CHAPTER 2

The Neuroscience of Emotions

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It is hard to imagine a field as different from sociology as neuroscience. The differences in theory, method, tradition, and practice could readily breed antagonism between any two fields. However, it is just because of these differences that neuroscience has been able to present important findings about covert brain processes that can expand sociological theory. Traditionally, sociological social psychology has focused on self-consciousness and language as primary mechanisms of human adaptation. This focus might be appropriate to the cerebral image of the human animal, but neuroscience has produced evidence that emotional capacities underlie the intelligence implied by this image and indeed make it possible (Carter and Pasqualini 2004; Damasio 1994).

Although this goes counter to old sociological assumptions devaluing emotion's role in the reasoning process, neuroscience frameworks have also challenged traditional psychological views on the very nature of emotion. Part and parcel of the evidence of the importance of emotion to rational decision-making is another challenge to sociological tradition—that emotional brain processes are much more typically unconscious than conscious. This focus on the covert has been honed and won in spite of resistance from experimental psychologists following the Jamesian insistence that emotion must, by definition, be a conscious bodily feeling. Of course, we *feel* our emotions, but for many neuroscientists, the covert processes that cause these feelings are now considered emotions. Neither of these reversals could have come about without the unique methods available to neuroscientists (e.g., their highly technical brain scans, electrical stimulation, and case studies of traumatized patients).[1]

Electrical stimulation of the mesencephalon in the brain stem of an otherwise healthy patient treated for Parkinson's disease instantly caused acute feelings of depression. Equally important, it also evoked remarkably stereotyped lines of language about her worthlessness and the futility

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of her life. Immediately after stimulation, the patient returned to normal (Damasio 2003). It is extremely difficult to find an empirical case of pure emotion because in any normal situation, emotion is inseparably intertwined with cognition. This case, limited as case studies are, nevertheless presents a rare example that clearly differentiates the two. There was no external perception to interpret cognitively—only the inner feeling. The case provides a stark illustration of emotion's capacity to precede and cause particular lines of thought.

The serious limitation of purely verbal, overt approaches to emotional processes is hinted at from within sociology by Katz's (1999) observation that words are the one thing that emotions are not. (Also see Turner, 1999, and Turner and Stets, 2005.) Emotion can be seen as the ineffable language of the body in contrast to the linguistic language of the mind.

Viewing emotion as "lived experience" purposely skirted the awkward definitional problems about what emotions were, but unavoidably kept sociological analysis on the phenomenological level of verbalized awareness. From the evolutionary perspective of current neuroscientists, however, the focus on overt emotional feelings leaves out just those covert emotional processes that these feelings are all about. Cognitively oriented sociologists need to know about covert emotions because they so often have causal effects on the directions that overt symbolic interpretations and perceptions take.

The emotional unconscious is important to social psychology for at least two additional reasons. Most important, the neuronal channels going up from the emotional centers of the brain to the more cognitive centers are denser and more robust than the cognitive centers going down to inhibit and control the emotional structures. Self-conscious efforts to avoid prejudice, fear, hatred, and depression are often rendered unsuccessful by this imbalance.

Second is the consistent finding that unconscious preferences and emotional leanings exert significantly more influence over our thoughts and behaviors than do conscious preferences. We cannot exert conscious controls over "things we know not of." This type of information is not merely of tangential interest to sociology. For example, another finding is that of the "mere exposure effect." Unbeknown to us, we tend to respond favorably to objects and statements simply because they are familiar to us. Power structures that communicate by means of constantly repeated messages might find that these exposure effects constitute reliable technological means of "hidden persuasion" and mind control (see LeDoux 1996:57).

A more than cursory look at the evidence from neuroscience is therefore needed to change long-held tenets and understand the potential contribution of neuroscience to the sociology of emotions. Some might not find this an attractive enterprise, but sociology's general reputation in academic circles will depend on being willing to do so. Massey (2002:25) summed this up in his presidential address:

> Because of our evolutionary history and cognitive structure, it is generally the case that unconscious emotional thoughts will precede and strongly influence our rational decisions. Thus, our much-valued rationality is really more tenuous than we humans would like to believe, and it probably plays a smaller role in human affairs than prevailing theories of rational choice would have it.

WHY THE EMOTIONAL BRAIN?

Massey's statement has strong confirmation from neuroscience and articulates an important reason why emotion has taken a central place in brain studies. Another reason is presented by sociologists Wentworth and Ryan (1992:38); in highlighting the embodied character of emotion, they described how emotions gain an "ego-alien" hold on us that cognitions characteristically do not. It is emotion that puts the compelling *imperative* into social duties, the *ought* into morality, the *feeling* into respect, and the *sting* into conscience. This observation is why Socrates argued to the affect that thought alone moves nothing. Serial killers have readily reported that they knew what they were doing was wrong, but they did not *feel* this wrong enough to have it inhibit their actions (Lyng and Franks 2002). Without appreciating the compelling nature of the *embodied* "role-taking emotions" of guilt, shame, and embarrassment, we lack a full theory that fuses self-control and social control of behavior in one process (Shott 1979). Thus, one reason why emotion is so critical to the study of the brain is that its embodiment moves us to action (see also Rolls 1999).

Directly relevant to "why the emotional brain" is LeDoux (2000:225) summation of the formative function of emotion:

> Emotional arousal has powerful influences over cognitive processing. Attention, perception, memory, decision-making and the conscious concomitants of each are all swayed in emotional states. The reason for this is simple: emotional arousal organizes and coordinates brain activity.

Finally, Tredway et al. (1999) have shown the priority of emotional brain processes in three other major areas. First is the historical priority of emotion to language in the evolutionary cognitive development of the species (see also Turner 2000); second is its critical role in laying down a firm foundation for childhood cognitive development; third is emotion's role in shaping the direction of the young self-system.

SOCIOLOGY AND THE NEUROSCIENCE DIVIDE

There are many reasons why some sociologists are hesitant to recognize the contributions of brain studies to their field. Several will be discussed here in hopes of opening what many sociologists still see as a closed door.

Evolution as a Narrative

Some sociologists might still reject neuroscience because it is based on evolutionary thinking, which, to them, is just another arbitrary narrative. Much of brain science, however, confirms the importance of narrative to the coherence of self and its tendency to create events as meaningful (LeDoux et al. 2003). We can hardly discard narratives because they tell a story. The knowledge one could learn about the brain without evolutionary thinking is so limited that it would be of little use to anyone. Evolution informs our thinking of the brain.

Lakoff and Johnson (1999) argued that because convergent evidence is produced by different methods and interests, our frameworks are prevented from being totally arbitrary narratives. This also minimizes the possibilities that researchers' assumptions will predetermine the results. For example, frameworks as different as traditional symbolic interaction and the more socially oriented neuroscientists have converged on important findings in spite of different methods and conceptual orientations (Franks 2003).

A New False Dualism: Reductionism versus Emergence

In neuroscience, this dichotomy is seen as "top-down" and "bottom-up" chains of causation. Both chains are usually accepted, although more researchers are comfortable with the traditional bottom-up approach.

It might come as a surprise that the Nobel Laureate Roger Sperry, mentor for Gazzaniga and LeDoux, proposed an even more radical form of causal emergence in biology. His "emergent mentalism" went so far as to contradict the axiom that physical action waited only on another physical action. Sperry's (1965) claim was that the *causal potency of an idea became just as real as that of a molecule, a cell, or a nerve impulse.* Consciousness plays a causal role in directing the flow pattern of cerebral excitation. Simply put, mind can move matter. As TenHouten (1999:44) concluded, "Sperry put mind into the brain of objective science and in position of top command." This is not a one-sided model, however. The emergent whole—the "weave of our lives"—can only arise from the parts because a *mutual* interaction exists between physiological and mental properties. Consistent with this statement, Tredway et al. (1999) warned that although we talk about the parts of the brain as if they are individual, self-moving cogs in a machine, we must remember that the brain actually acts holistically. Far from viewing the weave of our lives as reduced to neuronal firing, it is our mundane everyday living that engages the parts.

Brain studies indicate that the emergent "new" does not just pop up unrelated to its past. New parts of the brain carry some of the old parts with them. For example, Lakoff and Johnson (1999) argued that the emergent symbolic, so long seen as qualitatively distinct from animal gesture, is heavily dependent upon metaphors that arise from bodily movements and actions. This is not to minimize its distinctive novelty, but only to recognize that it is not totally free of its past.

There is another type of reductionism that many leaders of neuroscience go out of their way to deny: A philosophical reductionism that assumes that human experiences of love and hate, aspirations of all types, and so forth are essentially epiphenomenal. In the words of Francis Crick (1994:3), we "are nothing but a pack of neurons." This is not an empirically held belief because nothing of an empirical sort speaks to this issue. On the contrary, it is a philosophical question of ontology—what is assumed real. Murphy (2003) called it an *attitude.* LeDoux (2002:328) referred to this as an "absurd kind of reduction that we have to avoid." There is no lack of irony in the fact that some sociologists dismiss neuroscience because of its alleged reductionist tendencies, whereas it is precisely in this field that some of the most telling arguments for emergence can be found.

In sum, the above assumes a technical notion of the top-down, bottom-up causation model in neuroscience and suggests that we need both (Franks and Smith 1999). As TenHouten (1999) and many neuroscientists remind us, the existence of an overall emergent system does not stop with the individual, but must include the cultural and structural systems operating downward on each brain (see, e.g., Brothers 1997; Cacioppo et al. 2000; Panksepp 2000).

SOME GENERALIZATIONS ABOUT THE EMOTIONAL BRAIN

First, all academic fields have experienced difficulty in defining emotions as one general class of distinctive phenomenon. Scholars from psychology (Griffiths 1997), sociology (Scheff 1995), and history (Reddy 2001) have suggested that the term is not a unitary concept defining a single object of knowledge. Neuroscience, at least in the hands of LeDoux (1996), Panksepp (2000), and Brothers (1997, 2001), takes a similar stance. LeDoux (1996) warned that emotion is not something that the brain does or has. Terms like cognition, perception, memory, and emotion are necessary reifications for analytical purposes, but they do not have clear boundaries and do not have discrete, dedicated locations in the brain. Perception, for example, describes loosely what goes on in a number of systems. For LeDoux,

> The various classes of emotions are mediated by separate neural systems that have evolved for different reasons.... There is no such thing as the emotional faculty and there is no single brain system dedicated to this phantom function. We should not mix findings about different emotions all together independent of the emotion that they are findings about. (1996:16)

Second, the brain is highly reactive and needs to engage in actions within an environment to maintain itself and develop. Brain cells that are not used die. For example, children who are allowed to indulge in temper tantrums do not develop the neuronal pathways to control the robust circuits already existent in the structures involved in early emotion (Carter 1999). This leaves them without controls in their mature years. "Use it or lose it" is as true in childhood as it is in older age.

Third, the brain is a "tinkerer." Its relatively new structural features do not come out of the blue as perfect answers to its new tasks. Once again, the brain can only build on what the past allows, and its past is therefore a part of the new. For example, Wentworth and Yardley (1994) cautioned that we make a common mistake when we take the evolutionary youthfulness of the human neocortex and its comparatively large prefrontal lobes to mean that the neocortex alone reins the brain in queenly fashion—especially its older parts. We might fail to realize that the older emotional anatomy of the brain coevolved with the cortex. Nothing stays still. As a matter of fact, the development of human emotional capacities accelerated at a rate faster than did the neocortex, which is why emotional influences are causally favored over the cortex (Turner 2000). Contrary to common understanding, the old so-called limbic system, which was once considered the distinctive seat of emotion, has been decisively modernized. It is a full partner in whatever is distinctively and currently human.

Fourth, the brain has immense flexibility. Other structures do what they can to perform the function of traumatized structures. Related to this is the brain's "lateralization." Every structure in the brain is located on each hemisphere, with the exception of the pituitary gland and the corpus callosum. If a baby lost half of its brain, the other hemisphere would rewire itself to perform the tasks usually seen as the exclusive prerogative of one side. This firms up with age and myelinization—the hardening of the cover on nerve cells. Regardless of this lateralization, the left and right brains have different, but often complementary, styles and capacities, which will be discussed later.

Finally, neuroscience has driven a final stake into the heart of Locke's "tabula rasa" theory, wherein mind is conceived as an empty slate "writ" on by experience and passively mirroring "what is." According to Lakoff and Johnson (1999) correspondence theory is dead in the water. Our senses are transducers (Franks 2003). The brain and its senses must reconstruct incoming information, changing it to be "accommodatable" to the brain's capacity to process it. The brain consistently sees patterns where there are none, and much of it is designed to get the "gist of things" rather than precise details. Emotion is a pure, brain-given projection onto the world. It plays a significant role in what we remember, and it is now well accepted that memory is a highly edited and heavily revisionist capacity.

THE FUNCTIONAL ANATOMY OF EMOTION IN THE BRAIN

Structurally, the human brain is obviously an individual organ with discrete biological boundaries. Functionally, however, a *working* brain only operates in conjunction with other brains. For Brothers (1997:xii, 2001), who is probably the most socially minded of the neuroscience researchers, "cultural networks of meanings form the living content of the mind so that the mind is communal in its very nature."

The key to understanding the functioning human brain, even down to its genetic structure, is not solely an investigation of its self-contained parts but, rather, their relation and interaction in the brain as a whole. Furthermore, as Gazzaniga (1985) argued in *The Social Brain*, the left hemisphere's linguistically enabled "interpreter" plays an executive function attempting to pull together the many less analytical right-brained modules and their impulses into a nearly unified whole. Above all, the brain is a proactive and reactive organ. Any description of the individual brain's anatomy must be informed by the above.

The average brain is a 3-lb saline pool of brain cells called neurons that act like a conductor for electricity. It is only 2% or 3% of the individual owner's body weight, but it uses 25% of the body's oxygen. It takes up a full 50–55% of our genomes. The cerebral cortex covers the brain with convoluted folds and houses the "computation" part of the brain. This computational part is only one-fourth of the brain's functioning, the other parts being devoted to emotional, perceptual, motor, and maintenance tasks, among others. In short, within these 3 lbs of cells is a microscopic universe of incomprehensible expanse and complexity.

In a conservative estimate, Damasio (1994) writes that a brain contains several billion neurons. The number of synaptic connections formed by these neurons is at least 10 trillion. The timescale for neuronal firing is extremely short, on the order of tens of milliseconds, and the firing never rests. Within 1 s, the brain produces millions of firing patterns. Each neuron is supported by 10 glial cells that act as a nourishing glue that keeps the gelatinlike structure of the brain together. Recent speculation has it that glial cells also play a more substantive role. Given this complexity, caution about our understanding of the brain is in order. Although there have been important discoveries about the way the brain works, we should not deceive ourselves that we have anything but the most rudimentary knowledge of what there is to know.

Building Blocks of the Brain

At the center of each neuron is the *cell body*, which stores genetic instructions, performs housecleaning, and makes protein and other molecules necessary for its functioning. Stretching out of the cell body in both directions are nerve fibers that look like tree trunks with thick branches that communicate with other neurons. The first type—axons—are transmitters that send signals away from the cell nucleus (output channels). Some axons stretch out several feet, ending in the lower spinal cord. The second type of fiber—dendrites—are shorter and act as receivers (input channels) of messages from axons.

Most neuronal cell bodies have only one axon, but on the branches of each axon are numerous swollen parts (terminals), allowing the axon to send messages to the dendrites of as many as 1000 other neurons (Kandel et al. 2000). The same neuron receives as many as 10,000 messages. Thus, through these branches each neuron is a receiver and sender of messages. At the terminals, gaps thinner than the ink on this paper exist between axons and dendrites of other neurons. This is referred to as a *synapse*. Chemicals from vesicles in the axon terminal called neurotransmitters are released into this synaptic space when the neuron fires. These chemicals trigger gated ion channels to open or close in the dendrite, making the receiving neuron more likely or less likely to fire. Activity within neurons is electrochemical, whereas communication between neurons is chemical.

A neuron initiates its signal by creating a rise in voltage of about 50 mV where the axon emerges from the cell body. This rise in voltage is called an *action potential*. It has little to do with action in the usual sense. Nor is its electricity like that running through a wire. It is more like a pulse or propagation moving down the axon in a "neurodomino" effect, producing similar changes in adjacent parts to the transmitting terminal (LeDoux 2002).

Transmission only occurs one way because the chemical storage sites for the neurotransmitters exist only in the transmitting terminal of the axon. Thus, we have electrical signals traveling down axons being converted to chemical messages that help trigger electrical signals in the next neuron. This picture of single neurons is deceptive, however. Many input signals arriving within milliseconds of one another are necessary to trigger a neuron to fire. It takes many action potentials arriving at about the same time from different transmitting neurons to make a dendrite actually receive it. The elements of such a flood must occur within milliseconds of each other. This electrochemical event forms the material basis for the constant conversation between neurons that make human hopes and fears, joys, and sorrows possible.

One Person, Two Brains: Lateralization

The brain has two hemispheres. "Lateralization" refers to the fact that each hemisphere specializes in different capacities. In right-handed people, the left side is usually involved in processing, cognition and language. It tends toward the lineal and analytic. Above all, it is interpretive, seeking meaning and sensibility. The right side is perceptual, characteristically more gestalt-driven and intuitive. Whereas the left brain puts experiences in a larger context and risks mistakes to create sensibility, the right brain typically remains more true to the perceptual aspects of stimulus. This tendency toward literalness can add needed correction to the interpretive tendencies of the left hemisphere. Like other executives, however, the interpreter has a tendency to "kill the messenger." Obviously, with such strengths and weaknesses, both sides are needed to complement each other.

Structures in the human right hemisphere have a disproportionate involvement in the basic processing of emotion, but there are many exceptions to this picture of the functioning of the two sides. Most probably, the contrast is significantly more subtle than usually depicted. Carter (1999:35) wisely warned against the "dichotomania" regarding brain hemispheres in the popular literature.

Split-brain research began in the 1960s when Sperry (1965) and Gazzaniga (1985, 1998a, 1998b) found that certain cases of epilepsy could be cured by severing the corpus callosum connecting the two lateralized hemispheres. This is a massive bundle of some 200 million fibers enabling the fully linguistic left brain (in right-handed people) to know what the largely mute right brain is doing.

Split-brain studies helped establish the modular organization of the brain. Modules perform very specific functions and are relatively autonomous. They are found beneath the cortex in the form of lumps, tubes, or chambers the size of nuts or grapes connected by crisscrossing axons. Each module is duplicated in the other hemisphere. Taken-for-granted perceptions such as facial recognition, the organization of space, or sequencing of events are dependent on modular functioning. Modules have their own intentions, behavioral impulses, emotions, and moods. The task of the executive left brain to organize all of these impulses into some semblance of unity is daunting. According to Gazzaniga (1985), these are often capricious, but the left-brain "interpreter," as he calls it, will manufacture a verbal "account" (Scott and Lyman 1968) to make it appear sensible and creditable. This discovery hinged on the fact that Gazzaniga and his co-workers could instruct the right brain to do things unknown to the subjects' conscious left brain. Nonetheless, the left brain reliably gave its contrived reasons to explain why they acted. As Gazzaniga (1998b:54) concluded,

> [t]he interpretive mechanism of the left hemisphere is always hard at work, seeking the meaning of events. It is constantly looking for order and reason even when there is none—which leads it continually to make mistakes. It tends to overgeneralize, frequently constructing a potential past as opposed to a true one.

When the left hemisphere is involved with emotion, affect is usually positive. The right hemisphere is more typically involved with negative emotion (Rolls 1999). This hypothesis derives from earlier studies showing that catastrophic levels of depression were found more often in stroke patients after damage to their left hemispheres than to the right. Electroencephalograph (EEG) recordings for depressed patients indicated more activation on the right hemisphere, and for positive emotional episodes, there is more activation on the left. In these cases, it is suggested that the left brain is not able to assert the usual controls on the negative feelings that germinate more typically in the right brain (Carter 1999; Davidson 1992; Rolls 1999). The arguments for the lateralization of emotion are complex but have to do with efficiency and the imperative of minimizing weight and size in the 3-lb brain. Thus, neurons of similar function tend to group together in one place rather than being spread out in both hemispheres (Rolls 1999). Other findings encourage further work on emotional lateralization, like the fact that right-hemisphere cortical damage impairs the patient's recognition of the expression of fear in others.

TOP TO DOWN BRAIN STRUCTURES

The Cerebral Cortex

The cerebral cortex is the top layer of the brain covering its top and sides with a layer of densely packed cell bodies known as the gray matter. Underneath this layer is another layer of axons that connects these neurons known as the white matter—white because of the myelin that insulates the axons and facilitates the flow of electricity (Carter 1999; Damasio 2003). According to Heilman (2000), the cerebral cortex analyzes stimuli, develops percepts, and interprets meaning preliminary to emotional responses.

The deep fissures and crevices of the cerebral cortex allow its sixteen-square-foot surface to be packed into the skull. Each infold is referred to as a sulcus and each bulge is a gyrus. Two-thirds of the cortical surface is hidden in the folds of the sulci. Large convolutions are called fissures and they divide the cerebrum into five lobes. Frontal lobes are involved in planning action and control of movement; the parietal lobe with sensation and forming body image; the occipital lobe with vision; the temporal lobe with hearing and through its deeper structures it is involved with aspects of emotional learning and memory (Figure 2.1).

Precise motor and sensory functions have been located and mapped to specific areas of the cerebral cortex. The frontal cortex does not lend itself to such precise mapping but includes areas of association that integrate different pieces of sensory information. It plays an important part in the conscious registration of emotion through messages sent from deeper structures (Carter 1999). The sensory cortex is an important part of the cerebral cortex running across the top of the brain from left to right. It receives information from sense organs. In front of that, also from left to right, is the motor cortex.

Neocortex

The external part of the cerebral cortex described above is the neocortex, so called because it is the gray matter of the cortex most recently acquired in evolution.[2] The neocortex is by far the largest component of the human brain, comprising 75% of its neurons. These neurons are arranged in six layers that vary in thickness in different functional areas of the cortex ranging from 2 to 4 mm thick (Kandel et al. 2000). The massive expansion of the human neocortex in the frontal lobes is considered critical to full consciousness, thinking, planning, and linguistic communication. It

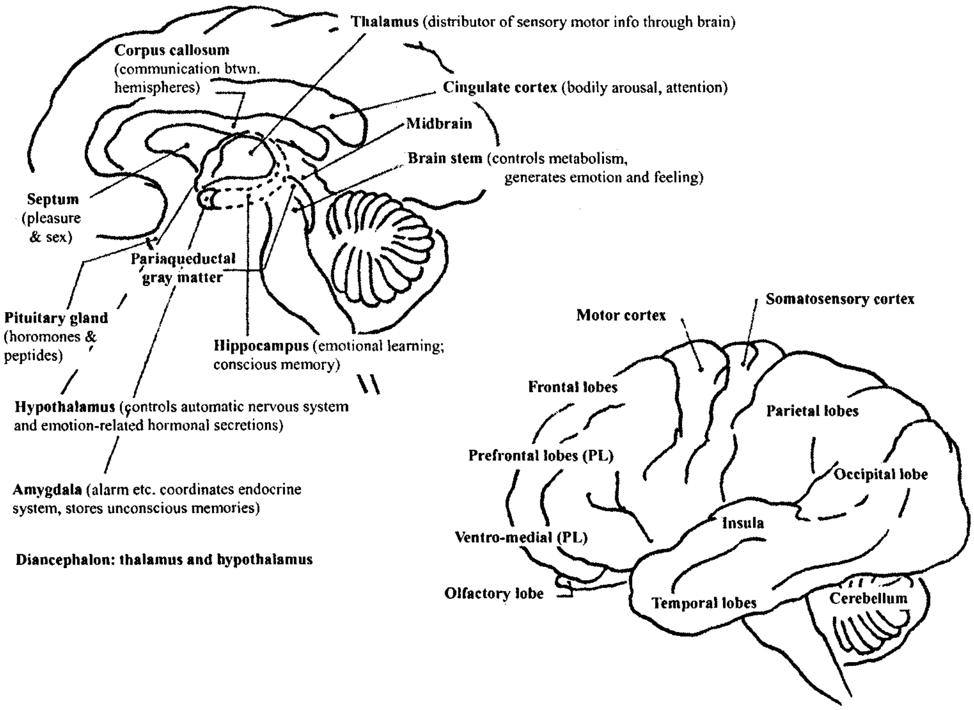

FIGURE 2.1. **Emotion-Related Structures in the Brain**

also houses its ample share of unconscious processes. Behind the prefrontal lobes, the neocortex also contains motor areas, the sensory cortex, and association cortexes (Turner 1999). It bears repeating that lower-level emotional structures powerfully bias and otherwise regulate higher neural structures. As one might suspect by now, the terms *cerebral cortex*, *cortex*, and *neocortex* are often used in overlapping ways.

LeDoux (1996) and a few other neuroscientists insist that the higher brain functions of the cortex are essential for the generation of emotional feelings. However, Panksepp (2000) pointed to the failure of direct neocortical stimulation to generate emotional states. It is clear, however, that the role of the cortex in lending sophisticated ways of controlling, inhibiting, and effectively organizing emotion is vital.

Cerebrum

The term *cerebrum* is used when the brain is looked at in terms of its two hemispheres separated by the longitudinal fissure. Damasio (2003) saw it as a synonym for brain, perhaps because it makes up 85% of the brain's weight and includes the cortex layers and their functions described above.

Cingulate Cortex

The cingulate cortex is a longitudinal strip running from front to back above the corpus callosum. The front of the cingulate cortex is especially implicated in emotion, including depression and transient sadness. The posterior is more associated with cognitive processes. This large area is an integral part of the somatosensory mapping system that creates bodily feelings or "arousals," from the chills created by music, to sexual excitement, and to bodily reactions to drug experiences (Damasio 2003). To be capable of feeling, the organism must not only have a body but also must be able to represent that body inside itself. One of the major characteristics of the human brain is that it is extremely nosey, and much of what it is nosey about is its self (Damasio 1994). The cingulate cortex plays a vital part of this representation. There is much more to emotion than feeling, but feeling is vital nonetheless. Experientially, without feeling from our bodies, emotions are indistinguishable from thoughts (Carter 1999). Damasio's "prefrontal" patients who can think of feelings but not feel them are vivid cases in point.

Intractable pain has been relieved by surgical destruction of the cingulate cortex (Berridge 2003). The recognition of emotional expression might involve its anterior regions. Pictures of happy faces have produced activation in the left side of this area. However, no cingulate involvement was found in response to sad faces. This asymmetry is considered consistent with Davidson's (1992) suggestion that the left hemispheric specialization elicits positive emotion and right specialization elicits negative emotion. It is one of the most consistently activated regions in patients with obsessive—compulsive disorder. Some suggest that the anterior cingulate acts as a bridge between emotion and attention. It is also described as being involved in the integration of visceral, attentional, and affective information necessary for self-regulation and, by implication, social control, as is the cortex as a whole. It is essential for integrating emotions with the forebrain (Turner 1999) and is also well connected with deeper structures.

Insula

The insula is another critical somatosensing region behind emotional feeling that Damasio (2003) considers underappreciated. It is tucked away deep inside the fold of the temporal lobe. In emotional feelings, signals from the entire body are conveyed from the brain stem to a dedicated nucleus of the thalamus and then to neural maps in the anterior and posterior insula. The insula, in turn, sends this on to the ventromedial prefrontal lobes and the anterior cingulate (Damasio 2003). The cingulate cortex and the insula are dominant sites of engagement in the feelings produced by ecstasy, heroin, cocaine, and marijuana. Damasio (2003) saw the body sensing regions such as the insula as the sites of neural patterns that are the proximate cause of feeling states.

Other Subcortical Structures

Lying deep within the cerebral cortex is the hippocampus and the amygdala. A small but very complicated collection of nuclei, the amygdala lies at the front of the long, horn-shaped hippocampus, whose tail end wraps around the thalamus. It is most known for being the brain's instantaneous alarm system. It monitors the external world for danger and enables instant fear and anger. Although it has many connections to the cortex, it can be engaged with minimum time-consuming cortical inputs. It is even important in *consolidating* memories—ensuring that emotionally significant memories will be well remembered (Kandel et al. 2000). It coordinates the autonomic and endocrine systems involved in emotions and is important for the ability to interpret others' emotions. According to Fellows et al. (2000), the amygdala also stores unconscious memories in much the same way as the hippocampus stores long-term explicit memories.

It is well known that emotional events facilitate such storage and are important in learning the lessons that life teaches. The pains and delights of emotional experiences make them vital as rewards and punishments in emotional conditioning. Thus, the role of the hippocampus in memory is crucial. Without memory, learning is severely limited and nothing approximating emotional intelligence will develop.

The hippocampus also works closely with the amygdala in context conditioning—the recognition and remembering of contexts that make objects dangerous or not. This enables us to be afraid of bears in the wild but not in the zoo.

It is well known that memory is enhanced by emotion. Memory "consolidation" depends on the hippocampus, which is connected to almost all of the cortex, making an elaborate flow of information between the two possible.[3] Consolidation means that the memories are arranged into one episode of many parts. Thus, remembering one part will often bring back the others.

Without an intact hippocampus, the person cannot incorporate anything new. The amygdala stores fearful covert past memories, but because cortical activity operates to depress amygdala activation, these memories cannot be voluntarily brought to consciousness. At later dates, when least expected, they might pop up as flashbacks. Long-term elevations of stress hormones as in childhood abuse and military actions can damage the hippocampus and literally shrink its tissues, causing the memory defects associated with posttraumatic stress disorder (Carter 1999).

Dienchephalon

The dienchephalon lies between the cerebral hemispheres and the midbrain. The latter is on top of the brain stem and continues to the spinal cord. This structure and the pituitary gland lying in front of it are mediators of sensory inputs that carry emotional charges (LeDoux 1996; Turner 1999). They also produce hormones and peptides critical to emotional responses. The diencephalon is composed of the thalamus and the hypothalamus, the latter lying in front of and below the thalamus. The thalamus is the large relay station for processing and distributing all sensory and motor information from the periphery going to the cerebral cortex. The emotional aspects of this information are regulated by the thalamus through its variety of connections to the cortex. More recently, it has been found that the thalamus determines whether this information reaches *awareness* in the neocortex (Kandel et al. 2000).

The pea-sized hypothalamus controls the autonomic nervous system and hormonal secretions by the pituitary gland. It has input and output connections to every region of the central nervous system crucial to emotional feeling. According to Damasio (2003), the hypothalamus is the master executor of many chemical responses that comprise emotion. For example, the peptides oxytocin and vasopressin, vital to attachment and nurturing, are released under its control with help from the pituitary gland. According to Kandel et al. (2000), it coordinates the peripheral expressions of emotional states. The hypothalamus is also involved in appetites, from hunger to sexual excitement. Finally, new areas of pleasure were apparently layered over the most ancient emotional centers—the amygdala and septum. The latter is located above the pituitary gland and is the repository of sexuality. Turner (2000) suggested that this might have heightened capacities for reciprocity and altruism in early *Homo sapiens*.

Brain Stem

The brain stem is a set of small nuclei and pathways between the diencephalon and the spinal cord. They are associated with the basics of life maintenance like metabolism. Because it is like the brain of current reptiles and formed around 500 million years ago, it is sometimes referred to as the reptilian brain. Emotion processes were an early evolutionary development taking place when brain organization was dominated by the brain stem, and present brain organization remains rooted in brain-stem neural systems.

Damasio (1999) and Panksepp (2000) viewed the brain stem as critical to mapping feelings because it is the conduit from the body to the brain and the brain to the body. Berridge (2003:36) reminded us that contrary to earlier understandings of the brain stem as merely reflexive, "almost every feeling of pleasure or pain felt by the forebrain must climb its way there through the brain stem."

According to Damasio (1999), areas of the brain stem work with the forebrain structures of the cingulate cortex and prefrontal cortex to generate consciousness, including emotional states. Damage to the brain stem most often causes the loss of all consciousness.

The midbrain rests on top of the brain stem and includes a group of nuclei called the pariague-ductal gray area. Damasio (1999) saw this area as critical to high-order control of homeostasis and a major coordinator of emotion. According to Panksepp (2000), it releases opiod neurotransmitter receptors important to many emotional states. He suggested that it was this area that first allowed creatures to cry out in distress and pleasure, and he agreed that the brain stem is a subcortical contributor to conscious feeling.

THE DEBATE ABOUT THE LIMBIC SYSTEM

At the end of the nineteenth century when sensory perception and movement control were found located in specific areas of the neocortex, questions arose about the specific location of emotions in the brain. James (1884), of course, concentrated on conscious feelings as a result of the behavioral responses to "emotional stimuli." Emotion was then located in our sensory cortices that perceived bodily movements appropriate to gearing up for action in different situations. This precipitant movement produced the bodily feeling. We ran, not because of the emotion of fear; the feeling of fear was the sensation of the body in the preparation for the act of running. This was refuted by Cannon's (1927) demonstration that the removal of the neocortex failed to extinguish emotional responses.

This pushed the search down underneath the neocortex, ending with MacLean's (1949) proposal that such a place could be found in the "limbic system." This comprised a discrete network of primitive structures between the supposedly more recent neocortex and the brain stem. The neocortex was thought to have enabled the cognitive and learning capacities of mammals as opposed to reptiles. Structures usually associated with the limbic system include the hippocampus, thalamus, hypothalamus, and the amygdala. MacLean's limbic system was an update of his original idea of emotion in general as essentially involving our blind, visceral reactions to environmental stimuli. This dimension of mentality "*eludes the grasp of the intellect because its animalistic and primitive structure makes it impossible to communicate in verbal terms*" (LeDoux 1996:94, emphasis in original). Phylogenetically, humans have the reptilian brain, the paleomammalian brain, and the later more advanced neomammalian brain, which is shared with late mammals and other primates. All three are linked in humans, but they were thought to have retained their own very different kinds of intelligence, memory, and sense of time and space. Above all, MacLean's framework was an evolutionary theory of the localization of emotion processing in the old reptilian cortex. Clearly, all of this was a strong force in keeping alive the cultural devaluation of emotion as primitive and antithetical to reason.

As brain anatomy became better understood, the difference in these cortical areas became impossible to order phylogenetically and with it, the evolutionary backdrop to MacLean's proposal

(LeDoux 1996). As observational techniques improved, it turned out that primitive creatures had rudimentary cortices similar to the supposedly more advanced mammalian neocortex. They were just in different places and had escaped notice. Thus, there was no distinctively reptilian cortex in humans that has remained unchanged since primordial times and that exclusively housed emotional processing. The neocortex turned out not to be so new and the supposedly distinct reptilian cortex was not so distinct. As a result, the old/new cortex distinction broke down (LeDoux 2002).

MacLean (1949) defined the limbic system particularly in terms of its connection to the hypothalamus. As research techniques improved, it became evident that the hypothalamus connected to all levels of the nervous system, including the neocortex. If the limbic system is significantly connected to the entire brain, as its structures seem to be, its ability to localize emotion or anything else is lost. As we have observed in other cases of newer structures, the limbic area could not be seen as ancient and static in time, because all areas were so interconnected that they influence each other, resulting in the allegedly old structures having new properties and roles. Presumably, they retain aspects of old characteristics and tendencies, but taken as a whole, they are not what they used to be. One criterion for inclusion in the limbic system was proposed to be connection with the thalamus, but it was soon recognized that such connectivity included structures at all levels of the nervous system from the neocortex to the spinal cord (LeDoux and Phelps 2000).

According to LeDoux (1996), the popular theory of the limbic system finally broke down with the finding that its essential structures like the hippocampus were by no means dedicated to emotion and actually had a clearer involvement in cognitive processes like declarative memory (LeDoux and Phelps 2000). However, in spite of numerous critics, this expected rejection was not to be the case.

The reason why the concept has refused to die starts with the amygdala. Its deserved reputation for generating emotional judgments with minimal cognitive input also made it a gateway to the study of "pure" emotion in the brain. The amygdala has a very low threshold to electrical stimulation, which adds to its reputation for producing emotional quick triggers. This capacity, however, is because of only one of its major pathways. Granted that emotion here is relatively cognition free and offers a "limbic" gateway to researchers, but at other times and in different ways, the amygdala is driven by cognitive pathways in the neocortex and prefrontal lobes. Nonetheless, the amygdala remained at the forefront of research into the emotional brain and carried with it the related notion of the limbic system.

A balanced view of the amygdala must recognize that it can also receive significant input from sensory cortical regions involved in consciousness and is acted on by cognitive neuronal pathways that can inhibit its felt strength. Lesions to areas of the amygdala disrupt positive as well as negative emotional reactions. As we have seen, some of these disruptions include the ability to apprehend emotional implications of social situations and the ability to generate appropriate emotional responses to them. Covert memories involving fear are presumably stored in the amygdala rather than the cortex.

Within all of this complexity it is nonetheless clear that the amygdala is more consistently involved in emotion than any other area between the hypothalamus and the neocortex. However, it is not involved in all emotions and commonly draws from areas outside of the limbic system.

One of the reasons researchers think that it might be easier to glean emotion independent of cognitive aspects in the amygdala is because it is so closely connected to the thalamus that it can send noncognitive messages directly from the outside environment without time-consuming input from the more distant neocortex. However, this is only one of the pathways in its emotional functioning. When potentially fearful objects come to attention, *two* parallel tracks send information to the amygdala. Prior to engaging either track, data simplified by the senses are sent to the thalamus, where they are further sorted and sent to appropriate processing areas (Carter 1999). In the case of the sighting of a snake, the fearful message is sent on the fast route described above. This path takes milliseconds. The long path goes to the visual cortex at the back of the brain and takes twice as long. At the visual cortex, it is uncategorized raw data. Next it must be categorized as a snake with the memories that go along with that, and then an emotionally laden and cognitively appraised message is sent to the amygdala, which stirs the body proper into action.

In sum, the concept of the limbic system was originally intended to explain emotion in general and localize all emotion in a specific place in the brain. Emotions are involved in many areas of the human brain and are tightly interwoven with structures of cognition, memory, and motivation. There is much more to emotional processing than the amygdala or its adjacent "limbic" system. Berridge (2003) concluded that neural substrates of feeling and emotion are distributed throughout the brain, from front to back and top to bottom. LeDoux's criticisms are no doubt correct, and it would probably be more accurate to talk simply of the "emotional brain." However, Berridge (2003) and Panksepp (2000) suggested that once we are aware of the inadequacies of the limbic system as a concept, we might be prudent to tolerate its use. At this stage of neuroscience, the term is not really less vague than many current anatomical concepts, and in order to advance our knowledge, we might have to tolerate successive approximations.

NEUROSCIENCE AND UNCONSCIOUS EMOTION

As critical as consciousness is to being human, the vast majority of what the brain does is accomplished through unconscious processes that often affect the course this consciousness will take. This has been a major theme of neuroscience and of this chapter. According to Gazzaniga (1998a) and Lakoff and Johnson (1999), more than 95% of what the brain does is below consciousness and shapes conscious thought. Much of what goes into these estimates, however, should be considered evident. We cannot bring into consciousness the processes that enable this consciousness, much less those involved in facial recognition, memory retention, or a sneeze. Any single second of consciousness is the smallest iceberg tip in an infinite sea of involuntary synaptic processes sealed from awareness.

A less evident type of emotional unconscious has to do with *content* rather than processes. For example, Scheff (1990) discussed the negative effects of chronic, unacknowledged shame. One can suffer from guilt or anxiety so long that these feelings become part of the person's "assumptive emotional order" and are only recognized when they are lifted. Defense mechanisms like projection and reaction formation are often emotional in character, and when acknowledged, they lose their efficacy. Unfortunately, process and content are often conflated when discussing the emotional unconscious.

Unconscious emotions tend to spill over and become misattributed to objects unrelated to their origins. Also, as we have seen, the usual cortical controls of emotion are rendered useless when we are not aware that there is anything to control. Ironically it is this psychologically important meaning of unconscious emotional content that has proven the most controversial.[4]

The Appeal of "Mentalism" and Disentanglement from the Early Freud

One reason for the reluctance to accept the idea of unconscious emotions is that it goes counter to an important Western assumption about thought and action. Certainly, an important dimension of thinking is the self-conscious weighing of alternative courses of action and our ability to reflect on our motives before we act. People know what they are doing and know their reasons for doing so. In this view, consciousness is first and action follows (Öhman 1999). Actually, there was little question of the rather narrow validity of mentalism as far as it went; the limitation, as stated in the beginning of this chapter, was one of scope.

According to Öhman, it was not until the mid-1980s that experimental psychology began to recognize the converging evidence for the unconscious, although they preferred the term "implicit learning." Writers in the sociology of emotions have long recognized the inability of those expressing negatively sanctioned emotions to recognize them in themselves. Jealousy and envy are clear cases in point, and others' attempts at enlightenment are very frequently met with irritation. In a culture where it is important to appear as masters of our own fates and practitioners of agency, notions of the unconscious can be unwelcome. Scientists are no exception.

The problem was exacerbated by the legitimate concerns that academics had over the widely popular acceptance of Freud's fanciful early speculations on the unconscious id and superego that rendered the ego epiphenomenal.

Neuroscience contributions to the unconscious have little resemblance to Freudian views and arise from very different perspectives and methods. In terms of processes, it is generally recognized in neuroscience that by the time a person consciously initiates an action, the brain has already done its work (Libet 1996). For every subject intentionally initiating a particular motor movement, Libet found a prior electrophysiological neural potential causing the action 100 ms before the conscious decision. Similarly, with emotion as content, by the time we become conscious of our feelings, the brain, especially the amygdala, has also already done its work. This is a major theme in the writings of Damasio and LeDoux among others, as will be seen below.

The neuroscience readiness to accept the emotional unconscious must be seen in relation to the overwhelming evidence for the cognitive unconscious and dramatic denials connected with various medical maladies. Prosopagnosia, for example, is the lack of ability to recognize faces, even those of one's most intimate family members. However, patients do seem to exhibit "emotional blind sight" reliably responding with higher skin conductance responses to familiar persons than to nonfamiliar ones and making appropriate responses to them on unconscious levels (Lane et al. 2000). Ramachachandrun and Blakeslee (1998) saw the dynamics of Freud's defense mechanisms writ large in such blatant cases of unawareness, repression, and denial. A conscious defense mechanism is an anomaly—a failed psychological operation.

The New Separation of Emotion and Feeling: Disentangling from James

Along with LeDoux's first argument that the brain was essentially emotional, there was also a new separation of emotion (which was characteristically unconscious) from feeling (which was always conscious). Feeling, and the awareness of the body as in fear and trembling or the chill of goose bumps, had taken center stage in James's view of emotion. According to James (1884:193), "If we fancy some strong emotion and then try to abstract from our consciousness of it all the feelings of its characteristic body symptoms, we find that we have nothing left behind, no 'mind stuff' out of which the emotion can be constituted."

Wresting psychologists away from the plausibility of this argument has been helped by the unique outlook of current brain studies. However, James himself had hinted at the entry point for current neuroscience, namely that these very sensory feelings to which he gave such emphasis were themselves caused by *involuntary reactions to events*. Whereas James gave relatively little attention to this once it was said, Damasio and LeDoux focused on just this point—not that emotions cannot be to some extent manufactured, but to them the essential characteristic of basic emotions is their involuntaristic and automatic character. If emotions are equated with feelings, then emotions seem intuitively subjective and private. For Damasio (2003), emotions are objective and public; they occur in the face, posture, voice, and specific behaviors. They engage heart rates, blood pressure, skin conductance, and endocrine responses. The subject is unaware of most of these emotional processes.

Thus, LeDoux and Damasio turned the lived experience of emotion so popular in sociology on its head. They granted the importance of feeling and its feedback that affects the original emotion and the importance of feeling to what it is to be human. They also recognized the importance of Wentworth and Ryan's (1992) felt "limbic glow" to our apprehensions of self and, thus, social control. However, from an evolutionary point of view, emotion is the set of "mute survival mechanisms rooted in the body," which itself is not conscious feeling and thus not mental. The experienced feeling is seen as a "sophistication" of the basic unconscious brain mechanism turning us from danger and attracting us to things of benefit. LeDoux at one point calls feeling "a frill—the icing on the cake" (Carter 1999:82). In the final analysis, he saw it as a very important frill for much the same reasons sociologists do.

The Unconscious in Evolutionary Perspective

LeDoux (1996), like Damasio, argued that to understand emotion, we must go deeper than the behavioral and physiological responses described by James. The interest of both men is to probe the unconscious system that causes the feelings (like fear) before we even know that we are in danger. Damasio's (2003:30) answer to why emotion comes first and causes feelings later is "because evolution came up with emotions first and feelings later."

From the beginning of life on Earth, organisms have been endowed with mechanisms to automatically maintain life processes. These include immune responses, basic reflexes, and metabolic regulation that maintains interior chemical balance. Working up to the more complex of these devises are systems of pain and pleasure, which automatically determine what is to be sought and avoided. Further up this ladder are the appetites, including hunger, thirst, curiosity, and sex. The crown jewel of such life regulation is emotion. Above emotion is feeling, which is ultimately seamlessly connected and looping back on it. Although all of these homeostasis devices are present at birth, the more complex the system is, the more learning is required to engage it.

Consciousness, being a late development in evolution, came long after emotion. One would therefore expect that unconscious emotional systems and conscious feeling systems would exist in the brain, and although interrelated, they would be, in some meaningful sense, distinct. Jacoby et al. (1997) have provided consistent support for the hypothesis that conscious and unconscious processes are independent. The fear system, for example, is available to consciousness but operates independently of it, making fear a prototypical unconscious emotional system. Of course, whether and to what extent fear can be generalized to other emotions awaits further study (Brothers 2001).

A study described by Öhman (1999) demonstrated that fear responses do not require consciousness. Subjects were recruited from two groups: those who were very fearful of snakes but not fearful of spiders and those fearful of spiders but not fearful of snakes. The control group consisted of students who did not fear either one. Pictures of snakes, spiders, flowers, and mushrooms were then shown on slides significantly faster than possible for conscious perception. Nonetheless, when exposed to the imperceptible snake slides, those fearful of snakes had elevated skin conductance responses (SCR) to the snake slides but not those of the spiders. The participants fearful of spiders responded similarly to the spider slides but not those of the snakes. The control group had no elevated responses to any of the slides. In sum, with no consciousness of the slides' contents, subjects showed enhanced sympathetic, unconscious responses. After describing similar studies, Öhman (1999) concluded, in accordance with LeDoux, that aspects of an unconscious fear response are independent of conscious processes, although they can be consciously accessed.

More Evidence of Unconscious Emotion from Neuroscience

One early illustration of emotional memories beyond the patient's awareness might prove somewhat disconcerting to current sensibilities. In 1911, a doctor pricked a patient suffering from short-term memory loss with a pin, causing significant distress. The physician left the room until the patient regained her composure. Suffering from *source amnesia*, she had no way of recognizing the doctor when he came back in with his hand out in a gesture of greeting. Reasonably enough, but with no conscious recall of the first incident, she refused to shake his hand again. She explained that "sometimes people hide pins in their hands." Fortunately, more current case studies demonstrate progress in doctors' concern for their patients.

One such illustration comes from Damasio's (1999) traumatized patient David. His damaged hippocampus and amygdala resulted in the loss of all conscious memory. He could not recognize individuals because he could not remember them. Nonetheless, he did seem to gravitate to certain people and avoid others. To probe this further, David was placed in social situations with three different types of experimental accomplices. One was pleasant and rewarding and a second was neutral. The third was brusque and punishing. David was then shown four photos including the faces of the three accomplices and asked who he would go to for help and who was his friend. In spite of his inability to consciously remember any of them, he chose the pleasant accomplice.

David was quite capable of feeling preferences and related affect when it did not depend on short-term memory. Because he suffered significant destruction to his ventromedial cortexes, basal forebrain, and amygdala, Damasio surmised that these areas, as involved as they are in regular emotional life, were not necessary by themselves for either emotion or consciousness (Damasio 1999).

According to Kihlstrom et al. (2000), the evidence for this type of unconscious emotion is not limited to anecdotal case studies, although they describe other current experimental case studies like the one above by Damasio. For example, using the strategy of mere exposure effects, unconscious preferences for melodies were created in amnesic subjects who have no ability to remember the exposure.

Damasio's (2003) stronger argument for the unconscious nature of emotion as opposed to conscious feeling came from his own empirical study. A hypothesis was tested regarding the brain structures that would be activated by emotions of sadness, happiness, fear, and anger. Activation was measured by blood flow in the hypothesized regions as measured by positron-emission tomography (PET) scans. These brain areas included the cingulate cortex, two somatosensory cortices (including the insula), the hypothalamus, and several nuclei in the back of the brain stem (the tegmentum). PET scans reflect the amount of local activity of neurons and, thus, the engagement of these structures when emotions are felt. Next subjects were coached in theatrical techniques of reliving memories of experiencing the four emotions to the point of actually experiencing some degree of feelings for each. Preexperimental tests determined which of the four emotions subjects could enact the best for the final experiment. In the actual study, subjects were able to make themselves feel their assigned emotion with surprising intensity. They were asked to raise their hand when they started to feel this emotion. Heart rate and skin conductance were measured before and after the hands were raised.

In terms of results, all of the brain structures identified above became activated during the onset of emotional feeling. Furthermore, these patterns varied among the four emotions in expected ways. Most important for the purposes here, changes in skin conductance and heart rate always preceded the signal that the feeling was being felt; that is, they occurred *before* the subjects raised their hands. Damasio (2003) concluded that this was just another situation where emotional states came first and conscious feelings afterward.

Damasio also insisted that we must separate emotion, which is always unconscious, from feeling, which is always conscious. Although they might operate in close interaction with each other and in the final analysis might be seen as fused, he argued for a clear analytical distinction between the two *at this point*. In sum, Damasio (1999) argued strongly that the basic mechanisms underlying emotion proper do not require consciousness, although they may eventually use it.

In conclusion, it should be clear that inquiry into the unconscious is an important, although difficult area. The route to rational emotional control is not in resisting the unconscious because its reputation was tarnished by "Freudian misuse" or because it goes counter to common sense and cultural assumptions about agency. We need to use common sense to go beyond it. From the beginning, the course of empirical research into the unconscious aspect of emotion has been dictated by definitional assertions and semantics. Neuroscience has very recently played its part in cracking this resistance, first by case studies of patients that clearly indicated the existence and causal importance of unconscious content. Damasio, for one example, took the next critical step by using normal patients in testing his hypothesis concerning the causal priority of unconscious emotion to feeling.

ON THE RELATIONSHIP OF COGNITION AND EMOTION: THE INTERACTION OF COGNITIVE AND EMOTIONAL PROCESSES IN THE BRAIN

The fallacy of dualistic contrasts between emotion and cognition that pit each against the other as inevitable antagonists is a familiar theme. Certainly, the conflict is true at times, but more satisfactory comparisons will depend on describing how they can be inextricably linked while capable of being in tension. Researchers predisposed to one side often fail to retain this difficult balance by making epiphenomena of the other side (Lyng and Franks 2002).

Because definitions are frequently biased by preferences for one side or the other of the dualistic coin, it follows that they cannot be unreflectively taken for granted or as carved in stone. Rather, they need to be handled with awareness that they are our own theoretical products to be evaluated in terms of their consequences for the advancement of knowledge. We will see below that as important as the collection of data is to the research process, definitions will determine how these data are interpreted. As such, definitions are social constructions, basically matters of considered judgment, at times productive and at other times not.

Definitions of Emotion from Cognitive Psychology

It is not surprising, therefore, that when Damasio and LeDoux talked about emotion, they were thinking about something different from the cognitive psychologists and perhaps most sociologists. Neuroscientists might be somewhat more inclined to stress those definitions that highlight the mute character of emotions as expressions from the "theater of the body," whereas cognitively oriented thinkers are more interested in the intertwining of emotions and appraisals from the "theater of the mind." Both emphases are critical in eventually maintaining the balance necessary in avoiding dualistic dead ends. Clore and Ortony (2000), for example, pushed their cognitive preferences to the limit and neuroscientists do the same to retain the separability of emotion and cognition.

To Clore and Ortony (2000), the cognitive component of emotion is the *representation* of the emotional meaning. Their definition of the cognitive extends its reach to include perception, attention, memory, action, and, of course, appraisal, but stops after the representation. They do not include an emotion beyond its cognitive representation. On the other hand, for these authors, the cognitive belief that someone is cheating you and the resulting emotion are not causally arranged in that order. Rather, they are two separate and parallel ways of experiencing the "personal significance of the situation" (i.e., emotion). Both are different levels of appraisals—cognitive and emotional. Here it seems that their boundary is honored.

For those interested in keeping the integrity of emotion per se, like Zajonc (2001), a problem arises in Clore and Ortony's familiar definition of emotions as relational. Emotions are always "about," "over," "at," or "with" their object. In philosophical terms, this relational quality is referred to as *intentionality*.[5]

However, where does this leave affects caused by electrical stimulation that might be considered by some a prime example of pure emotion? Such stimulation, taken as the *initiation* of the emotional process, is patently not appraisal of any kind. We have discussed the temporary full-blown depression followed by the recognizable pattern of depressive cognitions caused by such stimulation. Similarly, a recent case was reported when the left cortex of an epilepsy patient was inadvertently electrically stimulated, causing robust laughter. Each time the doctor applied the current, the patient found something different and normally unfunny to laugh at. Whatever the definitional issues, this artificially stimulated arousal indicates the separable integrity of something we can call "pure emotion" or "affect." This has the advantage of allowing for tension between emotion and cognition that lived experience tells us exists.

Given Clore and Ortony's (2000) contention that emotions always include cognition, the authors handle the problem posed above by including reactions to the electrical stimulation under "affect" rather than full emotion, even though the above descriptions seem quintessentially emotional. Nonetheless, to these authors, affect is only an incomplete, "degenerate" form of fully blown, intentional emotion. If it is critical to retain the tension between emotion and thought while also seeing them as interactionally intertwined, their definition might seem too narrow. None of this causes insurmountable problems as long as we keep a critical perspective on definitions as tools created relative to our purposes.

A Neuroscience Approach to Cognitive and Emotional Interactions

LeDoux (1996) emphasized the separability and primacy of emotion by pointing out cases when subjects "evaluate" objects before identifying them. More important for the primacy of emotion is the fact, mentioned above, that connections from the subcortical emotional systems to the cognitive systems are stronger than connections from the cognitive systems to the emotional ones. LeDoux also stated that emotional feelings involved many more brain systems than thoughts. This is why emotions engulf and commit us so inflexibly while cognitively we can easily argue one position as well as another just for the sake of argument. Attempts at "emotion work," although sociologically important on the collective level, often meet with individual failure.

LeDoux (2000) admited to more confusion than consensus about the relation between emotion and cognition. He attributed much of this to the fact that neither term refers to real functions performed by the brain but, instead, to collections of disparate brain processes. However, earlier, LeDoux (1996) made clear that emotion and cognition are best thought of as separate but interacting mental functions mediated by separate but interacting brain systems. When certain brain regions are traumatized, animals, including humans, lose the capacity to evaluate the emotional significance of particular stimuli but retain the cognitive ability to perceive and identify them. These processes are separately processed in the brain.

In line with the flexibility of cognition in contrast to emotion, systems involved in cognitive processing are not as closely connected with automatic response systems as those of emotion. Emotional meanings can begin formation before cognitive/perceptual mechanisms have completed their appraisals. Emotional and cognitive memories are registered, stored, and retrieved by different brain processes. Damage to emotional memory processes prevents an object with learned affective meaning (the sight of one's children or lover) from eliciting emotion. Damage to cognitive mechanisms prevents remembrance of where we saw the object, why we were there in the first place, and with we were whom.

Examples of Complex Interactions Between Cortical and Subcortical Regions of the Brain

Having made the argument that cognition and emotion are separate brain processes, LeDoux (2000) turned to listening to the interactions in the brain. Most of the interactions reported in his essay had to do with the amygdala and different cortical regions. However, one such study described a most curious feedback loop between these two.

We have seen that the overriding task of the amygdala is to scan the environment for danger, the quicker the better. We have seen that the thalamus gives it the quickest and most direct input for such assessment, and the slower but more "considered" inputs come from the numerous sensory cortexes. Thus, the amygdala is alert and active before these cortical messages arrive. This gives an opening in time for the alerted amygdala to project its quick and dirty "leanings" back into the early cortical processing. It then receives its own unconsidered biases mixed in with the final sensory cortical messages. Inputs from the thalamus, in contrast, are a one-way street contaminated by no such "regulation" from the amygdala. This leaves a quick, but most unreliable mechanism as both author and receptor of its cortical inputs—a most curious interaction.

According to LeDoux (2000:139) "amygdala regulation of the cortex could involve facilitating processing of stimuli that signal danger even if such stimuli occur outside of the (conscious) attentional field." No wonder that what we perceive most clearly and convincingly is our own fears and that scapegoating so often brings tragedy to innocent persons.

The Somatic Marker Hypothesis

There is a growing body of evidence that somatic states are involved in cognitive processes including learning (Carter and Pasqualini 2004). Damasio's (1994) somatic marker hypothesis, mentioned above, has been a major contribution to this development. Bodily feelings associated with emotional experiences are, figuratively speaking, "marked" and then retrieved when similar situations reoccur. These embodied markers are strongly connected with emotional systems of the brain.

Subjects for Damasio's first study comprised patients who, like the famous Phineas Gage, had damage to the ventromedial part of the prefrontal lobe. This is the area where cognition and the "secondary" emotions important to making social judgments are thought to be integrated.

Most of Damasio's patients scored highly on intelligence tests and even scored well on Kolberg's moral thinking test. They had been competent in their professions and social relationships. Like Phineas Gage, their lives unraveled socially and businesswise after their traumas. Four deficits destroyed their professional lives: they could not make decisions, they could not judge people, they were incorrigible at home, and they could not learn from previous emotional experiences.

More generally, they could not empathize even with themselves; they dispassionately told of their demise to interviewers who were themselves on the verge of tears. While looking at what they recognized readily as terrible pictures of car wreck victims and so forth, their bodies showed none of the skin conductance responses that are used to indicate emotional feelings.

When asked by the hospital staff when they wanted to make their next appointments, they would sit endlessly giving every possibility they could think of equal attention without any way to make a judgment. As de Sousa (1987:191) observes, "no logic sets *saliency*." In this regard the patients were remarkably like Pylyshn's (1987) purely rational robot made by the artificial intelligence workers. His story featured a completely objective robot that gave equal, unbiased attention to all conceivable consequences of its actions and therefore could not make the simplest decisions. This was because without emotional predispositions, it could not narrow down the infinite number of objective possibilities to those worth consideration. It is a matter of irony that the first scientists to discover the necessity of emotion to decision making were artificial intelligence workers.

The somatic marker hypothesis goes further to suggest that Damasio's "prefrontal" patients' major incapacity was an inability to fully embody secondary emotions relevant to complex social situations and thus learn by positive and negative previous experiences. Damasio is not suggesting that emotions are a substitute for reason, nor is he down-playing the fact that emotions can cloud thought. His conclusion is simply that a "selective reduction of emotion is at least as prejudicial for rationality as excessive emotion" (Damasio 2000:13).

Damasio's prefrontals lacked this ability to draw emotional feelings from their bodies and in so doing they lost the capacity for realistic choice making and learning. A game was devised referred to as the "Gambler" to test exactly where this deficit was in functional terms compared to normals. The basic assumption of the game was that if long-term values could not be felt somatically, players would bow to short-term decisions even when they were experienced as deadly in the long run. The game required the subliminal learning that some cards promised large financial rewards but also carried risks down the road that would destroy any chances of winning. The prefrontal patients could not learn to become suspicious or emotionally uneasy about these deceptive choices and invariably lost the game. Normal players intuitively caught on. Damasio concludes that without the help of their somatically marked thoughts, their images of the long run were weak and unstable. This lack of capacity does not have to be from medical trauma. Diagnosed sociopaths with criminal records acted much the same in similar games and Damasio (1994) does not rule out the effect of "sick" cultures on normal adult systems of reasoning.

As mentioned above, Carter and Pasqualini (2004) produced support for the external validity of Damasio's hypothesis when thirty normal women played the card game. Higher skin conductance responses to negative outcomes were strongly accompanied by more successful learning on the Gambler game. The opposite was true for those who lost. The hypothesized relationships were robust enough to show up clearly in a relatively homogeneous group of normal women.

Berridge (2003) cautions that loss of cognitive *integration* with emotion is not the same thing as lacking emotionality in general. Damasio's patients lacked the emotions that produce voluntary social control like guilt, shame, embarrassment, and empathy (Shott 1979). Berridge suggested that emotional *regulation* (emotion work) might be the most impaired in these subjects.[6]

CONCLUSION

A major theme of this chapter has been that emotion drives the brain. It was emotional long before its conscious cognitive powers developed and this character still permeates the brain. Emotion organizes its activity both enabling rational decisions and powerfully influencing cognition. LeDoux's (1996) challenge to cognitive science has advanced markedly in favor of the neurophysiological primacy of emotion, but closure is far away.

For LeDoux, higher brain functions are essential for the generation of conscious emotional feelings, but not for emotion per se. Direct neocortical stimulation does not promote affective states (Öhman 1999; Panksepp 2000). Damage to the cortex only limits *intensities* of emotion. Consensus among researchers does exist on the importance of the cortex in emotional regulation, although even here emotion has the advantage in having more plentiful neural pathways. Panksepp believed that more evidence exists that brain-stem areas, rather than the neocortex, mediate affect, as demonstrated with the electrical stimulation studies on depression and laughter. His is a strong argument for the primacy of emotion in the brain.

Despite the strategic importance of the establishment of pure emotion, the complementary interaction between emotion and cognition greatly predominates in the brain. None of its structures or regions are exclusively devoted to emotion or to cognition, instead, their respective systems most probably overlap. There is clear overlap between behavioral patterns and those representing emotion as well as cognition (Lane et al. 2000). To repeat LeDoux's (1996) conclusions, emotion and cognition are best thought of as separate but interacting mental functions mediated by separate but interacting brain systems. Lane et al. (2000) believed that emotional processes that are uniquely different from cognition have yet to be demonstrated. It is clear that on the neural level, they are the same. Perhaps emotion's simple embodiment—the autonomic, neuroendocrine, and musculoskeletal concomitants of emotional experience—will become what distinguishes it from cognition.

Neuroscience has brought back the unconscious in a very different guise from past renditions. Emotion and the unconscious characterize the brain. Once confused with feeling, emotion is now thought to be an involuntary, unconscious process involving behavioral tendencies that cause conscious feelings that then reverberate on the emotion. Even though fear, for example, can be accessed by consciousness, it operates independently of awareness. According to Öhman (1999), this explains why rational thought has little influence on strong fears.[7]

LeDoux has opted for a detailed analysis of fear as a possible prototype for other basic emotions, but how this can be generalized is not known. According to Brothers (2001), this strategy emphasizes one structure (the amygdala), one behavior (defense), and only one or two emotions (presumably fear and anger). Many researchers are dubious about finding principles of a general domain of emotion, expecting different mechanisms behind different emotions. Nonetheless, LeDoux's strategy was reasonable as a starter.

Although cognition is not free-floating, unconscious emotion like pathological affect can permeate experience like moisture or heat. It scatters and spills over to become attached to any stimulus often totally unrelated to its origins (see Zajonc 2001). There is a very strong convergence between neuroscience literature and those aspects of sociology emphasizing the power of emotionally driven cognition to interpret almost anything as true that supports one's predispositions or what is simply familiar to us.

We have emphasized that no satisfactory common thread is available that draws the myriad cultural emotional differentiations into one definitional basket. This is as recognized in the social sciences as in neuroscience, where many think taxonomies are premature. This problem with emotion as a general term does not apply to emotions like fear and shame that have been relatively thoroughly researched. Nonetheless, one stands on solid empirical ground by recognizing that emotion as a large category is necessary in balancing the still healthy cognitive bias in psychology and sociology. Many would think that this recognition is more important than the lack of closure produced by the definitional problem. It would be foolish to think that the lack of a common thread minimizes the functional importance of particular emotions to the brain and its mentality. Perhaps at this stage we can see emotion *in general* as a very important residual category in the sense that it is so often just what cognition is not. Rather than thinking categorically, it may be wiser to see emotion and cognition on a continuum with a very large middle ground. However that might be, we will learn more by putting aside for the moment the problems of emotions in general and investigating specific emotions with nontraditional empirical techniques tailored to the task. Panksepp (2000) suggested that because our ignorance concerning emotion so grossly outweighs our knowledge, we should minimize the emphasis on competing perspectives and concentrate more on integrative efforts, including biological and social constructionist positions.

Naive formulations of the rational capacities of humankind would benefit from a close look at neuroscience literature. Hopefully, more work will appear on the secondary emotions so intimately involved in social control and interpersonal relations.

NOTES

1. Various highly technical measuring scanners that are the hallmark of neuroscience do not dispel the fact that there is little unifying theory tailored distinctively to neurological processes that help interpret the data generated (Brothers 2001). Nor does magnetic imaging dispel the problems of spurious correlations and determination of cause. In our ever-so-familiar social world, we know that fire engines do not start fires and storks do not bring babies. Brain processes offer another world foreign to us and common sense is of little help in interpreting correlational findings. Thus, the vague term "mediates" frequently substitutes for more explicit causal descriptions.
2. White matter is more predominant in the right brain and the left has more gray. Right-brain white matter is made of neurons that have longer axons and, thus, can connect to several modules simultaneously, resulting in integrative but vague insights. Gray matter is composed of densely woven, shorter, left-brain neurons capable of intense, focused, logical operations.
3. See Carter (1999) for a description of how emotional long-term memories are laid down in the hippocampus and then relinquished to the cortex.
4. See Fellows et al. (2000) for the major complex nuclei of the amygdala and connections to other structures.
5. Psychologically, this stipulation is important. It separates emotion from pain or purely sensory feeling, both of which are self-contained. A bee sting is not "over" or "at" the bee. The stipulation also brings the perception of the object of emotion into the emotional process. This avoids a notion of emotions as self-contained entities in the brain divorced from pragmatic action on the world.
6. For a succinct discussion of brain structures and pathways involved in emotional control in murders, see Carter (1999).
7. Very likely this is why governments throughout the ages control the public through creating false fears.

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