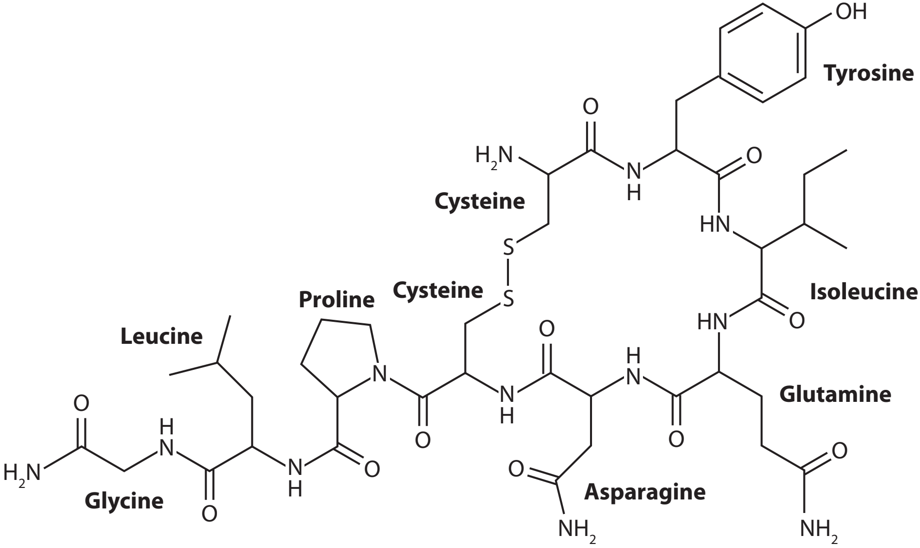

Figure 2.1. The molecular structure of oxytocin. Shown are its nine amino acids (cysteine occurs twice) linked by other molecules. By contrast, hemoglobin, the molecule in the blood that contains iron and carries oxygen, has about 500 amino acids. Hence oxytocin is considered a simple peptide (string of amino acids). Not shown is the three-dimensional structure of oxytocin.

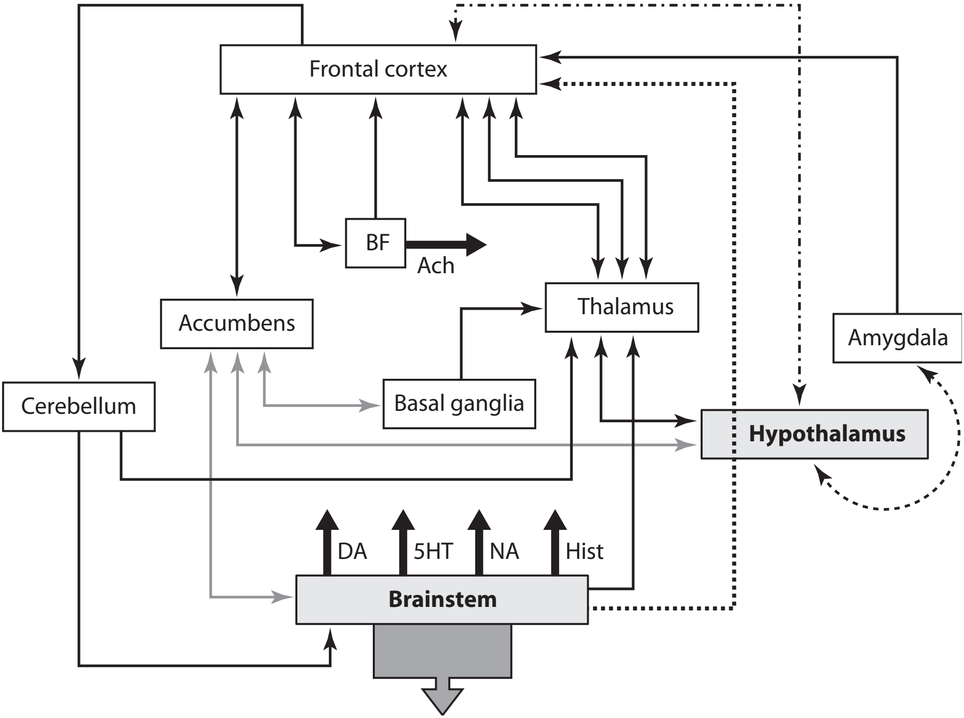

Figure 3.1. This schematically illustrates some of the subcortical structures and their connection to the cortex. Notice in particular the rich pathways between the frontal areas and the subcortical areas, including those involving reward (accumbens) and fear (amygdala). The hypothalamus is broadly connected to many structures, typically in a bidirectional manner. From the brainstem emerge four neuronal projection systems with distinct neurochemicals, each system reaching very broadly into many areas. The four neurochemicals, sometimes called neuromodulators, are serotonin (5HT), noradrenaline (NA), dopamine (DA), and histamine (Hist). Based on Josef Parvizi, "Corticocentric Myopia: Old Bias in New Cognitive Sciences," *Trends in Cognitive Sciences* 13, no. 8 (2009):354–59. (To see the location of the amygdala in 3-space, go to http://commons.wikimedia.org/wiki/File:Amygdala_small.gif.)

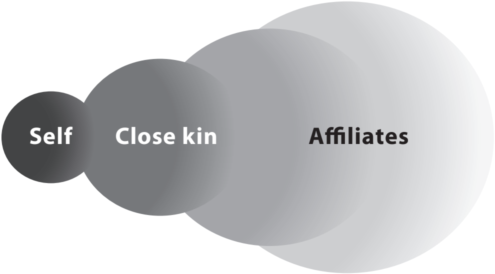

Figure 3.2. A cartoon depicting the spheres of caring. Circuitry serving one's own survival and well-being is modified in mammals to embrace one's babies. In social mammals, the embrace may include close kin, close friends, other group members, and even strangers, typically with decreasing intensity depending on the degree of attachment.

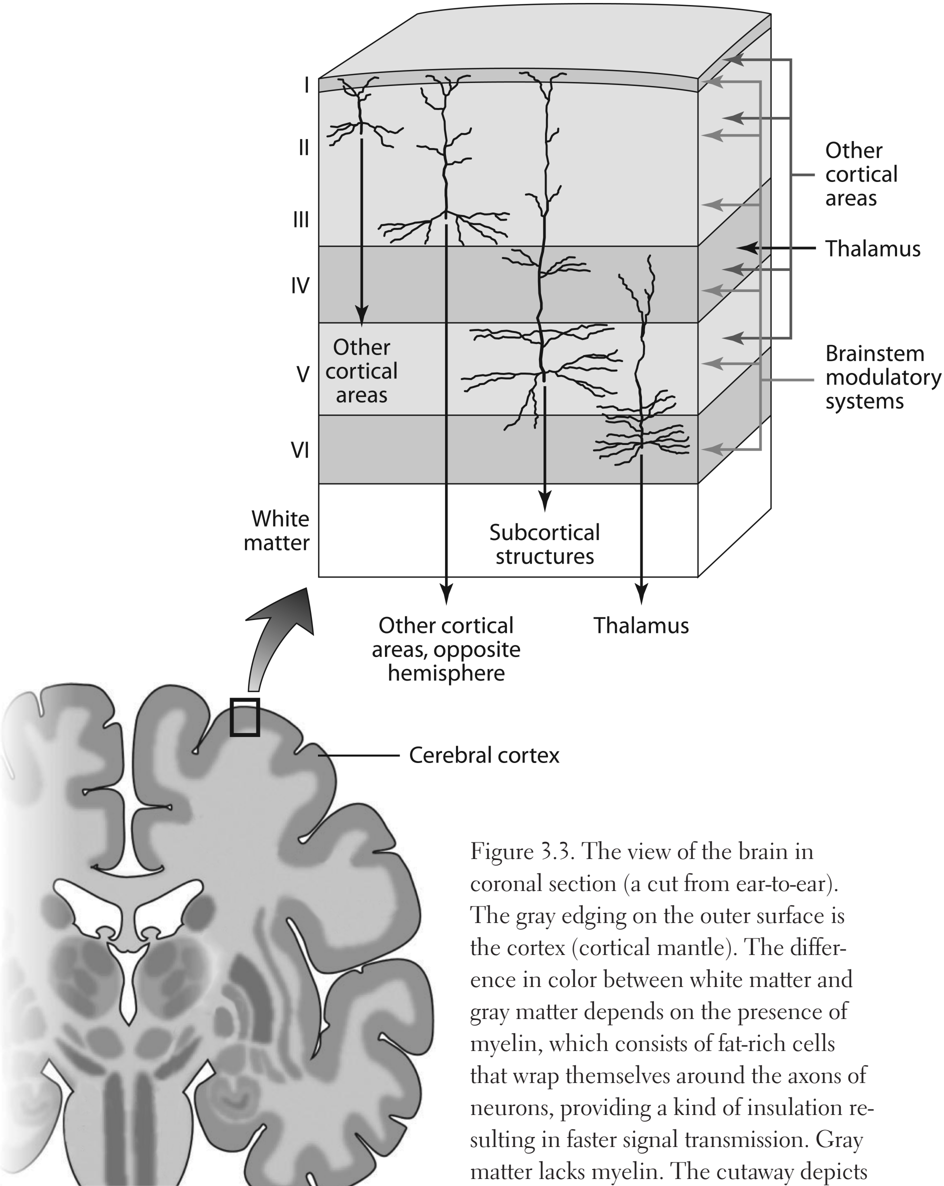

Figure 3.3. The view of the brain in coronal section (a cut from ear-to-ear). The gray edging on the outer surface is the cortex (cortical mantle). The difference in color between white matter and gray matter depends on the presence of myelin, which consists of fat-rich cells that wrap themselves around the axons of neurons, providing a kind of insulation resulting in faster signal transmission. Gray matter lacks myelin. The cutaway depicts the cortex's laminar organization and highly regular architecture. Not conveyed is the density of neurons: there are about 100,000 neurons in one cubic millimeter of cortical tissue, with about one billion synaptic connections between neurons. Adapted from A. D. Craig, "Pain Mechanisms: Labeled Lines versus Convergence in Central Processing," *Annual Review of Neuroscience* 26 (2003):1–30, and E. G. Jones, "Laminar Distribution of Cortical Efferent Cells," in *Cellular Components of the Cerebral Cortex*, ed. A. Peters and E. G. Jones (New York: Plenum, 1984), vol. 1, pp. 521–53.

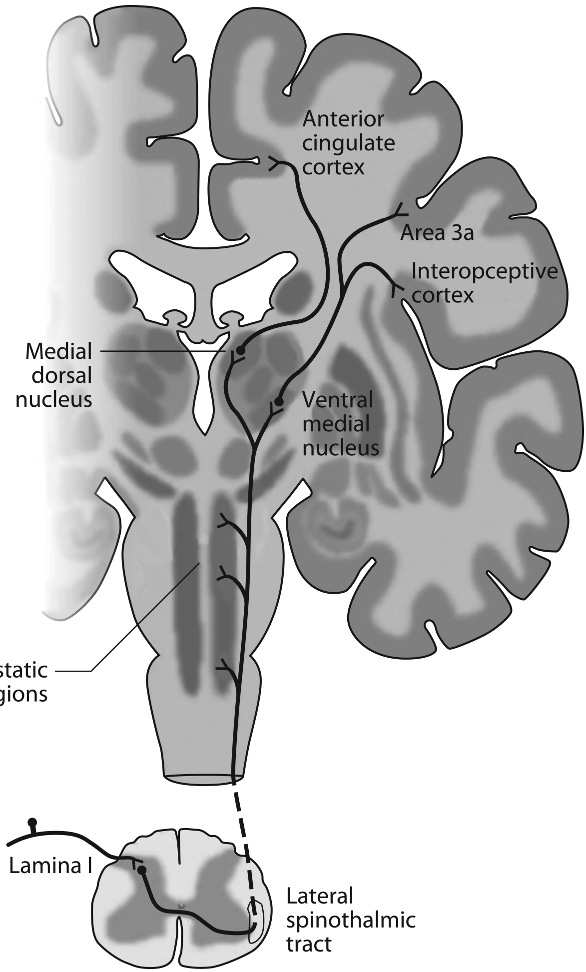

Figure 3.4. The drawing depicts the dominant pain pathway in the human brain and spinal cord as would be seen in a coronal section. The cortex and other gray matter structures (mainly the bodies of neurons) are shown as darker gray; white matter (mainly myelinated axons of neurons) are depicted as lighter gray. Notice that the lateral spinothalamic tract makes connections in the brainstem with the region regulating homeostasis, and then goes on to make synaptic connections in two distinct nuclei (gray matter regions) in the thalamus. One thalamic nucleus projects to the anterior insula (interoceptive cortex), containing a representation of the physiological state of the body, and to somatosensory cortex (area 3a); the other nucleus sends neurons to the ACC (anterior cingulate cortex). From A. D. Craig, "Pain Mechanisms: Labeled Lines versus Convergence in Central Processing," *Annual Review of Neuroscience* 26 (2003):1–30. Reprinted with permission.

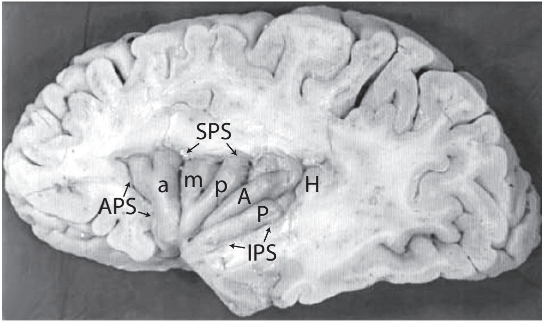

Figure 3.5. An anatomical photograph showing the insula in the left hemisphere. The insula has been exposed by dissecting away parts of the frontal lobe, temporal lobe, and parietal lobe. The insula can also be exposed without dissection by lifting the frontal lobe away from the temporal lobe. (A gyrus is a hill; a sulcus is a gully; the geography is the effect of folding as the growing brain is constrained within the boundaries of the skull. The landmarks are roughly, but only roughly, similar across individuals) a,m,p: anterior, middle, and posterior gyri of the anterior insula; A, P: anterior and posterior gyri of the posterior insula; APS: anterior periinsular sulcus; SPS: superior periinsular sulcus; IPS: inferior periinsular sulcus; H: Heschel gyrus. Reproduced with permission from Thomas P. Naidich et al., "The Insula: Anatomic Study and MR Imaging Display at 1.5 T," *American Journal of Neuroradiology* 25 (2004):226.

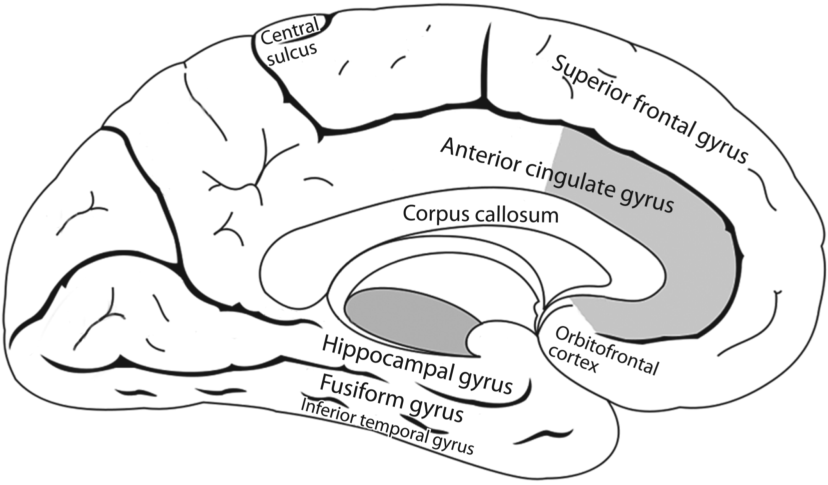

Figure 3.6. Sketch of the human brain showing the location of the anterior cingulate cortex, orbitofrontal cortex, (so-called because it is located just above the orbits of the eyes) hippocampal gyrus, superior frontal gyrus, inferior temporal gyrus, fusiform gyrus, and corpus callosum (the main connecting pathway between the two hemispheres). Based on Wikimedia Commons (http://commons.wikimedia.org/w/index.php?title=Special%3ASearch&search=anterior+cingulate).

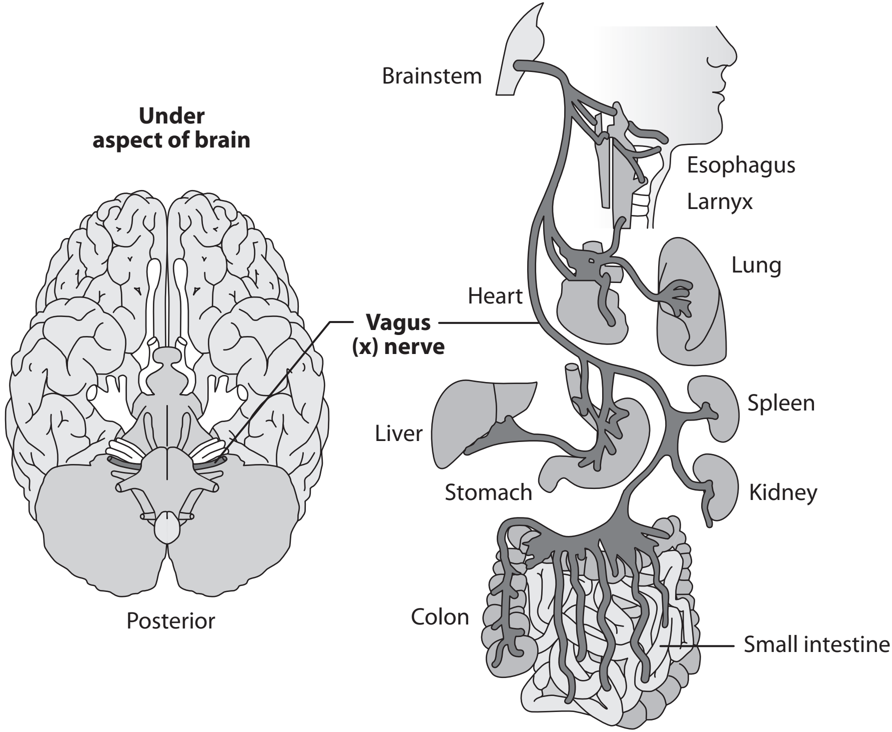

Figure 3.7. The vagus nerve pathways. Left: Schematic diagram showing the location of the vagus nerve (tenth cranial nerve) as it enters the brainstem, as viewed from the underside of the brain. Right: Schematic showing the exceptionally broad range of innervation by the vagus nerve. "Gut feelings" are believed to rely on signals from the vagus nerve. Copyright Bloomsbury Educational Ltd., www.clinicalexams.co.uk/ cranial-nerves-system.asp; adapted with permission.

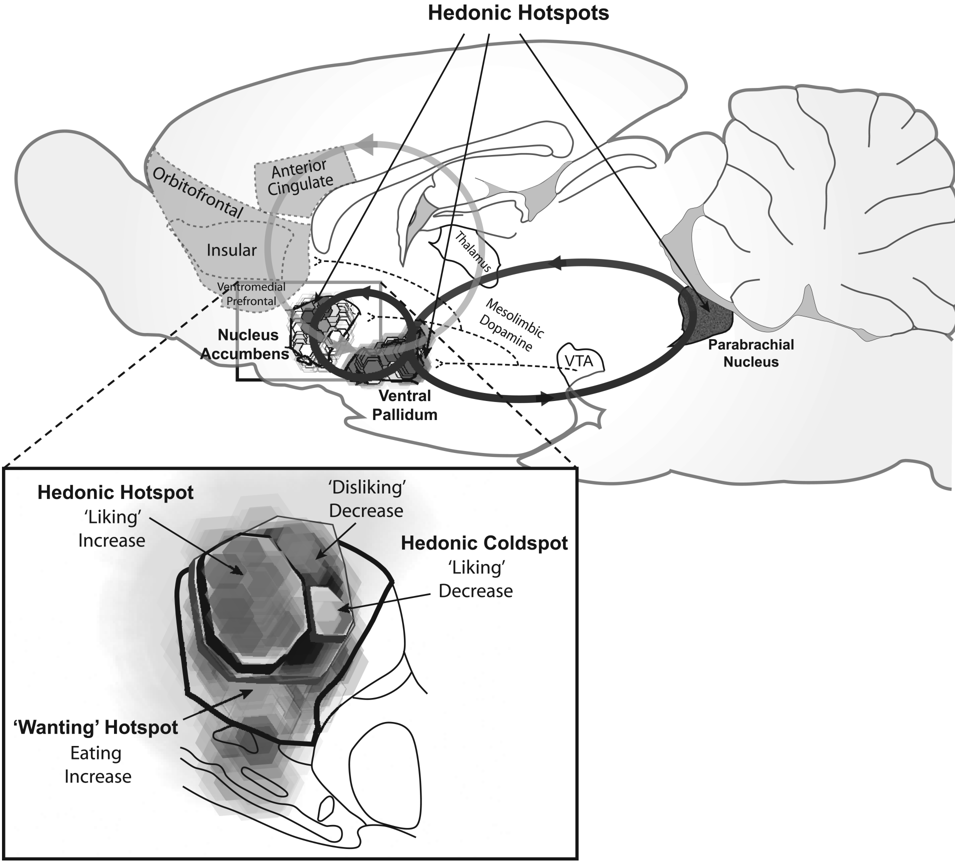

Figure 3.8. Drawing of a rat brain, showing the main circuitry of the reward system. Three crucial subcortical structures are the nucleus accumbens, the ventral pallidum, and the parabrachial nucleus. The main cortical structures connected to the hedonic hotspots are the anterior cingulate, the orbitofrontal cortex, the insula, and the ventromedial frontal cortex. The VTA (ventral tegmental area) contains neurons that release dopamine, and these neurons project into the ventral pallidum, the nucleus accumbens, and the orbitofrontal cortex, and are important in reward learning. All the structures and pathways exist also in the human brain. From Kent C. Berridge and Morten Kringelbach, "Affective Neuroscience of Pleasure: Reward in Humans and Animals," *Psychopharmacology* 199 (2008):457–80. With permission.

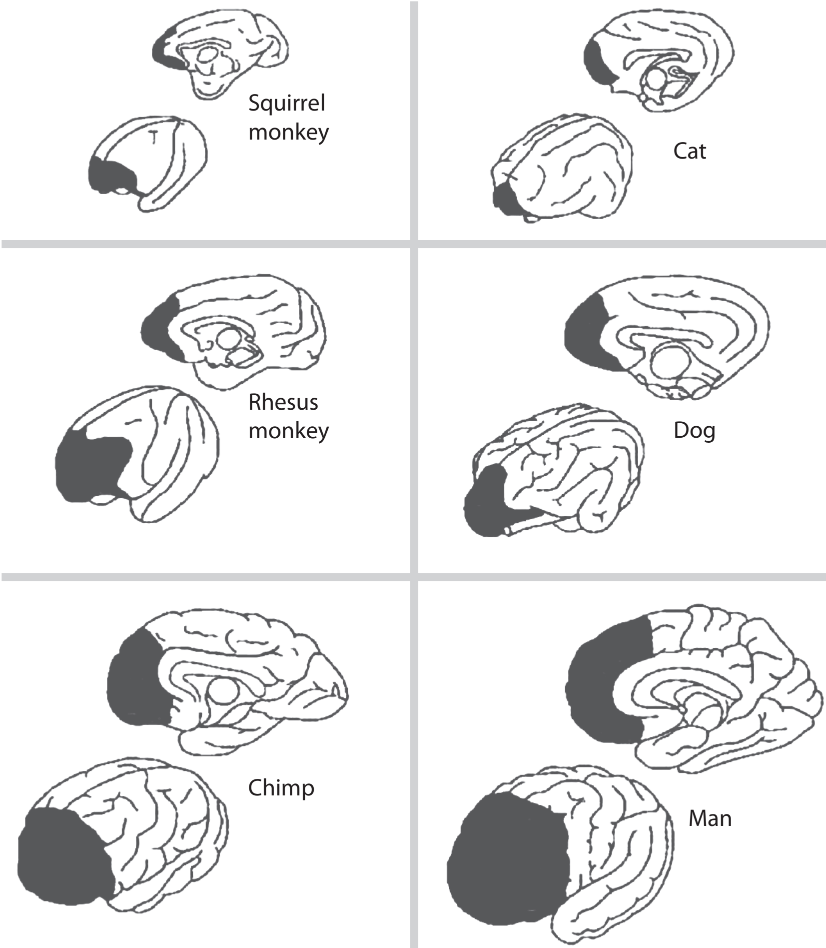

Figure 6.1. The dark area corresponds to the prefrontal cortex in each of the six species shown. Two views are shown: lateral-frontal (as though looking from the side and front), and medial, so the extent of the prefrontal cortex on the inner aspect of the hemisphere is represented. Not to scale. Reprinted from Joaquin Fuster, *The Prefrontal Cortex*, 4th ed. (Amsterdam: Academic Press/Elsevier, 2008). With permission from Elsevier.

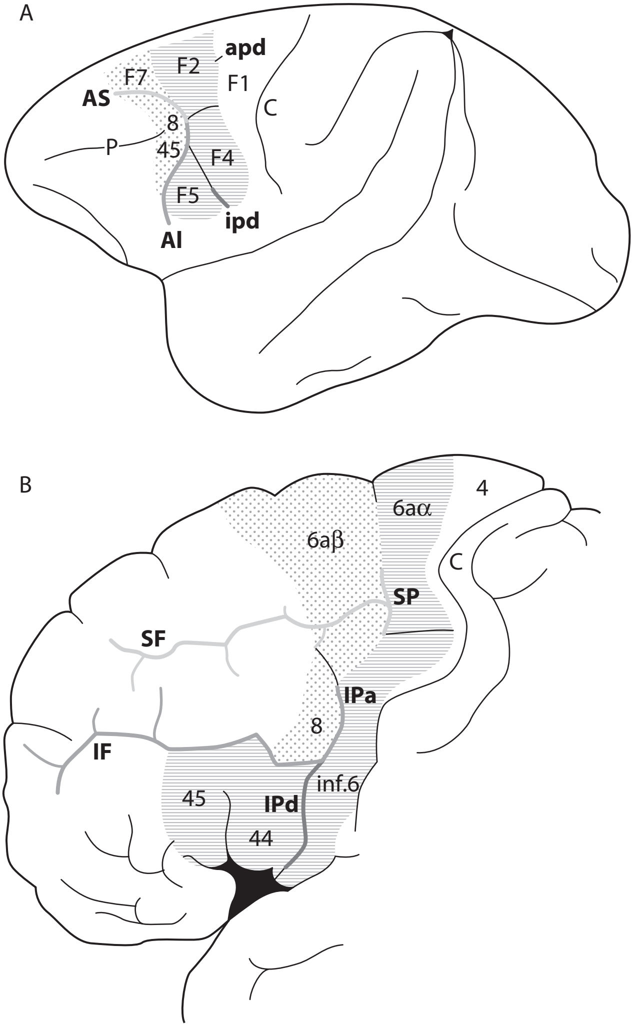

Figure 6.2. A (Top): Drawing of a monkey brain, showing area F5 in premotor cortex where mirror neurons were first found. F1 is the primary motor area. F2, F4 and F5 are premotor areas anterior to the motor strip; AS arcuate sulcus. B (Bottom): Drawing of the frontal region of the human brain showing area 44 (part of the inferior frontal gyrus), the area believed to be homologous to F5 and, along with area 45, also known in the human brain as Broca's area. The shading represents areas with anatomical and functional homologies. IF: inferior frontal sulcus; SF: superior frontal sulcus; IPa: inferior precentral sulcus; SP: superior precentral sulcus. The other numbers refer to Brodmann numbering of areas. Reprinted from G. Rizzolatti and M. Arbib, "Language within Our Grasp," *Trends in Neurosciences* 21 (1998):188–94. With permission from Elsevier.

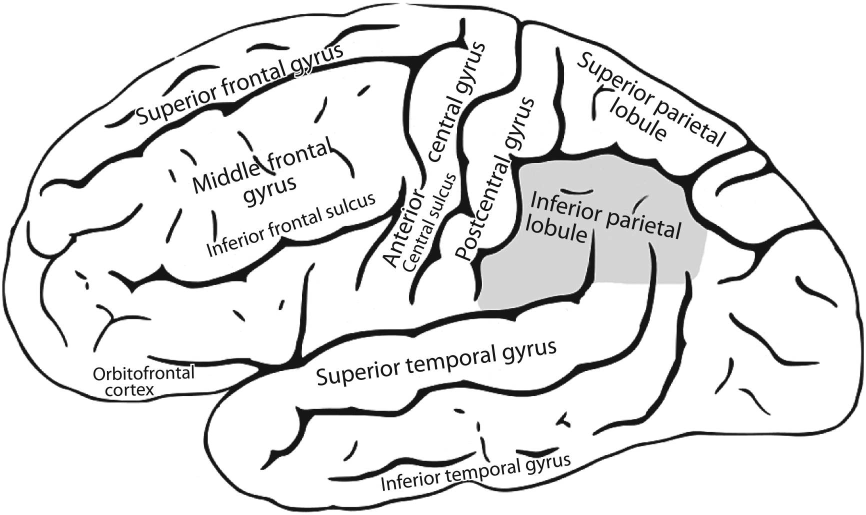

Figure 6.3. Diagram of the left hemisphere of the human brain showing the location of major sulci and gyri, and the inferior parietal lobule (in gray). Based on Wikimedia Commons, public domain. (http://commons.wikimedia.org/w/index.php?title=Special%3ASearch&search=inferior+parietal)