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Book Reviews

LINDEN, D. J. (2007)

The accidental mind: How brain evolution has given us love, memory, dreams, and God.

Cambridge, MA: The Belknap Press of Harvard University Press.
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Linden likens the structure of the brain to a multiple-dip ice cream cone. This vivid analogy characterizes the major premise of Linden's excellently documented, easy-to-read neuroanatomical excursion through the functioning of the human brain. What Linden means by this analogy is that the complex human brain has not developed as a precise, finely tuned machine but rather has been built on the brains of simpler organisms. Thus, the lizard brain is not unlike the mouse brain with "some extra stuff thrown on top." And the human brain is not unlike the mouse brain with "still more stuff thrown on top." The implication of this structure is that the hodgepodge of evolutionary trial-and-error did not start out to build a brain that could reason, love, and believe in God. Instead, over millions of years of evolutionary history, parts of the brain that evolved to solve problems for simpler organisms were recycled for other uses, and parts were added to solve the new problems of other organisms. The human brain that evolved from the brains of simpler organisms has never been redesigned from the ground up and for this reason contains ancient systems that may no longer serve the purposes for which they evolved.

An example of this redundancy of simple and complex mechanisms can be found in the visual system. As is well known, the experience of human vision resides in our visual cortex; people with lesions in their primary visual cortex report that they cannot see. But patients with lesions of this kind can often accurately locate an object in their visual field without any conscious awareness of seeing anything (a phenomenon known as *blind sight*). They can apparently see with the ancient midbrain visual system. Furthermore, they can even guess correctly the emotion shown in a photograph of a human face, and fMRI scans show activity in both the midbrain and the amygdala (the brain center associated with emotions). What is most important about this finding is that it suggests that these multiple systems can act to distort our sensory experiences because the visual pathways pass through emotional centers that make it impossible to separate emotion from perception.

The complexity of the human brain is required by the complexity of the behavior we must generate. Simpler organisms can do with simpler brains because the role of primitive brains was to produce behavior that evolution had programmed into the genes. These programs work well when there is little need for learning. For example, birds build nests when they reach their first breeding season without having to learn that they need a place to deposit their eggs. But in return for this reliability, animals give up flexibility. If the environment is stable, these programs work remarkably well, but when the environment changes and formerly predictable resources are no longer available, the programs may be rendered inadequate.

To complement these programmed instructions, most animals—even the simplest ones—have developed the ability to learn. In the simplest case, associations are acquired in which the predictive value of stimuli (Pavlovian conditioning) and responses (instrumental conditioning) is learned. This means that learning involves the interaction among perception, memory, and emotion—the detection of and memory for events that lead to important (good and bad) consequences (emotion). In humans, much learning, especially learning that involves complex reasoning, occurs in the cortex and particularly in the prefrontal cortex; but as Linden notes, lower brain functions are also involved. According to Linden, it may not be possible to have objective perceptions because perceptions are filtered through lower emotional centers and, depending on their associated consequences, the emotional aspects of consequences affect memory for those associations (the more important the consequence, the more emotion is evoked and the more memorable is the association), Thus, all perceptions may be colored by the memory of previously experienced perceptions and their associated emotions.

Much can be understood about the functioning of the parallel systems in the brain by studying humans who have memory deficits. H.M., a patient known to have damage to the hippocampus, appeared to be unable to form new memories. That is, he could not remember new factual information (semantic memory) or experiences (episodic memory) after he had surgery to relieve seizures. But, interestingly, H.M. could experience new motor learning (e.g., mirror reading) and Pavlovian conditioning, in spite of having no explicit memory of these experiences. This was possible because, although the explicit learning pathways were no longer functional, the implicit lower learning centers were intact.

Linden proposes that the multiple-dip ice cream cone structure of the human brain has led to some “unintended” consequences. We humans have a brain that, compared to the rest of our body, is larger than that of other animals. This has led to an unusual set of circumstances. Because the brain is so large, it is difficult for it to pass through the birth canal (historically, human females have been more likely to die in childbirth than other animals). The compromise made by evolution was for humans to deliver their young in a relatively altricial (undeveloped) state. But being relatively undeveloped meant that years of parental care would be required before offspring would be able to survive on their own. And if a female were to be able to raise several offspring to maturity, unlike most primates, she would need help from her mate. But how could she keep the male around to help? To do so, human females have evolved the ability to conceal their ovulation. Thus, unlike other primates, human females are sexually receptive independent of the likelihood of becoming pregnant. Continuous sexual receptivity allows for “recreational” sex, and if females are continuously receptive and because males do not want to raise offspring that are not theirs, the male is induced to stay close to his female partner. This pair bonding is the basis of what we humans refer to as romantic love.

Another interesting behavior addressed by Linden is that of sleep (and dreaming). The purpose of sleep, Linden says, is to consolidate and integrate memories. But the function of dreams is less clear. To account for dreams, Linden proposes that they provide a virtual reality in which we can simulate scenarios under safe conditions in which waking rules do not necessarily apply (e.g., surviving a free fall). Such simulation may allow us to imagine the results of behavior without having to actually experience them. Thus, dreams may help us to develop the skills needed for future planning and thereby reduce the likelihood of making errors.

One learns from this book that the remarkable organ responsible not only for directing the vital functioning of the body but also for our emotions, thoughts, and memories consists of about 100 billion neurons that integrate and propagate signals in a complex, interconnected array. What is striking about the neurons that make up the brain is their inefficiency relative to simple electrical circuits. Relative to copper wires, signals travel along these neurons at a much slower rate and the frequency with which they can transmit pulses is much more limited. Neurons also tend to leak signals to their neighbors (causing them to fire inappropriately), and they successfully propagate their signals to the next neuron unreliably (only about 30% of the time). Thus, Linden likens the human brain to a Rube Goldberg contraption that manages to function quite well, not because of its intricate complexity but in spite of it. The brain makes up for the neurons' inefficiency by relying on a kind of democratic process among the neurons in which action depends on the combined output of a large number of neurons, some of which are excitatory and "vote" for action, while others are inhibitory and "vote" for inaction.

Perhaps the most controversial chapter in the book is the one devoted to the relation between the human brain and religion. Linden proposes that one function of the brain is to weave coherent stories out of unconnected bits of information. In the case of visual perception, this means filling in the gaps produced by saccades (eye movements) between visual "snapshots." But similar processes also occur when trying to recover memories. Often those memories are incomplete, and when they are, one tends to fill in the gaps with reasonable but unremembered confabulations. Linden suggests that it is this function of the brain, primarily in the left cortex, that predisposes us to create narratives from fragments of perception and memory—narratives that are the basis of dreams and that can become religious beliefs.

Finally, Linden addresses the "creationist" notion that something as complex as the human brain could not have evolved by natural selection from less complex brains but, because it is "irreducibly complex" must have come about through intelligent design. In fact, by this point in the book, it is obvious that the human brain contains all of the parts of simpler brains and, far from being an efficient product of an intelligent designer, has evolved in successive layers, each incorporating the structure of the earlier brain, rather than as a completely new structure. In fact, Linden describes the human brain as a true design nightmare that works as well as it does in spite of the way in which it evolved.

Linden's book not only presents a fresh, readable explanation of the structure and functioning of the brain but, much like the structure of the brain itself, also shows how the building blocks of the brain have been combined and added upon through evolution to develop into not only the thinking, rational, and complex human brain, but also an organ with a natural tendency to confabulate, creating the processes responsible for dreaming and religious experience.

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