of conflictual material (Luborsky, 1967), poorer recall of verbal material associated with induced failure (e.g., Levinger & Clark, 1961), and so on. Each of these phenomena is likely to involve different psychological processes as well as different underlying neural processes.

We might be wise to pick up on Singer and Sincoff's (1990) suggestion that we substitute for the term "repression" something like "avoidant defenses or strategies" and then make serious efforts to delineate as precisely as possible the various ways these defenses and strategies are implemented as well as their neural correlates. Such delineation ought to rely on ordinary cognitive and affective processes about which we know a good deal. These include, among others, barriers to encoding and formulating, deployment of attention, impediments to rehearsal of information already encoded, and to retrieval of such information, and so on. Such efforts serve not only the integration between psychoanalysis and psychological research, but also point to where to look for neural correlates.

As noted, Heather Berlin's article provides us with an enormous range of material on the neural correlates of unconscious processes. The next step is to carefully evaluate these studies and findings with regard to their specific implications for psychoanalytic assumptions, concepts, and formulations and for future research.

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Emerging Insights on Implicit Emotion Regulation

Commentary by Amit Etkin (Stanford, CA)

The study of emotion regulation has received a lot of interest over the past two decades and, with it, an increasingly sophisticated understanding of the neurobiological processes involved. The primary focus of this literature has been on explicit (i.e., deliberate) emotion regulation, and only recently has there been greater investigation of implicit (i.e., nonconscious) emotion regulation. It is the latter type that is therefore most relevant to an understanding of the neurobiology of the dynamic unconscious, as presented in psychoanalytic theories. In this commentary I summarize the state of knowledge regarding implicit emotion regulation, primarily focusing on experimental paradigms for which neural data have been reported. It is hoped that this perspective will augment Heather Berlin's article, covering other aspects of nonconscious processing relevant to the psychoanalytic concept of the dynamic unconscious.

Keywords: emotion regulation; implicit; explicit; reappraisal; emotional conflict; ventromedial prefrontal cortex

In her Target Article, "The Neural Basis of the Dynamic Unconscious," Heather Berlin nicely outlines many areas of research focusing on unconscious or subliminal processing, ranging from perception to decision-making and goal-setting. An important area underemphasized in her article, however, is the area of emotion regulation. I will focus this commentary on expanding the target article in the direction of emotion regulation, with a focus on those domains in which neurobiological evidence exists.

The importance of regulating emotional impulses in general, and anxiety in particular, was highlighted by early psychodynamic theorizing, dating back to Sigmund Freud, who made anxiety regulation the centerpiece of a psychodynamic theory of mental life (A. Freud, 1936; Freud, 1926). It has not been until recently, however, that neuroscience has provided a brain basis for emotion regulation, and, together with advances in affective science, has led to a new and evolving conceptualization of emotion regulation. Most salient for the topic of Berlin's article, the past few years has brought a new understanding of types of emotion regulation that happen outside of awareness, which has been referred to in the literature as implicit or automatic emotion regulation, and which

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we have recently reviewed (Gyurak, Gross, & Etkin, 2011).

To start with, it is important to recognize that emotions are whole-body responses that signal personally relevant, motivationally significant events, changing physiology, motivating action, tuning attention, and resulting often in changes in subjective feeling-states (Frijda, 1986). Thus, emotion regulation can be regarded as a set of processes that alter the intensity, duration, or type of emotion experienced (Gross, 2007). Moreover, a distinction can be drawn between explicit emotion regulation, which refers to processes that require conscious effort for initiation and demand some level of monitoring during implementation, and implicit emotion regulation, which involves processes that are evoked automatically and run without conscious monitoring, and can happen without insight and awareness.

Perhaps the clearest case of implicit emotion regulation, and which has the strongest evidence of clinical applicability, is based on the emotional conflict task that we have recently described (Egner, Etkin, Gale, & Hirsch, 2008; Etkin, Egner, Peraza, Kandel, & Hirsch, 2006; Etkin, Prater, Hoeft, Menon, & Schatzberg, 2010). The task is the emotional version of the classic Stroop paradigm (Stroop, 1935). In this task, participants are presented with pictures of emotional faces (fearful or happy) with superimposed words ("fear" or "happy"). The task is to indicate, with a button press, whether the facial expression is happy or fearful. The face and word either match the facial expression (congruent trial; e.g., happy face with the word happy), or there is an emotional conflict between the word and face (incongruent trial; e.g., happy face with the word "fear"). Compared to congruent trials, incongruent trials are associated with behavioral interference, which is measured as a slowdown in reaction times.

The reaction-time interference caused by emotional conflict, however, is decreased if an emotionally incongruent trial follows an incongruent trial than if it follows a congruent trial (an effect termed "emotional conflict adaptation") (Botvinick, Nystrom, Fissell, Carter, & Cohen, 1999; Egner and Hirsch, 2005a; Egner et al., 2008; Etkin et al., 2006; Gratton, Coles, & Donchin, 1992; Kerns et al., 2004). This trial-to-trial adaptation to emotional conflict reflects the operation of an emotional processing regulatory mechanism, activated by previous trial conflict, which improves performance on the current incongruent trial (Botvinick, Braver, Barch, Carter, & Cohen, 2001; Botvinick et al., 2004; Etkin et al., 2006; Mansouri, Tanaka, & Buckley, 2009) and occurs at an implicit (nonconscious) level (Etkin et al., 2010). Unlike healthy subjects, patients with generalized anxiety disorder fail to adapt to emotional conflict (Etkin et al., 2010).

Neuroimaging data in this paradigm, analyzed in a manner consistent with the "conflict-monitoring hypothesis," which is the cognitive model that best accounts for the conflict adaptation effect (Botvinick et al., 1999, 2001; Botvinick, Cohen, & Carter, 2004; Carter et al., 2000; Egner & Hirsch, 2005a, 2005b; Gratton, Coles, & Donchin, 1992; Kerns et al., 2004; Mansouri, Tanaka, & Buckley, 2009), distinguishes between two important functions—emotional conflict evaluation versus regulation. In doing so, we also examined evaluation- and regulation-related activation in a complementary nonemotional conflict task (gender identification of the same faces while ignoring gender label words). Regulation of emotional conflict was specifically associated with activation of the pregenual/ventral cingulate and dampening of amygdalar reactivity through connectivity with the cingulate (Egner et al., 2008; Etkin et al., 2006, 2010). By contrast, regulation of nonemotional conflict was associated with dorsolateral prefrontal activation and modulation of target-specific processing in ventral visual cortex (Egner et al., 2008). Importantly, subjects with generalized anxiety disorder failed to activate the ventral cingulate and dampen amygdalar activity, consistent with their behavioral failure to adapt to emotional conflict (Etkin et al., 2010).

Several other areas of emotion regulation research have also produced evidence of likely implicit emotion regulation, albeit with a less-developed neurobiological basis or translation to clinical contexts. As noted by others (Gross Richards, & John, 2006), people report using emotion regulation fairly frequently and engaging in habitual patterns of regulation strategies, which can be assessed through self-report accounts or questionnaires. Habitual use of reappraisal, which involves cognitive manipulation of emotional material in order to alter its meaning, is associated with greater positive affect, better interpersonal functioning, and higher well-being, compared to habitual use of expressive suppression, whereby expression of emotion is inhibited (Gross & John, 2003). During viewing of emotionally expressive faces, individuals who habitually use reappraisal more also show greater activation of prefrontal regions implicated in cognitive control (Drabant, McRae, Manuck, Hariri, & Gross, 2009). Interestingly, these prefrontal regions more closely resemble those involved in regulating nonemotional conflict than do those involved in emotional conflict in the paradigms above.

Finally, it has been noted that engaging in a number of specific activities can have an incidental or unintended emotion-regulation-like effect. For example, matching emotional expressions on faces with affect label words results in lower activation in emotion-processing regions such as the amygdala, along with greater activation in the ventrolateral prefrontal cortex (PFC), as compared to matching expressions to other expressions, matching the gender to gender labels, or simply viewing the face (Lieberman et al., 2007). Interestingly, in this task, activity in the ventromedial prefrontal cortex, near the region involved in the regulation of emotional conflict, mediates the relationship between increased ventrolateral PFC activation and decreased amygdala activation (Lieberman et al., 2007).

In summary, there is a growing literature describing various types of implicit emotion regulation and associating them to prefrontal regulatory circuits centered primarily on the ventromedial prefrontal cortex, as well as regions within the lateral prefrontal cortex. Though this area is very exciting and appears to have direct relevance for understanding clinical states, the relationships between the affective neuroscience context of implicit emotion regulation and psychodynamic theories of defense and unconscious processes remain largely unknown.

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The Scientific Study of Unconscious Processes: The Time Is Ripe for (Re)Convergence of Neuroscientific and Psychoanalytic Conceptions

Commentary by Eric A. Fertuck (New York)

Psychoanalytic and scientific conceptions of unconscious processes are reconverging. This commentary on Heather Berlin's Target Article, "The Neural Basis of the Dynamic Unconscious," discusses the current status of the study of the neural substrates of cognitive, affective, and motivational dimensions of unconscious processes. The current research is contextualized with some thoughts on the historical tensions between psychoanalytic and academic models of the mind. Recommendations for advancing both psychoanalytic and neuroscientific investigations of unconscious processes are proposed, with a focus on psychopathology and psychoanalytic treatments and processes in different types of pathological personality structures.

Keywords: unconscious; implicit; psychoanalysis; cognitive neuroscience; neuropsychoanalysis

> The nineteenth century gave birth not to one but to two psychologies, one at Leipzig, the other at Vienna. For a hundred years each struggled to develop into a viable science of mind but each, perversely complementing the other, remained incomplete.
>
> M. H. Erdelyi (1985, p. xii)

Heather Berlin is one of a new generation of cognitive neuroscientists who take psychoanalytic conceptions of unconscious processes seriously. With this review, "The Neural Basis of the Dynamic Unconscious," she has provided us with a scholarly, comprehensive overview of the scientific status of the neural understanding of unconscious processes. The most compelling message of Berlin's article is an increasingly unavoidable reality: psychoanalysts and cognitive neuroscientists can and should collaborate to investigate the unconscious mind's relation to the brain in a collaborative manner. In fact, her article invites us to reflect on why it has taken so long. As the above quote articulates, Wilhelm Wundt, the father of experimental laboratory psychology, and Sigmund Freud, the father of psychoanalysis began their disciplines at virtually the same time and in the same geographic region over one hundred years ago, but their mutual interests have been curiously and sometimes acrimoniously depreciated.

In this commentary on the Target Article, I cover three issues: first, some general comments on the state of the science of neural underpinnings of unconscious processes; second, a historical perspective on the tension between psychoanalysis and academic science in investigating unconscious and related mental processes; finally, a tentative framework for integrating the research approaches The aim of this framework is to study the neural mechanisms of pathological unconscious processes that analysts consult and treat.

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The state of the science

At the broadest level, what does Berlin's review tell us of the state of the science of unconscious processes and their neural underpinnings? First, unconscious processes do not just manifest in the psychoanalytic consulting room. There are now literally thousands of peer-reviewed experimental psychological studies documenting unconscious processes (cf. Bornstein & Masling, 1998). What is relatively new is the use of neuroscience approaches to attempt to identify the neural substrates of unconscious processes. Moreover, the myriad of methods, measures, and concepts in this emerging area of scientific inquiry lead to the conclusion that there is no singular "neural correlate of consciousness." As Berlin summarizes, "rather than activation of specific brain regions, conscious [and unconscious] perception appears to depend on coordinated dynamic states of the cortical network, and transient synchronization of widely distributed neural assemblies." There seem to be a multiplicity of unconscious processes, including motivational, affective, attentional, memory-based, and "defensive." Finally, the nature and varieties of these processes are far from fully charted and differentiated.

Historical issues

Bornstein (2005) has addressed the historical tensions between academic psychology and psychoanalysis, which is germane to the neural study of unconscious processes. He proposes that, despite the historical devaluation of core psychoanalytic theories and principles by academic psychologists, cognitive and personality psychologists have actually incorporated many psychoanalytic ideas—but under different names. Bornstein describes three historical steps involved in the appropriation of psychoanalytic ideas into mainstream psychology. *Revision and reinvention* begins the process. An idea from psychoanalysis gets revised and translated into a new discipline, usually psychology. "Unconscious" processes from psychoanalysis, as an example, became "implicit" processes in cognitive psychology (Schacter, 1987). Or, the "ego" became the "central executive" (Baddeley, 1992). The translator is sure to emphasize the distinctions between the old (psychoanalytic) and new (psychological) concept. Second, the now-mainstreamed concept is further developed in terms of measurement and methods in the experimental laboratory. Consequently, an *empirical base of literature is established*, and the concept becomes a widely accepted and psychometrically validated construct. Finally, in step three, *acknowledgment of parallels and reintegration* begins. Now that the concept is completely dissociated from its psychoanalytic roots, researchers (re)discover parallels between the construct and its origination, "noting (with some amusement) that Freud speculated about this issue way back when—and some of his hypotheses actually have been supported by recent empirical studies!" (Bornstein, 2005). It easy to wonder if some of this process is evident in Berlin's review. Could it be that the cognitive neuroscience and psychoanalytic views of unconscious processes are re-converging, rather than just converging? Did psychoanalysis spawn the psychological study of unconscious processes, which became estranged from psychoanalysis, and now academic psychology and neuroscience are rediscovering their long lost influence? It is of significance that a new generation of researchers, less swayed by sectarian and ideological biases than their forbearers, "rediscover" old parallels.

In support of the proposition that there is a reconvergence occurring, Berlin states: "Researchers are beginning to discover that the same principles that apply to cognition operate with unconscious (implicit) affective and motivational processes as well. So the cognitive unconscious (Kihlstrom, 1987) is now becoming the *cognitive–affective–motivational unconscious*." There are other areas of convergence and opportunity as well. While psychoanalytic theories were largely rooted in the in-depth treatment of individuals with "neurotic" psychopathology, cognitive neuroscience is historically rooted with famous neurological cases such as H.M. (an inspiration for research on memory), and Phineas Gage (whose brain injury focused neuroscientists on inhibitory personality processes associated with the orbitofrontal cortex). More recently, neuroscientists have focused on laboratory studies of young adults and healthier individuals using brain imaging techniques to study basic cognitive, affective, and motivational processes. In the last ten years, there has been a tidal wave of studies in neuroscientific journals examining unconscious processes in psychopathological groups, particularly those with mood and anxiety disorders (cf. Rauch et al., 2000; Whalen et al., 1998), suggesting a mutual interest in psychopathology by both psychoanalysis and neuroscience, leveraging what we have learned from case studies in neurology and experimental studies to elucidate common forms of psychopathology.

Mainstream neuroscience is now grappling with issues that garner the interest of psychoanalysis, which, in turn is imploring psychoanalysis to revisit some of its assumptions about unconscious and conscious mental life more generally. There is now a mutual interest in motivational and affective processes, in psychopathology, and in "defensive" mental operations such as repression, suppression, and dissociation. One fascinating theme emerging from neuroscience that psychoanalysis needs to grapple with is the capacity of unconscious processes to be not just wishful and "primitive," but to also be efficient for analysis of complex information, adaptive in certain contexts, and to include nonaffective, "cold" processes. The largely adaptive, efficient, and often "cold" nature of unconscious processes revealed by cognitive and neural science indicates that psychoanalysis has depreciated the scope, ontological and evolutionary significance (in addition to "drive" influences), and intelligence of unconscious human processes. In short, unconscious processes are more adaptive, smarter, and survival oriented than previously assumed by psychoanalysis. The state of the science, then, is both friendly to and challenging of psychoanalytically informed conceptions of unconscious processes.

Integrating psychoanalytic and cognitive models of unconscious processes

The natural question, now, is whether we can unify neuroscientific and psychoanalytic conceptions of unconscious processes. Perhaps the cardinal feature of a psychoanalytic unconscious process is the aim to mentally reconcile conflictual drives and emotions. At the level of personality, the tendency to use particular classes of unconscious defensive mental operations to reconcile conflict seem tightly related to primitive versus mature levels of personality organization (Stern et al., 2010). One potential contribution for psychoanalysis to make to neuroscience is the insight that defensive processes do not operate the same way in all individuals. Rather than studying "repression" or "dissociation" in relative isolation, we might gain more scientific traction if we study individuals with differing levels of maturity and health in overall personality organization.

The unconscious processes that are the daily work of analysts come in complicated forms and can unfold over months and years. For instance, consider an analysand who is unconsciously competitive with his boss due to unresolved oedipal conflicts. In analysis, such competitiveness manifests in the analysand "reading up" on her diagnosis and debating with the analyst about this, while denying any feelings of rivalry. Or, conjure an image of an individual with borderline personality and a history of childhood abuse and neglect who consciously yearns for a loving relationship but repeatedly, and unintentionally, "chooses" abusive, neglectful romantic partners due to the largely unconscious belief that he is fundamentally bad and, therefore, does not deserve a good relationship. These illustrations of unconscious processes are the bread and butter of analytic practice, and, due to their unfolding over time and multifarious variation, do not translate easily into laboratory paradigms, even those that attempt to study defense mechanisms directly inspired by psychoanalysis—repression and dissociation.

To further close this gap between clinical realities and laboratory-based, clinical neuroscience, psychoanalytic clinicians and researchers need to team up with neuroscientists. We need to move from the armchair sidelines to the scientific front lines. To address these questions, cognitive neuroscience and psychoanalysis need to integrate more naturalistic and qualitative research designs (Bucci, 2000). While many psychoanalytic phenomena do not lend themselves to laboratory study, there are other methods that have matured in psychometric sophistication that can be employed for these purposes (Blatt, Corveleyn, & Luyten, 2006) and can be integrated into other experimental studies. Our research group, for instance, is investigating the conscious and unconscious aspect of social appraisal in borderline personality disorder (BPD) (Fertuck et al., 2009), and we have incorporated an additional intensive study of personality and attachment using participant-generated narratives of attachment relationships.

However, current psychoanalytic efforts, while a promising start, are not sufficient. We need to diligently increase efforts to develop reliable and valid measures of the phenomena we treat (e.g., measures of object relations, defensive processes, personality organization, analytic process). By employing these measures in conjunction with the laboratory paradigms summarized by Berlin, we can begin to rigorously address pressing questions such as: How do we expect conscious and unconscious processes to change in effective treatment? For most neurotically organized personalities, does transferential exploration of repressive processes result in more adaptive compromise formations and defensive structures? Comparably, for borderline disorders, do we employ the transference exploration to help the individual integrate polarized, "dissociative" aspects of self into a more coherent self? Can we activate these processes in the laboratory setting at different stages in treatment to investigate these questions? The state of the science indicates clearly that the ingredients for these types of studies are in place.

In sum, Heather Berlin represents a new generation of cognitive and affective neuroscientists who openly embrace and acknowledge analytic influences in studying unconscious processes. The time is ripe for psychoanalysts to reciprocate the effort to advance the science and practice of our profession.

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Two Roads Less Travelled by Psychoanalysis

Commentary by Christof Koch (Pasedena, CA)

Two recent developments that are of import to discovering the brain basis of the unconscious are discussed: First, the development of optogenetics, allowing the astute neuroscientist to causally intervene in a specified neuronal population in a very specific manner in behaving experimental animals. Second, the development of an information-based account of consciousness—Tononi's integrated information theory.

Keywords: monkey and rodent experiments; neuronal correlates of consciousness; integrated information

Heather Berlin's magisterial overview of the cognitive neuroscience of conscious and unconscious processing summarizes in overwhelming detail the recent literature on the dynamic brain processes that influence the immediate or long-term behavior of the subject yet that bypass conscious awareness. I have nothing specific to add to her masterful presentation of this material. However, in order to make progress on these daunting problems that have challenged humankind's best minds for millennia, we need to take two roads less traveled by psychoanalysis.

Single cell recordings in behaving animals

The ongoing refinement of such visual psychophysical techniques as motion-induced blindness, continuous flash suppression, fading, masking and so on permit images to be rendered perceptually invisible—that is, unconscious—with millisecond precision. As Berlin's Target Article makes abundantly clear, there are fecund ways in which these laboratory techniques can help characterize what were until recently taboo subjects in neuroscience departments—to whit, Freudian defense mechanisms in healthy and clinical populations.

The synaptic and neuronal mechanisms underlying one such defense mechanism, repression, is now within reach. As pointed out by Berlin, "binocular rivalry" (*sic*) is the automatic and alternating perceptual suppression of one of two distinct images projected into the two eyes. This is one example of the reduction or complete elimination—to adopt a neutral language—of sensory information from conscious awareness that might serve as a model system for more general-purpose "defense" mechanisms.

Recordings from individual neurons in macaque monkeys by Logothetis and his group (Leopold & Logothetis, 1996; Sheinberg & Logothetis, 1997) have revealed that neurons in early cortical regions follow the physical stimulus and are little affected by the percept reported by the subject, while neurons in the inferior temporal (IT) cortex—one of the last purely visual cortical processing regions—correlate with the subject's percept. That is, the conflict between the two images is resolved in IT. A recent study (Libedinsky & Livingstone, 2011) found that neurons in the frontal eye fields of monkeys rapidly signaled the animal's perceptual response in a motion-induced-blindness suppression paradigm, suggesting that regions of pre-

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frontal cortex may play a critical role in the formation of conscious percepts, possibly simultaneously with earlier visual regions, such as IT (Crick & Koch, 2003).

The advantages of single cell neurophysiology is the unprecedented temporal (millisecond) resolution with which the microvariables underlying consciousness—neurons—can be queried. However, these observational studies suffer from the defect that they do not untangle the inexhaustible multiplicity of factors that play a causal role in the formation of conscious percepts and behaviors. This is also true, of course, for all the fMRI and EEG studies reported on by Berlin.

In the past five years, a revolutionary method has fundamentally changed the neuroscience. Called *optogenetics*, this method targets specific groups of nerve cells deep inside an animal's brain that have been infected with modified viruses (Boyden, Zhang, Bamberg, Nagel, & Deisseroth, 2005). The viruses cause the neurons to express bacterial opsins in their membrane that respond only to light of a specific wavelength. The neurons can then be turned on with brief pulses of blue light and turned off with equally brief pulses of yellow light. Optogenetics allows researchers to deliberately intercede at any point within the tightly woven networks of the brain, moving from observation to manipulation, from correlation to causation. Any group of neurons with a unique genetic barcode can be turned on or shut off with unparalleled precision. So, rather than exciting or inhibiting all the neurons in a particular neighborhood, as done when stimulating cortex with an electrode, let alone when stimulating the brain transcranially with magnetic or electrical fields, it becomes feasible to focus on a subset that synthesize a particular neurotransmitter or that send their output to a specific place. Or feedback or feedforward connection into a thalamic, cortical, or basal ganglion region can be selectively silenced or activated (Cruikshank, Urabe, Nurmikko, & Connors, 2010).

Close to a thousand laboratories worldwide are exploiting this technique, to investigate the basis of sleep, learning, anxiety, and movement disorders by intervening selectively, deliberately, and delicately into the system (e.g., Adamantidis, Zhang, Aravanis, Deisseroth, & de Lecea, 2007; Gradinaru, Mogri, Thompson, Henderson, & Deisseroth, 2009). The bulk of this work is done in the mouse, although some researchers are exploiting optogenetics in the monkey (Han et al., 2009), and with one study in the *ex vivo* human retina. Given the existence of this powerful technique, it would be important to develop murine versions of binocular rivalry and other perceptual phenomena that involve the specific and limited removal of perceptual information. Mice and rats possess a rich substrate of social interactions that could be mined—using computer-vision methods that allow for long-term automatic evaluation of motor patterns (Dankert, Wang, Hoopfer, Anderson, & Perona, 2009)—for behaviors that require suppression of socially inappropriate behaviors. It may be plausible that the neuronal basis of voluntary forms of suppression can likewise be studied in such model systems that are much more accessible to causal intervention than are patient populations.

A theory of consciousness

Ultimately, what is needed besides identifying the behavioral and neuronal correlates of unconscious and conscious processes is a firm theoretical understanding of consciousness. That is, we need to understand what sort of systems of highly organized matter, organic or not, have experiences (a patient in persistent vegetative state, fetus, monkey, dog, fruit fly, roundworm, and so on). In light of the many studies cited by Berlin that purport to report functional behavior in the absence of consciousness awareness of them (or delayed awareness), we need to understand the functional role of consciousness for the survival of Darwinian organisms. The one candidate for a firm theoretical understanding of consciousness is *integrated information theory* (IIT; Tononi, 2008; Balduzzi & Tononi, 2008, 2009).

Since the early days of computers, scholars have argued that the subjective, phenomenal states that make up everyday experience are intimately linked to the information expressed at that time by the brain. Yet they have lacked the concepts to turn this hunch into a concrete and predictive theory. IIT does so, based on two axioms.

First, conscious states are highly informative. One can be conscious of an uncountable number of things. For example, every frame of every movie ever made is a specific conscious percept, which is highly informative because it is what it is by ruling out trillions of other possible percepts. Second, this information is integrated. This is what philosophers refer to as the unity consciousness (Bayne, 2008). Whatever scene one is conscious of is wholly and completely present to consciousness; it cannot be subdivided into independent, unrelated components. Underlying this unity of consciousness is a multitude of causal interactions among the relevant parts of your brain. If areas of the brain start being disconnected, become fragmented and balkanized, as occurs in deep sleep or in anesthesia, consciousness fades and might cease altogether. Split-brain patients, whose corpus callosum has been cut to alleviate severe epileptic seizures, are a case in point. The surgery literally splits the person's consciousness, with one conscious mind associated with the left and the other with the right cortical hemisphere.

In summary, consciousness requires a single entity (integration) with a large repertoire of distinguishable states (differentiation). A system's capacity for integrated information, and thus for consciousness, can be measured by asking how much information is available to the system as a whole above and beyond what is available to its parts. This quantity, called Φ, can in principle be calculated for the brain or for any other system of causally interacting parts. The more integrated the system is, the more synergy it has, the more conscious it is (Tononi, 2008).

Processes that have low Φ will therefore have only little conscious experience. Yet they could still influence the behavior of the organism. Take keyboard typing, a visuomotor skill that is daily practiced for hours by most readers of this journal. Psychophysical experiments (Logan & Crump, 2009) demonstrate that most of us can rapidly type 4 to 6 characters a second with little consciousness awareness of the details. Indeed, paying attention to any one character dramatically impedes performance. Such highly trained sensorimotor systems bypass conscious awareness. Their content remains informationally encapsulated (with what finger do you type the letter "h"?). Recent electrophysiological evidence from the premotor nucleus of zebra finch controlling the animal's song (Long, Jin, & Fee, 2010) suggests that groups of neurons, chained to each other in a forward manner, can implement such rapid action in a very reliable manner. The Φ associated with such structures will be low. The challenge in front of us is to analyze the more complicated processing that is purported to be done unconsciously in terms of complexity of the underlying causal interactions. For instance, to what extent is the unconscious retrieval (parallel search) of facts or images a truly integrated process? Can all unconscious processes be carried out by local, isolated modules?

In this way, we will be able to come to a deep theoretical understanding of the nature of consciousness, how the water of the brain is turned into the wine of our own experiences.

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The "Dynamic Unconscious" May Be Experienced: Can We Discuss Unconscious Emotions When There Are no Adequate Measures of Affective Change?

Commentary by Jaak Panksepp (Pullman, WA)

The brain has many deeply unconscious neural processes, but the realm of phenomenal consciousness (qualia) rather than "awareness" is the critical issue whether there is nothing relevant in mind while so-called "dynamically unconscious" processes are operating in the brain. Concepts such as "conscious awareness" are one step above phenomenal experiences and can easily lead to confusions about what is or is not experienced during dynamically "unconscious" emotional information processing. If one does not explicitly evaluate for the presence of affective phenomenal experiential shifts, with the most sensitive and relevant measures, one can fall into the trap of calling something unconscious when it is simply not being processed in higher order "awareness." I provide examples of where the failure to monitor affective experiential shifts has too easily led investigators to place experienced aspects of mind into the unconscious, based more on their limited methodologies rather than on the absence of experiential affective shifts that pass through the mind experimentally unnoticed. Such lapses in experimental control may have had invidious, but currently unevaluated, effects on the very substantial review of available research and thinking on the "dynamic unconscious" that Heather Berlin superbly summarizes.

Keywords: affective consciousness; phenomenal consciousness; emotional experiences; dynamic unconscious; intentionality; signal detection

Heather Berlin provides a fine synopsis of the avalanche of recent empirical work on the "unconscious" aspects of MindBrain processing. As Berlin highlights, one of Freud's most important contributions was his conceptualization of the varieties of unconscious *cognitive* information, long before there was any experimental science to illuminate such issues. I suspect Freud's dynamic unconscious may largely reflect those abundant brain functions that can be *affectively* experienced, in unreflective ways, and are potentially capable of being *cognitively* recruited, to motivate actions and encourage self-reflection. Berlin's analysis serves almost as a litmus test for both the advances and perhaps foibles of modern studies of the unconscious, a growing field full of ambiguities, especially when it comes to how affective experiences are dealt with, or more typically ignored.

Berlin is clear about the advances. I will focus mostly on the foibles here, for there are many, that may currently prevent us from having a clear vision of a fully valid meaning of the term *unconscious*. Clearly, the term itself does not have a single meaning, as Freud struggled with the nuanced variations of the concept, with the *preconscious* often filling in the vast range of possibilities between the extremes—explicit conscious awareness and the deep comatose unconsciousness of brain-dead individuals. No doubt a variety of terms will be required to discuss the levels and types of consciousness between the extremes, and I wonder how Berlin deals with the concept of affective consciousness, which seems distinct from, and more ancient than cognitive consciousness (e.g., Panksepp, 2005, 2007). In general, Berlin's analysis looks down on the vast complexities of "experiences" within the brain, from a rather lofty "cognitive" perspective.

Thus, at the very outset, we may wish to ask how many *types* of conscious processes are there, and are there some that are (or seem) dynamically unconscious under certain testing conditions but experienced under others? Namely, might a disciplined vision of the various levels of the experienced mind be essential for any coherent discussion of consciousness and unconsciousness? Let us consider one dichotomy, at the very foundation of mind, that is pregnant with implications for psychoanalysis: Don't we, at a minimum, need to make distinctions between perceptually driven cognitive forms of "*awareness*" and deep internally driven affective "*experiences*"? I suspect we may be wiser to reserve the term "awareness" for higher order mental activities, and use the term "*experience*" when we talk about feelings, whether raw perceptual or affective. We will be sustaining troublesome ambiguities if we do not have better definitions of levels of consciousness. Perhaps we need more distinctions among the varieties of *experience* than are contained in Berlin's discourse about awareness?

In my reading, Berlin is using the term "awareness" as being almost synonymous with consciousness itself. I do not think we can make sense of the mass of available data, or even of the concept of consciousness, un-

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less we inquire about *experiences* that are often outside of explicit left-hemispheric linguistically accessible awareness—that is, beyond all studies that utilize experimental tools that require language to "read-out" the nature of underlying experiences. In this vein, I will provide my own views on three key issues—definitions; level's of MindBrain organization; and several issue about experiences that exist below "cognitive awareness"—in the hope of providing a useful sounding-board for Berlin to provide her own views on such critical issues.

Definitional issues

Admittedly, in many people's minds "awareness" is a term used synonymously with consciousness. This may suffice if one restricts their analysis to cognitive consciousness, which is based on perceptual *experiences* and hence can be well controlled, typically through the use of "masking manipulations," even though the most compelling work still comes from studies where the perceptual information is presented at below the absolute sensory-detection threshold. Howard Shevrin's work shines out above all others when it comes to the analysis of behavioral consequences of totally unconscious *cognitive* information inputs into the brain—namely, tachistoscopic presentation of visual stimuli at 1 ms (not possible on video screens), where *d′* of signal-detection analysis indicates that nothing was experienced in the visual field (key papers are noted by Berlin, but see also Shevrin, 2000). These stimuli do have measureable brain effects, and also influence decision-making (Bernat, Bunce, & Shevrin, 2001; Bernat, Shevrin, & Snodgrass, 2001). However, the more common, and less rigorous, procedures currently widely used are "masking paradigms" where presentations of very brief, but detectable, stimuli are promptly "erased" by more salient "masking" stimuli. Such methods have been used to provide debatable evidence even for unconscious affective processes, with the most oft-cited study being that by Winkielman, Berridge, and Wilbarger (2005).

Still, if one simply focuses on exteroceptively triggered perceptions, one still needs to make a disciplined distinction between explicit cognitive *experiences* of stimuli (i.e., the lowest possible level being detection that some kind of information was entering the brain; typically *d′* is not evaluated in "masking" studies), and the large range of possible *valuations* and *evaluations* of the stimuli, especially, for my purposes, experienced affective changes. Should we apply "awareness" to all of these varieties of experience? I don't think so. Perhaps investigators need to spend more time on such conceptual issues, and on how they may impact consciousness studies in humans and other species, especially since we may be using the term unconscious for testing conditions where there are significant experiential shifts in the subjects we study, but ones that are experienced in ways that are not commonly verbally reported.

Typically evaluation of "awareness" in human beings has to be monitored by verbal feedback, which promptly leads to a dilemma. In terms of MindBrain evolution, one could easily make the case that one of the most recent acquisitions of the human brain—namely, propositional language (along with other resulting abilities, such as rational evaluation of circumstances)—should not be the arbiter of what other parts of the MindBrain may be capable of *experiencing*. This is poignantly highlighted by a series of recent brain-imaging studies of presumably unconscious vegetative individuals that suggest some kind of residual experiences remaining in their brains (for recent work see Owens, Schiff, & Lauereys, 2009, with an analysis of ethical implications in Panksepp, Fuchs, Garcia, & Lesiak, 2007). Furthermore, when we rely on linguistic feedback, from a levels-of-analysis perspective, how sure can we be that left-hemisphere speech functions are sufficient for telling us what the rest of the brain may be experiencing? For understandable, but superficial reasons, we think our chatterbox side of the brain is adequately versed in describing all our experiences. In a wonderful recent analysis, Ian McGilchrist (2009) summarizes the complexities to be considered when we are evaluating what the "emissary" is describing in the cognitive contents of mind. When emotions overwhelm, we are often speechless. Furthermore, if one considers the various self-serving verbal confabulations that right-hemisphere stroke damage can release in the left hemisphere (Feinberg, 2010; Kaplan-Solms & Solms, 2000), we would be wise to make sure that we have given the nonspeaking right hemisphere optimal opportunity to inform us about its affective experiences. In my estimation, to be conscious is to have internal experiences, whether one can cognitively reflect on them (is "aware" for them) or not. For anyone having trouble with this distinction, remember the last time you slammed your thumb with a hammer.

Levels of organizations of the experienced MindBrain

Consciousness, just like every other intrinsic function of the brain, has an evolutionary history, with levels of ontogenetic development and phylogenetic evolutionary emergence. If one does not get the foundations right (affective survival issues, in my estimation), one is bound to have paradoxes if one just focuses on the higher cognitive levels, as is *au courant* these days. There is every indication that newborn babies have an unreflective affective consciousness. So do all species of mammals and birds at the very least (Panksepp, 1998, 2005; Panksepp & Biven, 2011).

If we focus on the common philosophical distinction between pure *experiences*—namely, raw phenomenal consciousness, especially affective states, which surely exists in all other vertebrates—and try to distinguish such pure affective states of mind from higher order forms of cognitive consciousness—we may be confronted, as was I, by a massive conundrum while reading Berlin's expert analysis. Does this, once again, put the other animals into the category of unconscious zombies? Another emerging dilemma among the nonspeaking is that brain imaging is revealing individuals with so-called persistent vegetative states (PVS) who may still have certain types of experiences in their uncommunicative minds (Machado & Korein, 2009; Marino & Bramanti, 2009; Nachev & Hacker, 2010; Owen & Coleman, 2008). Neither the consciousness of animals nor humans beset by PVS can provide linguistic self-reports, but it may be accessible using other procedures (e.g., eye movement, EEG responses, as well as in animals self-stimulation of and escape from certain types of brain circuit arousals). If we do not leave open such MindBrain possibilities, we may all too easily be tolerating human and animals suffering when we have better options (Panksepp et al., 2007).

In short, *phenomenal experience*—commonly called *qualia*—is surely the lowest order of consciousness. The all too abundant use of the higher order term "awareness" in consciousness studies puts readers in a position of not having much confidence about how the term consciousness is being defined or used. Many aspects of Berlin's fine summary of the literature become troublesome as soon as one considers such issues in the overall analysis of unconsciousness, especially across species. As I will discuss later, affective *experiences* can, in fact, be readily studied in animal models, while cognitive *experiences*—namely, those linked to sensory information channels—are distinctly more problematic. With respect to cognitive states of mind, animals have essentially no compelling way to "tell us" about what they are experiencing, except perhaps in sensory-perceptual discrimination studies. With valenced affective states, where "rewarding" and "punishing" aspects of neural circuit activities can be objectively monitored, positive and negative affective states of experience can be empirically evaluated, with direct predictions for human beings and our psychiatric disorders (Panksepp, 1998, 2005, 2010a).

So what does it mean when Berlin notes that "Animal studies suggest that fear-related responses occur via a direct subcortical pathway from the thalamus to the amygdala, allowing emotional (specifically threatening) stimuli to be processed automatically and outside awareness (LeDoux, 1998)"? The only meaning that I can extract from such claims is that fearful behavioral arousals are not experienced by animals, which of course is just opinion, especially when the data speak loudly for FEARful experiences (Panksepp, 1990; Panksepp, Sacks, Crepeau, Abbott, 1991, Panksepp, Fuchs, & Iacabucci, 2011). What about these animal studies suggest that the amygdalopedal pathways (i.e., the unconditioned stimulus and unconfined response networks that convey the feelings and responses to foot-shock, used to condition animals) are not experienced? Although LeDoux's rats may not have "awareness" of their situation, and may not have the capacity to reflect on their experiences, the key question for consciousness studies is surely whether the rats have aversive experiences when their unconditional amygdalofugal FEAR response systems headed for the periaqueductal gray (PAG) are aroused? Are we to accept that rats do not experience the pain of shock and the horror of FEAR just because LeDoux has so often claimed that animals have no emotional experiences because they do not have enough working memory (perhaps the first statement of this awkward ontological position being surreptitiously presented in his 1998, p. 302)? The epistemological evidence has long spoken otherwise in both animal and human studies, using direct stimulation of the unconditional FEAR pathways concentrated below the central amygdala, with the most fearful feelings being generated in the dorsal PAG (Nashold, Wilson, & Slaughter, 1969).

I capitalize FEAR to highlight that we are referring to a primary-process emotional/affective network of the brain—the unconditioned response system that is supposedly activated as an experience-free emotional "output" function in most mammals, according to the never-mind vision of fear-conditioners such as Michael Davis and Joe LeDoux. (Capitalization can promote clarity in communication—we must have a distinct nomenclature for emotional-primes, a scientific language that may allow us to discuss the affective nature of brain rewards and punishments, openly, without falling into the pit of mereological fallacies (i.e., part–whole confusions and insubstantial claims that animal experiences are identical to those experienced by human beings). We humans obviously have vast cognitive resources to contribute to the overall experiential equation because of massively expanded neocortices. My point is that Berlin's indefinite use of "awareness" as the anchor concept for talking about all the other supposedly unconscious brain processes, of which there are surely many, tends to bias her arguments toward potentially untenable conclusions, at least as far as raw emotional feelings are concerned. The slippery and ambiguous word "awareness" provides more conceptual flexibility than the topic currently deserves for systematic scientific progress in understanding the foundations of consciousness which, in my estimation, can only be experimentally well studied in animal models (Panksepp, 1982, 1998).

A wiser semantic anchor—the lowest common denominators for talking about consciousness—are the concepts of raw phenomenal and affective "*experiences*," the internal states that feel like "something" for living organisms. We now have scientific tools to tackle such supposedly unanswerable, age-old questions by directly monitoring the reward, punishment, and differential discriminative aspects of the artificial arousal of specific brain systems (Panksepp, 1982, 1998, 2005; Panksepp & Biven, 2011). "Awareness" is just too loose a term for those purposes; it does not capture the fundamental phenomenal feel of many of our raw emotional experiences—the diverse "rewarding" and "punishing" experiences of life: facets of mind that I prefer to call "affective consciousness" (Panksepp, 2005, 2007). If we just make "awareness" the gold standard for consciousness studies, it can have as many nuanced meanings as people debating an issue. Statements about "awareness" need linguistic competence, and that criterion can arbitrarily coax scholars to restrict the concept consciousness to humans. *Experience* may be a better descriptor for prelinguistic, foundational forms of consciousness, such as various sensory, homeostatic, and emotional valuative states of experience that many other animals surely have. But they may not constitute consciousness "awareness"—obviously animals cannot discuss such issues.

The bottom line is that we have long had experimental ways to evaluate issues such as "Do nonspeaking animals have emotional *experiences*?" The best empirically based answer to that question has long been "Of course they do!" As already noted, the most robust evidence comes from brain stimulation studies where we monitor "reward" and "punishment" effects of such artificial forms of brain arousals. And humans always report intense feelings when those systems are stimulated in their brain. In fact, when we electrically stimulate animal FEAR systems, descending from the central amygdala, all species of mammals, birds also, and perhaps cold-blooded vertebrates as well, uniformly do their best to escape the "punishing" states that are evoked (Panksepp, 1982, 1990; Panksepp et al., 1991). They do the same for when the RAGE system is artificially aroused (Panksepp, 1971). Humans exhibit intense feelings of anxiety and anger when these same brain areas are stimulated (Nashold et al., 1969; for summary, see Panksepp, 1985).

Even more poignantly, when lowly rats, with no mind at all according to some opinion leaders (LeDoux, 1998), are tested in such harsh (one might say tortuous) paradigms, such as classical conditioning of fear, they "sigh" consistently (i.e., show a double inspiration) when relieved of their harsh experiential burdens. How do we know? If in addition to providing threatened rats with danger signals (conditioned fear stimuli) that are followed by foot-shock, as is most common in this type of research, we periodically provide safety signals that consistently indicate no shock is forthcoming for a while, those little "mind-less" rats "sigh" and stop their persistent vocal complaining (persistent emission of 22-kHz ultrasonic alarm calls). They do this as soon as they "realize" they are safe for a few moments (Soltysik & Jelen, 2005). Of course, when their emotional tensions subside, they explore a bit more, which Kandel's group has envisioned as a model for positive affect that may be used to treat depression (Pollak et al., 2008), even though safety signals surely mediate "relief" (a negative reinforcement) rather than any active form of positive affect (positive reinforcement).

If perceptual and affective *experiences* need to be our conceptual anchor for consciousness, rather than *awareness*, then the mental consequences of many of the experiments that Berlin summarizes become indeterminate: They need to be replicated with affective measures in order to know what is actually transpiring within the wider field of human experiences. Namely, we need to know whether people were having any relevant/measurable shifts in experienced affective states during the many kinds of experiments that Berlin discusses. There is always the possibility of emotional/mood shifts even as one remains cognitively unaware of the incoming cognitive stimuli. In other words, Berlin's conclusions may be correct, but we should have no confidence that the phenomena discussed are as clear as she sometimes asserts. For all of the various potential affect-generating experiments that she discusses, if one only monitors verbal-cognitive responses about things one has perceived, one may be leaving many *relevant* affective shifts, even so-called fringe feelings, unmonitored(see Panksepp, 2003). Without having conducted such relevant tests, no investigator should feel justified in claiming that no relevant internal *experiences* were transpiring while making cognitive decisions. In this context, we should recall that Freud repeatedly asserted, with only occasional doubts, that affective states are always experienced. This is of rather momentous importance for the discussion of unconscious brain processes, since tasks that seem to be purely cognitive may commonly be accompanied by experienced affective changes, most especially in real-life situations.

To explicitly highlight relevant issues, let us consider a key "unconscious affect" experiment that Berlin focused on to cover this dilemma, namely the work of Winkielman, Berridge, and Wilbarger (2005). In light of the above analysis, the conclusion of Winkielman and colleagues should be deemed more controversial than the authors themselves emphasized. Briefly, in that experiment faces displaying positive and negative affect were presented at 16 ms—namely, above the perceptual detection threshold—but cognitive registration was "masked" by a promptly succeeding 400-ms "erasing" stimulus of a neutral face. Although people were not able to cognitively discriminate the positive faces from the negative ones, they were also allowed to consume sugar water during the tests, and surprisingly they drank more following presentation of positive facial stimuli than negative ones. Berlin noted that such work highlights that "nonconscious stimuli can influence motivation, value judgment, and goal-directed behavior without affecting conscious feeling." But how sure can we be that there were no relevant affective shifts?

Of course, every fact in science has alternative explanations, which typically leads to the next key experiment. In the Winkielman et al. project, one "semi-definitive" follow-up experiment was reported. But after that, the investigators seemed satisfied to claim that their thirsty subject experienced no affective shifts from presentation of happy and negativistic faces, because their most sensitive mood measure (the PANAS, "to measure 20 nuances of experience"; Winkielman, Berridge, & Wilbarger, 2005, p. 128) did not reveal any hint of experienced affective change. But most of the 10 Positive and 10 Negative mood items—such as feeling "proud" and "jittery"—could be deemed of debatable relevance for the drinking outcome measure. The "Positive Affect and Negative Affect Scale" was surely a good start, but for optimal clarity they should have monitored more targeted affects that were most relevant for their behavioral-consummator changes they had explicitly observed (increased intake of a sugar-sweetened lemon-lime Kool-Aid drink)—namely, were there any appetitive shifts in the participants? Did they have a heightened "eagerness" to consume a tasty drink? If they had expressed such changes in "desire," they could not have concluded that the elevated Kool-Aid consumption was *unconsciously* motivated. But such sophisticated "targeted" affect measures were not included. Thus, until someone replicates the experiment and asks a few more relevant affective questions such as: How thirsty are you? How much would you like to drink a tasty drink right now? etc. using sensitive "ratio" as opposed to categorical "nominal" scales (see below), we have no basis for making a reasoned decision whether the shifting motivational states of these subjects were unexperienced. Of course, demonstrating true negatives results is much harder than demonstrating true positive ones. However, if such measures also yielded no hint of shifting experiences, then one could better make the case that no *relevant* affective change had transpired. Thus the Winkielman et al. results are suggestive but not close to definitive.

When one is discussing as contentious a topic as feelings, one should remain alert to the pre-existing (unconscious?) cognitive biases of investigators. We might consider whether the authors of the above study favored getting the results that they did. Indeed, this is a germane concern for all studies, for methodological decisions of what to measure and how to measure are always potential bias-promoting issues in MindBrain research. For instance, Kent Berridge, the second author of the above study, has long asserted that his famous measures of taste responsivity are generated without any conscious changes in the rats he studies. Berridge's main method has been the study of facial "pleasure responses"—the delightful lip-licking of rats receiving "rewarding" sugar water, something they unconsciously "wanted" (his concept), infused onto their apparently highly receptive tongues (i.e., the solution is administered directly, via cannulae, into animals' mouths). This is contrasted with the facial disgust of rats forced to have "punishing" quinine infused in their unreceptive mouths. Kent has consistently insisted that these responses only reflect preconscious reflexes that may underlie human hedonics and, hence, are only unconscious gustatory responses in the animals being tested. Might this decision reflect a desire not to have one's hard-won data marginalized? Rigidly behaviorist colleagues still rule in animal research and do not tolerate any discussion of experiences in animals being studied.

In general, we currently remain in an era where the imputation of affective and intentional zombie-hood to animals is perhaps too commonly even extended to our own species (e.g., the seminal work of Benjamin Libet, well summarized by Berlin). Perhaps Libet failed to realize that raw intentionality itself has primordial feeling aspects (e.g., twinges of desire) that are commonly ignored in the analysis of ongoing mental contents. And what if the sources of our primal intentionality are very deep in the brain, and not tightly linked to the visual system, but perhaps still under the original guidance of the more ancient limbic-olfactory apparatus? Perhaps in Libet's experiments, subjects when intending to move had to set up visual attentional-processing after the felt intention, in order to report when the intention occurred. This possible lag could have explained his famous delay between his subjects "intentions" and the visually mediated temporal estimate of the time the intentions occurred. I think we do need a more comprehensive analysis of mental experiences before being too confident that there are no experiential changes when so-called unconscious information-processing occurs—for example, a neurophenomenology that Francisco Varela (1990) envisioned but no one has yet formulated into a coherent research program. Until that is done, we should hesitate to claim unconscious mental processes as readily as it is currently done. This is especially important when affective shifts may be occurring in the midst of cognitive studies.

An example of some of the above concerns

Although many of the cognitive antecedents of affective change may be deeply unconscious, it is commonly assumed that if they are, then the accompanying affective shifts do not need to be considered. I raised this issue with Howard Shevrin at the turn of the century. Since his lab had provided the most definitive evidence that totally unconscious presentation of emotional words, tachistoscopically at 1 ms duration (about 5% of the duration typically used in "masking" experiments), were having effects on the brain as well as on future behaviors (Bernat, Bunce, & Shevrin, 2001; Bernat, Shevrin, & Snodgrass, 2001), I inquired whether he had ever evaluated whether those stimuli provoked affective shifts. He look puzzled and asked me to explain. I clarified what I meant by affective shifts and indicated how they might be nonverbally measured by using Peter Lang's Manikin cartoons, using a ratio-scale—a continuous line where subjects could check off their feelings—underneath a series of five cartoons depicting each of the three major dimensions of feeling— namely, valence, arousal, and power/surgency (Bradley & Lang, 1994; Lang, 1995).

The experiment was conducted using previous sets of positive and negative words that had been validated to have both cerebral and behavioral consequences. After exposure to sets of emotional words, subjects were simply requested to check off on the line where they were in affective space. Although signal detection analysis indicated that *d′* (detectability) of stimuli was zero, in the first experiment there were reliable elevations in the power/surgency of feelings (which in the vernacular reflects how much the current feeling is "filling" the mind). We were both surprised by the results and decided to replicate. Again, the valence and arousal measures were not modified, but an identical effect was found with the power/surgency measure (Panksepp, Shevrin, Brakel, & Snodgrass, 2004).

Although we could never quite agree on how to interpret these finding, and formal publication has accordingly been delayed, my interpretation was that totally unconscious cognitive information could reliably modify affective experience. The message for me is that those ancient subcortical powers of mind, which clearly evolved long before there were any propositional thoughts, are still experienced by our minds, and we should beware of premature acceptance of totally unconscious information processing in the typical types of cognitive experiments that Berlin summarizes, unless there are concurrent sensitive measure of affective shifts that can also be experienced, but typically are not monitored in studies of unconscious information processing.

On the varieties of "rewards" and "punishments" in the brain

To the best of our knowledge, mammalian brains elaborate a vast menagerie of affective feeling states. Why? Because the whole subcortical terrain is vastly populated with "sweet" and "sour" hot spots that can sustain rewarding and punishing effects in various learning tasks. And humans stimulated there have some of the most intense, and often stimulation-bound, affective experiences that are imaginable. There is not twopence worth of evidence that those neural circuits are fundamentally unconscious, nor the common assertion that experiences arise only when those ancient emotional network dynamics ripple into the neocortex (for full discussion, see Panksepp & Biven, 2011). A few examples should suffice.

We do know that when we electrically evoke such FEAR behaviors in specific brain areas (the PAG being the most intense), animals rapidly learn to terminate the stimulation; we also know that humans feel intense anxiety during such stimulation, a typical report being sudden onset of a feeling described as "I'm scared to death" (Nashold et al., 1969). There are abundant empirical reasons to conclude that animals have corresponding affective feelings (for summaries, see Panksepp, 1981, 1982, 1990, 1998, 2005; Panksepp & Biven, 2011)–anoetic consciousness, in Endel Tulving's terms (for summary, see Vandekerckhove & Panksepp, 2009)—but no evidence that they are self-consciously "aware" of such feelings.

It might be worthwhile for all in this field to consider Tulving's (1985) scheme of anoetic, noetic and autonoetic consciousness. Most cognitive studies focus especially on the latter, and at times the noetic levels, with practically silence on the anoetic primary-process form, where the term "awareness" becomes very problematic. When one begins to consider anoetic consciousness, it may help explain piles of paradoxes in the literature, from Libet to Wegner, so to speak. Currently few cognitivists seem to be in touch with the concept of anoetic consciousness. For instance, if there is even something like anoetic intentionality (the presumed feeling of the SEEKING system) which may be envisioned as "intentions in action" (Panksepp, 2003), we can more readily imagine how pure affective-anoetic consciousness might guide behavior without being readily recognized (acknowledged?) by higher forms of consciousness. If so, a morass of paradoxes in the field may be better understood, especially those that rely on latency measures of willful actions.

In any event, it should be of considerable concern to all who seek to appreciate Berlin's arguments how she is using the term "awareness." Investigators should also probably be frank about their belief systems in such work, since that can surely bias the way one constructs the details of experiments and reviews of the literature. Thus, I acknowledge that my bias, ever since I entered the field in the early 1960s, is that "animals surely must have emotional feelings." If I did not believe that, I would not have shifted from clinical psychology to physiological psychology (as it was called in those days); I wanted know how—neuroscientifically how!—emotional feelings were created in human brains; there was no alternative but to take a neuroevolutionary approach and to study spontaneous (unconditioned) animal emotional behaviors neuroethologically (Panksepp, 1982, 2010a, 2010b). And my reading of the evidence is that it is now empirically established that animal do have emotional feelings, because direct activation of their subcortically concentrated emotional circuits can serve as either "rewards" (e.g., stimulation of the SEEKING, LUST, CARE, and PLAY networks) or "punishments" (e.g., arousal of RAGE, FEAR, and PANIC/GRIEF networks). These networks are identified by distinct emotional action patterns that are evoked from homologous brain regions in all mammals, including humans. Their affects are evaluated by (1) the capacity of brain stimulation to serve as "reward" and "punishments" in simple learning tasks, and (2) the capacity to predict human feelings when the same brain systems are manipulated electrically or chemically.

Thus, we do need clearer terminologies when we discuss experience. That is why I decided a long time ago to capitalize emotional primes. That way we can still retain emotional language but not pretend that we can ever precisely know what other animals (or other humans) feel, while still recognizing that their feelings are important and do fall into some distinguishable categories that can lead to important phenomenological predictions in humans. It is probable that those deep-brain systems allow objects and events in the world to be experienced as "rewarding" and "punishing." Seems like a no-brainer, but one is hard put to find that suggestion openly discussed in the vast field of behavioral neuroscience—and even more surprisingly, in consciousness studies.

This said, I have no doubt that the brain has many truly unconscious processes that control our behavior, but perhaps cognitive science is currently reaching beyond its grasp—for more than exists in the unconscious minds. Our scientific methodologies are limited, and among cognitive approaches there is still abundant disregard for the many affective shifts that accompany our behaviors, but which, in many individuals, are often repressed because of conflicts between cognitive and affective frames of mind—truly, the Freudian "dynamic unconscious." However, this does not obviate the need for cognitive research to start including sensitive affective measures more routinely. They are quite easy with Bradley and Lang's Manakin self-assessment tools, the PANAS, and other state measures for emotional primes and homeostatic feelings. In certain individuals, this means attending more to the "fringes" of perceptual-cognitive consciousness. In others, it is simply a matter of asking whether they experienced affective shifts that they rarely talk about.

This leads me to wonder: How do emotional feelings figure in Berlin's fine summary of the contemporary literature on unconsciousness as well as the so-called dynamic unconscious? Are such dynamics deeply unconscious, or are some people only cognitively unaware of their ongoing affective shifts?

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The Cognitive Unconscious Seems Related to the Dynamic Unconscious—But It's Not the Whole Story

Commentary by Maggie Zellner (New York)

Psychoanalytically minded thinkers can feel optimistic that our belief in a dynamic unconscious—motivational, emotional, and cognitive processes that happen outside of awareness, yet influence our conscious experience and behavior—is finding increasing support in cognitive psychology and the neurosciences. Heather Berlin ably summarizes a wealth of findings indicating that our feelings and actions are influenced by stimuli that are not perceived or attended to. Because these findings emerge from experimental work, in which conditions are controlled by the investigator, skeptics outside of psychodynamically friendly circles are now more likely to accept that unconscious processes must be taken into account. This is surely good for our field. However, because the nature of experimental work relies on external stimuli, presented under control of an investigator, we still have a long way to go toward understanding the neural nature of those aspects of the dynamic unconscious that arise from within the subject, including endogenous drive processes and an internal world of mental representations.

Keywords: unconscious; external stimuli; endogenous processes; object representations

It appears that Heather Berlin has written the first (or, at least, one of the first) articles to have the words "neural" and "dynamic unconscious" together in the title—a PubMed search for titles including "dynamic unconscious" yields exactly three hits, none of which have to do with brain processes. Her review article therefore makes an extremely important contribution to a dialog that should deepen over the next decade.

Many psychoanalysts reading Berlin's excellent survey of recent findings on the "cognitive unconscious" and other empirical and clinico-anatomical work pointing toward the neural substrates of the dynamic unconscious may have had the same two reactions that I had:

1. A somewhat relieved and almost righteous sense that, *finally*, "they" (the cognitive neuroscientists) are generating findings that support what we have thought all along: that much of mental life happens out of awareness, and this mental life includes motivational and affective processes that shape how we feel, think, and behave.
2. A nagging sense, perhaps arising as we read further on, that while all of this is very exciting and clearly relevant to our psychoanalytic understanding of the mind, we have not yet *really* approached anything like the true *dynamic* unconscious, a realm filled with fluctuating but very consistent, primarily endogenously arising drives, needs, desires, and impulses, as well as a constellation of fears, rules, and templates for reacting to our own impulses and to what happens out there in the world. In other words, do the findings reviewed here also relate to consistent unconscious phenomena like attachment to internal objects, disavowed yet sustained aggression, and so on?

In this commentary I reflect on just a few of the metapsychological implications of the evidence reviewed by Berlin, while offering some thoughts about how these preliminary findings may relate to our experiences in the treatment process.

Ammunition for dealing with skeptics

Berlin starts with a set of findings that, at least initially, seem to correlate strongly with our notion of a

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dynamic unconscious: stimuli perceived consciously but not explicitly attended to (like a briefcase on a table while answering a questionnaire) or perceived out of awareness (like an angry face presented subliminally, too briefly for conscious awareness) can influence behavior in ways that suggest the triggering of desires or fears. What these findings provide, as Berlin and others have pointed out, is extremely strong evidence that a *lot* of mental activity is happening outside of awareness. So far, so good—anyone who has been on the couch knows from experience that lots of stuff is going on outside of awareness, and this certainly fits into that picture. An additional level of evidence, accumulating more recently as unconscious mental processes have become a legitimate area of neuroscientific study, is that brain activity is correlated with the presentation of stimuli that are not perceived consciously. Those studies that also demonstrate an association between brain activity (an objective measure) and changes in behavior or subjective awareness provide the next level of confirmation of the significant role of unconscious cognitive, emotional, and motivational processes.

A clear point of contact between the dynamic unconscious and these findings of responses to stimuli perceived out of awareness is in the realm of transference. Specifically, we can assume that patients find "hooks" in the treatment experience to hang transference reactions on when they react to any of a number of things: a fleeting expression on the therapist's face, the furnishings, seeing the office door closed before the session, how the therapist responds to lateness, and so on. As other authors have previously suggested (e.g., Roffman & Gerber, 2009; Westen & Gabbard, 2001), these stimuli presumably activate procedural memory, emotional memory, expectations that then shape perception of subsequent transactions, and so on. We can think of this particularly as dynamic because often the reaction is not in awareness, which means that some process is preventing it from crossing that threshold.

This body of evidence helps us as therapists in a number of ways. First, it substantiates that these processes *do* take place; a skeptic may reconsider our crazy psychoanalytic notions when confronted with findings that people behave differently just because a briefcase is on a table near them. If that doesn't work, we can now break out the heavy artillery—your amygdala activates to a spider even when you haven't "seen" anything! Second, it points to a neural substrate for these processes, which will allow us to understand the process more thoroughly as we accumulate more research findings. Finally, I think these findings support our conviction that "listening with the third ear" (Reik, 1948) is so important in psychodynamic therapy—paying attention to shifts in discourse, patterns of behavior, expressions that are out of sync with verbal content, etc., because the patient may be having a reaction that he or she is not aware of and that was triggered by something perceived out of awareness. Equally important, we pay attention to our own experience, especially when it seems discordant with the manifest content, because surely we are responding equally to information from the patient triggering our own reactions.

But is reacting to stimuli outside of awareness similar to, say, negotiating with an internal object representation?

However, we do have to ask to what extent this body of evidence on behavioral and brain responses to subliminal stimuli gives us a purchase on the truly *dynamic* unconscious, because these studies rely on presentations of external stimuli. They are not able to assess endogenously arising processes, which is the hallmark of the dynamic unconscious. We conceive of the dynamic unconscious as constituted by, on the one hand, endogenously arising representations of needs, desires, and impulses (roughly speaking, id processes) and, on the other, fears, inhibitions, or self-regulatory processes arising internally (ego and superego functions), with impulses and regulatory processes in more or less continual interaction—it is precisely this interaction that we mean by *dynamic*. These interactions can be conceptualized as being integrated into constructs discussed by various strands of psychoanalytic theory—for example, internal object relations (e.g., Fairbairn, 1952), strivings or fears in relation to selfobjects (Kohut, 1971), or the templates and expectations activated in the particular interactions co-constructed between patient and analyst (e.g., Stolorow, Atwood, & Brandchaft, 1994).

Of course we presume an impact of external stimuli on these endogenous processes: our endogenously arising needs and desires can certainly be stimulated by external stimuli, and many of our internal rules and templates originate in rewarding or punishing experiences with significant others in the external world. However, regardless of the original source, we presume that much of the dynamic unconscious is operating independently of, or sometimes even in spite of, what is being externally perceived. Indeed, it is this perspective that psychoanalytic thought emphasizes and that is still relatively unusual in the realm of the mental health sciences—for example, we can hypothesize that a depressed patient is constantly relating to a negative introject that demands the suppression of ambition, and not just feeling the effects of mood-regulating infrastructure having been impaired by chronic stress (although we presume that often these processes may coexist, because stressful conditions are likely to give rise to pathological object relations). If we help the patient have access to the aim of staying attached to that introject, or become aware of the tendency to ward off other rewarding experiences because it threatens the relationship with that introject, for example, then we create new conditions for being aware of and regulating desires and fears.

The question therefore arises whether the emotional, behavioral, and neural responses to externally perceived stimuli have similar dynamics as endogenously arising ones. If they *are* similar processes—if, for example, the amygdala, hippocampus, prefrontal cortex (PFC), etc. respond to a subliminally presented angry face with the same dynamics as an internally generated representation of an angry face, then this research is an important component in mapping some of the neural infrastructure of the dynamic unconscious. If the processes are *not* similar, then we have some additional challenges to consider.

If picturing your negative paternal introject is the same as seeing your angry father, then partially yes

Assuming that at least some portion of the dynamic unconscious involves responding to mental representations that then trigger emotional, motivational, or regulatory processes, it is reasonable to assume that the research that Berlin surveys does provide a window into the dynamic unconscious, and particularly components of internal object relations. If Fairbairn and other object relations theorists are correct, there is an active internal realm of strivings and fears in relation to images of significant others, a complex back-and-forth woven of actual experiences with and fantasies about others. We then generate or restrict behavior based on our representations of their imperatives or prohibitions. We can presume that if unconscious mental representations of objects are generated in the same areas as externally perceived representations, they would feed into the same emotion-generating or emotion-regulating circuits. The literature comparing the neural bases of perception as compared to memory or voluntarily generated imagery would be relevant here. If similarities have been established, the activity found following presentation of an angry face may be very similar to activity found in the “spontaneously” generated internal representation of an angry face, which might correspond to an image of a disapproving parent, called up as the mind determines how to response to an impulse. These circuits mediating the images of the representations (including visual images of emotional faces, auditory images of emotional tone, and so on, involving association areas in occipital, parietal, and temporal cortex) would then interact with distributed networks mediating reward/punishment coding (orbitofrontal cortex and ventromedial PFC) and impulse and inhibition (cortico-striatal-thalamic loops, including both more reward-related behaviors mediated by ventral striatum, and more habitual behaviors mediated by dorsal striatum).

But as for those deep, drive-derived strivings, maybe not so much

It may be, therefore, that the literature Berlin reviews has fairly direct relevance to understanding how we react to our internally generated representations and regulate ourselves according to them. But it may have less access to the strivings and impulses that call those representations into being. As psychoanalysts, even if we may have moved far theoretically from the early days of psychoanalytic theory, we presume that a fair amount of the dynamic unconscious is composed of endogenously arising desires, wishes, and impulses that are drive derivatives (for a discussion of the possible neural bases of drives, and the relationship between drive and emotion, see Solms & Zellner, in press). This presents a challenge to neuroscientific research: first, how to measure something of which the subject is not aware, by definition; second, how to measure something that arises on its own schedule, not keyed to experimenter-controlled presentations.

As a very beginning in this direction, the studies Berlin cites on unconscious motivation are definitely intriguing. The behavioral ones, which almost exclusively have relied on external stimuli, provide nice support for our psychoanalytic ideas of unconscious motivation, and clinically we have a century’s worth of data that suggest that we are often guided by impulses and goals operating outside of our awareness. As we become able to image brain activity at finer anatomical and temporal levels, we may eventually get a window into the brain processes that are endogenously arising. Neural changes in response to motivationally relevant stimuli perceived out of awareness (as in the studies cited by Custers & Aarts, 2010) certainly point in the direction of a dynamic unconscious. However, as processes arising from sensory activity in thalamic (and possibly cortical) circuits, they still may have a different pattern or "signature" as drive-related activity that may arise from hypothalamic and mesolimbic activity (for more elaboration, see Solms & Zellner, in press) that may underlie more drive-based activity per se. To the extent that any drive-related or motivational processes eventually access the mesolimbic networks, this body of research may be relevant.

However, to the extent that we are interested in processes taking place independent of external conditions, at present we are quite limited if we can only get brain measures when experimenters can control conditions. This allows for time-locked assessment of brain activity, and also allows investigators to know whether what the subject is conscious of is the whole story or not—as Berlin notes, "people tend to make up sensible, often incorrect, explanations about their behaviors after the fact," and we can only assess whether the explanations are "incorrect" if the experimenter controls the external variables. But if we can get to the point where we can register specific signatures of particular representations (say, an approving mother or a rejecting father), we will then be able to investigate further the brain processes that precede their emergence, as well as know whether the representation is present in the subject's mind but not in his or her awareness.

A few final thoughts

One of the many intriguing aspects of Berlin's review is the section on neural coalitions that may be correlated with contents reaching consciousness, and the related question of neural activities that may prevent content from becoming conscious. As Berlin suggests, the fact that NMDA (*N*-methyl-D-aspartic acid) antagonists are linked with dissociation points to the active process of integrating neural activity in order to bind different aspects of experience and yield an experience of unity and agency. These findings also support the idea of a purposeful inhibition of excitatory transmission, which keeps contents separate or from reaching consciousness. In addition to the useful linkages Berlin makes between these processes and the psychoanalytic concepts of defense and repression, her discussion also made me think about what is happening during the analytic experience, as patient and analyst explore. When the therapist draws the patient's attention to something that she is unaware of (a behavioral pattern, a tone of voice, an association, and so on), does this shift the balance of thalamic coalitions, allowing new content to emerge? If attention itself is one of the variables that biases these coalitions, the therapist drawing attention to new sensations and new data may tap into a network of suppressed or ignored associations.

I also thought that the finding that "access to the affective content of the stimuli disappeared after prolonged task training" might relate to the specific defense of intellectualization—a kind of paying attention, focusing on language and details, that dampens or excludes emotional arousal and content. More broadly speaking, this is an additional argument in favor of listening with the third ear, attending to more than what appears to be happening on the surface, because perhaps what we are most easily conscious of sometimes purposely obscures more threatening, vulnerable, or otherwise conflictual content. Even *more* broadly speaking, the evidence summarized throughout Berlin's article that inhibitory/regulatory processes tend to occur virtually simultaneously with affective processes supports our clinical wisdom that we must purposely draw attention to and create space for material to emerge that is continually being regulated or defended against. In other words, the analyst tries to hear, see and understand what the patient is not able or does not want to see, hear, or feel for herself yet, keeping in mind that defensive processes may be operating almost continually.

In this commentary I have only elaborated on some of a very large number of interesting implications raised throughout Heather Berlin's review. I am confident that if a researcher of her caliber finds something of value in psychoanalytic thought and can draw linkages to a wide variety of neuroscientific literatures, we are indeed moving in the right direction toward a much deeper understanding of the mind and brain. I look forward to future contributions!

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The Neural Basis of the Dynamic Unconscious: Response to Commentaries

Heather A. Berlin

Keywords: unconscious; psychodynamic; repression; suppression; dissociation; neural

BUILDING A BETTER "NEUROPSYCHOANALYTIC" BRIDGE

First and foremost, I would like to thank the commentators for their very insightful responses. Most of them suggested helpful enhancements and refinements of my arguments, which are very much appreciated. I will make some remarks on a few general themes that ran across many of the replies as well as address some specific points.

Morris Eagle highlighted the differences between the dynamic unconscious, which he describes as involving "unconscious *emotional* and *motivational* factors that can mold the unconscious mind," and the descriptive (Freud) or cognitive unconscious. He claims that many of the studies I cite support the concept of ubiquitous unconscious processing, but do not test directly the "dynamic unconscious." I appreciate this distinction, and while I do cite studies that show that unconscious affective and motivational factors can mold and shape cognition and behavior, it is harder to determine empirically how unconscious affective and motivational factors can mold and shape the *unconscious mind*, which is central to processes like repression. However, if everything is taking place outside of awareness—that is, both the input and output, or the independent and dependent variables—how can we measure these phenomena in the lab? Researchers can begin to resolve this conundrum by devising inventive paradigms to accurately test the neural basis of unconscious defense mechanisms experimentally. But they must also work together with analysts who can help to better define the concepts scientists are trying to quantify.

For example, Eagle points out that repression may not be a unitary process and may, in fact, be referring to a wide range of phenomena, each of which may involve different psychological processes and therefore different corresponding neural processes. Accordingly, there are mixed results and inconsistent findings with regard to the relationship between repressive style and psychological and physical stress. Some studies show that people with a repressive style have fewer psychological, somatic, and health problems than those with a nonrepressive style, while other studies show the opposite results. This may be related to differences in methodology—for example, how repressive style is measured—or it may be that repression is initially beneficial, but the negative effects may emerge over the long term.

What this problem emphasizes, as several commentators correctly pointed out, is that clearer, more concise, empirically measurable definitions of the concepts rooted in psychoanalysis are needed in order for scientists to conduct properly controlled experiments. Researchers need to have a good understanding of the constructs they are attempting to find the neural correlates for in order for consistent and accurate experiments to be conducted. In particular, this demands the definition of appropriate behaviors or measurements (e.g., stress hormones) to assay these constructs. So, analysts and neuroscientists need to work together to determine how to best describe and quantify complex, somewhat vague psychodynamic concepts and to devise more sophisticated experimental paradigms to measure them.

Accordingly, I appreciate Vaughan Bell's clarification of the concept of dissociation, which is an indistinct concept even among exerts in the field. Bell also points out that my discussion of dissociation focused largely on dissociative identity disorder (DID), a disorder plagued by controversy. This was because, outside of depersonalization disorder, the majority of the research on the neural basis of dissociative disorders is in DID. In the future, investigators should explore the neural basis of dissociation in healthy people and across different dissociative disorders to see where there are similarities and differences and whether, in fact, dissociation is a cohesive construct with distinct underlying neurobiological correlates.

Another important point Eagle raised is that, according to Freud, repression is elicited by "an 'inner' forbidden wish that is associated with anxiety rather than an external percept." According to psychoanalytic theory and clinical testimony, much of the dynamic unconscious is made up of endogenously arising, unconscious impulses, desires, and motives that guide a person's emotions, thoughts, and behaviors. Most of the studies I cite rely on the presentation of external stimuli/triggers to elicit internal process that may produce anxiety and compensatory processes like suppression. But, these studies may not be properly measuring "endogenously arising processes," the signature of the dynamic unconscious, which can operate "independently of, or even in spite of, what is being externally perceived" (Maggie Zellner). Repression is difficult to study in the laboratory precisely because it is initiated from internally generated stimuli, at least according to Freud's conception.

However, using sophisticated techniques, researchers are now able to reliably measure the neural signature of internally generated representations (Gelbard-Sagiv, Mukamel, Harel, Malach, & Fried, 2008). The next step is to ascertain how to explore the neural basis of the impulses, desire, and motives that generate or lead up to the emergence of these internal representations. Neuroscientists need to determine "how to measure something of which the subject is not aware, by definition; second, how to measure something that arises on its own schedule, not keyed to experimenter-controlled presentations" (Zellner). The studies I cite on unconscious motivation may be a good start, for although they use mostly externally presented stimuli, they support the psychoanalytic concept of unconscious motivation.

Future studies could investigate motivation in drug addicts or people with behavioral addictions like pathological gamblers whose yearnings to use drugs or gamble are internally driven. The neural basis of their uncontrollable urges and drives could be investigated from a psychodynamic perspective. For example, the ability to inhibit impulses may emerge from the dynamic interaction of two separate neural systems (Bechara, 2005). An "impulsive system," which may be likened to the "id," where the amygdala is a key structure involved in triggering the affective/emotional signals (e.g., pleasure and pain) of immediate outcomes; and a "reflective system," which can be likened to the "superego," where the ventromedial prefrontal cortex (PFC) is a key structure involved in triggering the affective/emotional signals of long-term outcomes. Bechara (2005) suggests that addiction is the product of an imbalance (genetic or environmentally triggered) between these two neural systems that control decision-making. In general, people with impulse control problems tend to have amygdala hyperactivity, which may propagate their urges, and deficits in prefrontal activation, which may impair their ability to "repress" or "suppress" those limbic drives (Bechara, 2005; Berlin, Rolls, & Iversen, 2005; Berlin, Rolls, & Kischka, 2004; Hollander & Berlin, 2008; Hollander et al., 2008).

In the same vein, Maggie Zellner correctly asserts that investigators need to clarify whether externally presented and endogenously produced stimuli (e.g., mental representations of objects; memory; voluntarily generated imagery) can generate the same neural responses. If so, it can be presumed that the neural processes regulating the emotional and behavioral responses to the stimuli—that is, the unconscious dynamic processes trigged by the stimuli—should be similar. Neuroscientific studies have in fact shown that while certain brain areas like the medial anterior (PFC) monitor whether a stimulus is internally or externally generated (Simons, Henson, Gilbert, & Fletcher, 2008), there is significant overlap between cortical areas that are activated regardless of whether a stimulus is generated internally or presented externally (Helmchen, Mohr, Erdmann, Binkofski, & Büchel, 2006; Stawarczyk, Majerus, Maquet, & D'Argembeau, 2011). For example, in the visual domain, imagery activates similar regions of visual cortex as retinal input does (Reddy, Tsuchiya, & Serre, 2010), and this has also been shown at the single-neuron level (Kreiman, Koch, & Fried, 2000). Furthermore, similar areas of auditory cortex are activated whether speech is internally or externally generated (Simons et al., 2010), and areas of the pain network associated with the affective qualities of externally generated pain are activated when a person feels internally generated empathy (Singer et al., 2004).

Related research also shows that endogenous attentional shifts increase apparent contrast in visual stimuli in much the same way as exogenous attractors (Liu, Abrams, & Carrasco, 2009; Störmer, McDonald, & Hillyard, 2009; Yeshurun, Montagna, & Carrasco, 2008). In other words, voluntary and involuntary attention both increase perceived contrast of visual stimuli. The fact that endogenous and exogenous attention have similar effects on phenomenal appearance along with the imaging studies described above gives us some reason to believe that exogenous stimuli, like those used by an experimenter, and the endogenous stimuli from the dynamic unconscious have overlapping effects and neural signatures.

There is also the case of J.I. (Sacks & Wasserman, 1987), an artist who suddenly became colorblind after a car accident and concussion, which resulted in damage to his visual cortex (area V4). He subsequently was unable to distinguish any color and could only perceive shades of gray. But what is relevant here is that he could not even imagine colors, dream in color, and eventually even remember color, while people who become blind from injury to their eyes or optic nerves do not lose imagery or memory. So imagery and memory for color appear to rely on the operation of at least some of the same cortical areas necessary for the original externally generated perception of color.

Despite the overlap in neural areas triggered by internal and external stimuli, scientists can also devise paradigms whereby subjects are asked to internally generate a stimulus if it is thought that this would more accurately simulate how "repression" actually occurs *in situ*. Investigators, with the help of analysts' clinical insight, can invent new and creative ways to measure dynamic unconscious processes if it is felt that the methods employed thus far have been insufficient at tapping into these processes. Conversely, experimental evidence may modify the psychodynamic concepts that Freud and his colleagues originally put forth. For example, we might keep the repression/suppression distinction, but not Freud's idea that repression is always of forbidden wishes. For, as many people have pointed out, some of Freud's theories may have been unduly biased by the early twentieth-century Austrian culture in which he lived.

Ned Block described the "Anna Karenina Theory of the Unconscious," which asserts that "all conscious states are alike," and that "each unconscious state is unconscious in its own way." Accordingly, the studies I describe reveal a number of processes that can result in unconscious states. But, as Block intimated, while consciousness (C) may be viewed as a "uniform phenomenon" because it subjectively feels like a unitary state, there are likely a variety of processes that occur consciously, just as there are a variety of processes that occur unconsciously, and there may be certain C states that do not correspond to unconscious states and vice versa.

Block distinguishes between "phenomenal consciousness" (what it is like to have an experience), and "access consciousness" (cognitive accessibility) (Block, 2002), and also suggests there are various forms of monitoring C and self-C. He claims that in certain cases of "unconsciousness" both phenomenal and access C are absent, but in other cases, only access C may be missing while phenomenal C (i.e., the raw "feeling") may be preserved. Jaak Panksepp also points out that the term *unconscious* does not have a single meaning, and that there are many different types of unconscious processes some of which may be "dynamically unconscious under certain testing conditions but experienced under others" (see below). As Block and Panksepp suggest, it may be that in some instances when a process appears to be completely unconscious (i.e., no access or phenomenal C), it may in fact be conscious on a certain (i.e., phenomenal) level, although the person does not have "access" to it. But how can a researcher distinguish between unconscious processes that posses phenomenal C from those that do not? More evidence is needed to identify when phenomenal C is present in order for this to be a useful distinction in experimental investigation.

Bell also makes the very good point that a full understanding of the workings of the unconscious via cognitive neuroscience may be difficult because the unconscious can be interpreted at the level of symbolic meaning according to Freud. In other words, "personal meaning, information processing, and neurobiology rely on different levels of explanation and may have to be integrated through a process of 'patchy reductionism' (Kendler, 2005)." Zellner further asserts that despite all of the findings in the fields of cognitive and affective neuroscience in relation to unconscious processes, they do not fully reflect the workings of the truly *dynamic* unconscious, which is in constant flux and consists of internally generated drives and impulses, and unconscious phenomena like attachment to internal objects, disavowed aggression, and transference—that is, more than just transient emotional responses. And Eric Fertuck points out that since dynamic unconscious processes reveal themselves over long periods of time (months and years) and manifest in complex and varied ways, they do not conform easily to experimental paradigms. But this is a common problem in experimental psychology and cognitive neuroscience since human emotions and thoughts, whether conscious or unconscious, are multifaceted and difficult to predict and quantify.

So while I agree that it may be difficult to make the translation from the esoteric symbolic unconscious to its physical neural substrate, I do not think it is an insurmountable task and we should certainly make our very best efforts to overcome the chasm between what is actually occurring *in situ* (e.g., during therapy) and empirical research. Cognitive and affective neuroscientists, psychologists, and psychoanalysts need to engage in an active, open dialogue and work together to come up with inventive ways to overcome the gap between the phenomenal experience of humans observed in the clinic, and objective, valid, reliable, and quantifiable laboratory measures, with the goal of integrating and advancing their respective fields.

In many case, cognitive neuroscientists and psychoanalysts may actually be talking about the same phenomena, but just under different names. For example, as a relevant and appropriate supplement to my article, Amit Etkin discussed evidence that is beginning to illuminate the neural basis of implicit emotion regulation—that is, automatically elicited processes that regulate emotion and proceed without conscious monitoring and that can occur without awareness or insight. One might liken this to "repression." In contrast, explicit emotion regulation requires conscious effort for initiation and monitoring during execution, a process similar to "suppression." There are various techniques to regulate emotion, and each may be referring to a different psychoanalytic mechanism.

Etkin cites studies that show that emotional regulation of conflict is related to "activation of the pregenual/ventral cingulate and dampening of amygdalar reactivity through connectivity with the cingulate" (Egner, Etkin, Gale, & Hirsch, 2008; Etkin, Egner, Peraza, Kandel, & Hirsch, 2006; Etkin, Prater, Hoeft, Menon, & Schatzberg, 2010). These neural mechanisms are similar to the ones I describe in relation to repression and dissociation—for example, the corticolimbic disconnection hypothesis of dissociation. Furthermore, similar to the mechanisms thought to be involved in suppression, people who reappraise habitually when observing emotionally expressive faces show increased activation of prefrontal regions that are involved in cognitive control (Drabant, McRae, Manuck, Hariri, & Gross, 2009). Also, distraction (e.g., engaging in demanding cognitive activities) can have an "emotion-regulation-like effect" and results in lower activation in areas like the amygdala, which is involved in the processing of emotions, and greater activation in ventrolateral PFC, and ventromedial PFC acts to mediate the relationship between increased ventrolateral PFC activity and decreased amygdala activity (Lieberman et al., 2007). Again, these mechanisms are similar to the ones I described with respect to suppression. So, there appear to be overlapping neural mechanisms involved in emotional regulation techniques and suppression, repression, or dissociation. But how these processes are similar and distinct both phenomenologically and neurally requires further exploration.

Interestingly, compared to healthy controls, during an emotion regulation of conflict task, people with generalized anxiety disorder failed to adapt behaviorally to emotional conflict and to activate their ventral cingulate and dampen amygdalar activity (Egner, Etkin, Gale, & Hirsch, 2008; Etkin et al., 2006, 2010). So there appears to be a breakdown of their defense mechanisms, and the opposite neural reaction to what occurs during repression or dissociation, where amygdala activation is diminished as an adaptive response to stressors to protect the ego. Investigators need to further explore what happens when adaptive defenses become dysfunctional—for example, when used excessively or not at all—and determine when defense mechanisms are adaptive, when they are pathological, and how this distinction can be made at the neural level.

Another intriguing question is: can emotion regulation occur without the person experiencing the triggering emotion consciously? People use emotion-regulation strategies often, and it can become habitual (Gross, Richards, & John, 2006). But when the triggering emotion is experienced unconsciously and emotion regulation occurs implicitly (akin to repression), how can a person report when it is occurring, and how can we measure this process in the laboratory? Bell claims that my statement, "People can feel things without knowing they feel them, and they can act on feelings of which they are unaware," is contradictory because "feeling" is generally defined as "the conscious subjective experience of emotion (e.g., VandenBos, 2006)." But couldn't a "feeling" be experienced "unconsciously," as when phenomenal C is experienced in the absence of access C (see above), or during Panksepp's "affective shifts" (see below)? Must conscious subjective experience always require reportability? If, as studies suggest, stimuli (emotive or cognitive) that subjects are subjectively unaware of can change their behavior and motivate them, could it be said that these stimuli are being "experienced unconsciously"? These and other relevant questions need to be addressed. As Etkin states, despite the obvious overlap, the exact relationship between psychodynamic theories of unconscious processes and the neural basis of implicit emotion-regulation processes is unclear. We need to work on merging the exciting new findings from affective neuroscience with psychoanalytic concepts that have been observed clinically for over a century.

In further support of my call to arms, Eric Fertuck advocates the "(re)convergence of neuroscientific and psychoanalytic conceptions." The psychological study of unconscious processes may have emerged from psychoanalysis, but then it became alienated from it, only for its roots and conceptual equivalences to now be "rediscovered" by neuroscientists and experimental psychologists. Perhaps this "rediscovery" of psychoanalytic concepts by neuroscientist will spark a counter-interest by analysts to, for example, strive to more precisely define the terms they use regularly, which will allow neuroscientists to better study their neural basis. Psychoanalysts can also make conceptual contributions to neuroscience, such as the idea that defensive processes can operate differentially in different people, depending on things like variations in maturity and personality organization (Fertuck). Extrapolating from there, individual differences in underlying neurobiology and related genetic variations are also important. Researchers may one day be able to link genetic variations and neurobiological predispositions to individual differences in defensive styles, and subsequently be able to predict which coping mechanisms particular individuals will be more likely to use and who might be more resilient to psychological stressors. Therapists could then adapt and custom-tailor their techniques based on the biological biases of the patient. For example, variations in genes that code for serotonin receptors are associated with impulsivity and aggression (Hollander & Berlin, 2008). So, people who possess an "impulsive" genotype may be less apt to use mechanism like repression or suppression and may need training on how to employ alternative defenses to control their impulses.

This provokes the related question: how does therapy work on the neural level? Zellner asks: "When the therapist draws the patient's attention to something which she is unaware of (a behavioral pattern, a tone of voice, an association, and so on), does this shift the balance of thalamic coalitions, allowing new content to emerge? If attention itself is one of the variables that biases these coalitions, the therapist drawing attention to new sensations and new data may tap into a network of suppressed or ignored associations." I think this is a valid assumption. Attention can enhance or bias one coalition of neurons (representing the attended object) at the expenses of others (representing nonattended stimuli) (Lee, Itti, Koch, & Braun, 1999) and may be necessary for many, but not all, forms of conscious perception (Koch & Tsuchiya, 2007). Attention can also make sensory impressions appear more intense. For example, psychophysical studies have reported that attention enhances spatial resolution (Yeshurun, Montagna, & Carrasco, 2008) and perceived contrast of visual stimuli (Liu, Abrams, & Carrasco, 2009) by boosting early sensory processing in the visual cortex (Störmer, McDonald, & Hillyard, 2009). So, otherwise repressed thoughts, emotions, or memories may be reintegrated into the conscious mind in a healthy, non-anxiety-provoking way when attention is brought to them during therapy. And neural plasticity may explain some of the long-term positive effects that continue to occur even after the therapy session has ended.

Along these lines, Christof Koch suggests that techniques in basic neuroscience research, such as single-cell recording studies in behaving animals, are the next level of research that needs to be applied to psychoanalytic concepts. But can basic neuroscience techniques like single-cell recording, although very precise with exceptional temporal resolution, really scale up to such complex concepts as defensive processes which involve much more than just seeing a presented stimulus or not? Can one make the conceptual leap, for example, from the neural mechanisms that control phenomena like binocular suppression—that is, suppression on the sensory level—to the highly charged, emotive repression Freud was referring to? Can single cells firing to masked incoming stimuli translate into coding for highly intricate psychoanalytic unconscious processes? While neurons are the basic units by which this translation will occur, it is unlikely to take place on the scale of single neurons, or even hundreds of neurons firing, but, rather, with large coalitions of neurons on the order of thousands firing, and at the circuit level, which is not adequately captured by single-cell recording. Another technique that Koch refers to that seems more encouraging is "optogentics," which allows researchers to activate or deactivate precise neural circuits that may then be used in inventive ways to measure things like voluntary suppression. For example, a recent study used microelectrodes and optogenetics to manipulate aggressive and mating behavior in mice (Lin et al., 2011). Optogentics is moving research from observation/correlation to causation and may represent a promising new way to probe dynamic unconscious processes and motives.

Koch goes on to discuss the *integrated information theory* of C (Balduzzi & Tononi, 2008, 2009; Tononi, 2008), which claims that "a system's capacity for integrated information, and thus for consciousness, can be measured by asking how much information is available to the system as a whole above and beyond what is available to its parts." This quantity is referred to as Φ, and it represents the degree to which a system is integrated and therefore how conscious it is. But what about disorders where C appears to be fragmented—for example, schizophrenia, DID, or depersonalization disorder? Are people with these disorders considered to have lower Φ and thus be less conscious? If metrics are assigned to C, then some people (and nonhuman animals) will inevitably have more and some will have less of it, and the ethical implications of this will need to be considered. Also, do the complicated unconscious processes I described, which make up the dynamic unconscious, rely on a high degree of integrated, differentiated information? If so, one would expect them to have a high Φ and thus be conscious, which is counterintuitive since they occur outside awareness. How much integrated information is involved in the unconscious processes I discuss? As Koch aptly asks "Can all unconscious processes be carried out by local, isolated modules?" If not, then this is a major criticism of the integrated information theory of C, which needs to be addressed.

On a final note, in addition to making some valid points, Jaak Panksepp also made some false assumptions, which I would like to clarify. One marked misconception was in relation to Joseph LeDoux's research that shows there is a direct subcortical pathway that allows threatening stimuli to be processed outside of awareness. Specifically I state that, "Animal studies suggest that fear-related responses occur via a direct subcortical pathway from the thalamus to the amygdala, allowing emotional (specifically threatening) stimuli to be processed automatically and outside awareness (LeDoux, 1998)." This does not imply that animals do not feel any emotions at all. There are two pathways by which affective stimuli can be processed, one of which is conscious and the other is not (Miller, Taber, Gabbard, & Hurley, 2005). I was simply stating that some emotions can be processed outside awareness, but I am not denying, as Panksepp suggests, that animals also have raw qualia or feelings. As opposed to Panksepp's assertions, neither LeDoux nor I claim that animals do not *also* experience the conscious sensation (subjective sense) of fear, or that they have no feelings at all. LeDoux does not deny that animals have C, only that it must be distinct from human C, which is tied up with language. He even agrees that there is probably a core C that may be shared. I refer readers to the last chapter in his book, *The Emotional Brain* (LeDoux, 1996), in which he states, "Other animals may also be conscious in their own special way due the way their brains are," and to his chapter in *Frontiers of Consciousness* (LeDoux, 2008), where he further elaborates on what C in nonhuman primates and nonprimate mammals might be like.

Panksepp also makes the distinction between the terms "*awareness*," referring to perceptually driven cognitive, "higher order" mental activities, or "higher order forms of cognitive C," and "*experiences*," referring to deep internally driven feelings, either affective or "raw perceptual" or "raw phenomenal" states—that is, the internal state that feels like "something" for a living organism, or "pure affective states of mind." This "awareness" versus "experience" distinction has some similarities to Ned Block's access vs. phenomenal C distinction (see above, and Block, 2005), yet Panksepp never cites Block or describes how his partitions are different from Block's. Also, this just seems like a matter of semantics, for I could simply make the distinction between cognitive and affective "awareness." What is more important is understanding how one could operationalize this distinction. So while I agree that a more refined distinction could be made by slicing apart the term "awareness" into affective and cognitive components, until these processes are explored further and operationalized I will use the more general term "awareness" to cover both types of C. Rather than getting caught up in semantics, perhaps Panksepp can suggest ways forward, like devising new methods to empirically test these distinctions.

Panksepp also claims that I look down on "experiences," take a "lofty" cognitive perspective, and do not deal with "affective" C. This is simply not true—for example, see the section "Affective and Motivational Unconscious Processing" in my article. Although I use the terms awareness and C interchangeably, as do other researcher in the field (e.g., Koch, 2004), this does not mean that when I speak of "awareness" I am only referring to cognitive/linguistic C. I am also referring to nonlinguistic conscious emotions, aka raw feelings, qualia, phenomenal C, or what Panksepp calls "experiences." Animals, including humans, are also "aware" of their raw nonlinguistic "experiences," if they are in fact conscious. If they are not aware of these experiences, then they are not conscious and not experienced.

Furthermore, Panksepp's opposition to the term "awareness" seems self-defeating. He recommends we use the term "experience" for animal conscious affective states and that we put emotional terms applied to animals in capital letters. But that suggests that animals do not experience feelings like fear consciously. Labeling animals with inferior terms like "experience" and FEAR only propagates doubt that animal "fear" is in fact a real conscious state. It would be as if animal rights advocates declared that a special term was needed, call it RIGHTS, for what animals have instead of rights. That would legitimize the idea that animals do not really have similar rights to humans. Similarly, using a special term for animal C implies that animals do not really posses it in the same way as humans do (Ned Block, personal communication).

Finally, I agree with Panksepp's point that linguistic reports are an imperfect way of assessing conscious experience, both because of left-hemisphere-mediated confabulation, and the converse problem of experiences that do not transmit information to language centers—for example, in aphasic or vegetative patients (Cruse & Owen, 2010; Owen & Coleman, 2008), human infants, or other nonlinguistic animals. But not all experiments require linguistic responses. Many experiments utilize nonlinguistic stimuli, such as faces, and nonverbal, behavioral responses by which subjects can indicate whether or not they are having an "experience" (Lau, 2008). Subjects need to be able to respond in some way to let the experimenter know that they are actually feeling or experiencing something. Perhaps we can try to come up with better ways to measure "unreflective affective C" with behavioral responses. Panksepp also suggests the possibility that people may be having "relevant/measurable shifts in experienced affective states," "emotional/mood shifts," or "fringe feelings" (Panksepp, 2003) even when they claim to be "cognitively unaware of the incoming cognitive stimuli"—for example, during experiments in which stimuli are thought to be unconscious or are not experienced. He states that if investigators only monitor "verbal-cognitive responses" about whether a person has or has not perceived stimuli, they may be missing "relevant affective shifts." Consequently, researchers cannot confidently claim that there are no experiential changes when supposed unconscious information processing is occurring. In other words, until they understand more about the nuances of mental experiences, investigators cannot claim that no relevant internal (affective) "experiences" occurred during a cognitive task.

Therefore, researchers need to refine their assessment measures to be sensitive to possible affective shifts when masked or supposedly subliminal cognitive or affective stimuli are presented. Measures should be able to detect whether a stimulus and its related feelings are being processed completely outside of awareness or whether the subject is experiencing conscious affective shifts. This may mean, as Panksepp suggests, telling subjects to attend more to the "fringes" of perceptual-cognitive C and asking them not only if they perceived the stimuli, but also if they perceived a "feeling" or "affective shift." But Panksepp also claims that these feelings are "often repressed because of conflicts between cognitive and affective frames of mind." If this is true, then these "feelings" may not be experienced consciously at all, and the stimulus *is* truly being processed outside of awareness. Experiments show that "nonconscious stimuli can influence motivation, value judgment, and goal-directed behavior without affecting conscious feeling." Thus, it is crucial that we create better ways to accurately differentiate unconscious and conscious affective processes. Only by operationalizing and testing this subtle difference can we gain insight into the workings of the dynamic unconscious.

Findings in cognitive and affective neuroscience and psychology are now providing empirical support for what analysts have been observing anecdotally for years—namely, that motivational and affective processes that occur outside of awareness can shape how people think, feel, and behave. However, by subjecting strongly adhered-to, clinically useful psychoanalytic concepts to rigorous scientific inquiry, some of the concepts may also be challenged, refined, or revised. As Fertuck points out, psychoanalytic theory must integrate the pragmatic, intelligent, survival-oriented, cognitive unconscious that neuroscientific and cognitive studies have revealed, with their more emotional and drive-oriented concept of the unconscious. Unconscious processes are not just restricted to wishful, primitive impulses and drives; they are also efficient and adaptive and involve the analysis of complex information and other nonaffective, "cold" processes. The warm, emotive, impulse-oriented unconscious must be integrated with the cold, cognitive one for a full understanding of unconscious processes. It is important that scientists and analysts are certain they are discussing and examining the same phenomena.

Freud and his fellow founders of psychoanalytic theory had brilliant insights, some of which have endured the test of time, but others have yet to be been proven correct. The task of scientific research is to uncover fundamental truths. The twenty-first century should consist of the integration of psychoanalytic theory with what neuroscientists are discovering, using advanced technologies, about how the brain works. If Freud and his contemporaries were alive today, I predict they would be enthusiastic about this emerging information and would use it to update their own theories of the mind. Scientific investigation is a dynamic process of continual revision and modification of theories based on new evidence arising from carefully controlled experiments. The process is never finished but is in a constant state of flux. And as we learned from Einstein's discoveries, even the laws of physics are susceptible to change.

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