Make Up Your Mind?

By Stan Franklin

A review of

Walter J. Freeman, *How Brains Make Up Their Minds*, London: Weidenfeld & Nicolson, 1999, 180 pp., ISBN 0 297 84257 9. (also New York: Columbia University Pres, 2001)

The oft-repeated claim that the human brain is the most complex system in the universe has always struck me as far-fetched and presumptuous. Isn't it part of an even more complex system, the human body? And, how can we know what's in this vast universe, of which our solar system is only a molecule. Nonetheless, the human brain is certainly awesome in its complexity, and the mind, on reflection, hardly less so. How can we make sense of brain and mind?

During the "decade of the brain" many authors have attempted to help. Psychologist Bernard Baars told us of "The Theater of Consciousness" (1997), philosopher David Chalmers of "The Conscious Mind" (1996), neurologist Antonio Damasio of "The Feeling of what Happens" (1999), bio-anthropologist Terrence Deacon about "The Symbolic Species" (1997), neuroscientists Gerald Edelman and Giulio Tononi of "A Universe of Consciousness" (2000), evolutionist Nicholas Humphreys about " How to Solve the Mind Body Problem" (2000), cognitive scientist Steven Pinker about "How the Mind Works" (1997), and computational neuroscientist Edmund Rolls about "The Brain and Emotion" (1999). All of these works concern themselves to a greater or lesser extent with the working of the brain, of the mind, and with the relationship between the two. Though coming from such varied disciplines all these authors more or less share the currently commonly held view that can be so roughly stated as 'mind is what brain does.'

But within that view, there's room for divisions. Freeman distinguishes three distinct philosophical traditions that attempt to explicate the relationship between mind, brain and the world, the materialist, the cognitivist, and the pragmatist. He traces the materialist view, which holds that minds are "physical flows, whether of matter, energy or information, which have their sources in the world," stemming from Hippocrates, and through chemists and biologists (atoms, genes, enzymes), to behaviorist psychologists and neuroscientists. "Simply put, brains process information by manipulating matter and energy." I doubt we'll find many materialists among the authors mentioned in the last paragraph.

Cognitivists, according to Freeman, view minds as consisting of collections of representations, that is, symbols and images. "[Minds] are software running on 'wetware'." This view, which he traces from Plato, through Descartes and Kant, to

Chomsky and the AI founders, is probably held, in some form, by most of the authors mentioned in the last paragraph. I suspect it's today's dominant view of mind.

In Freeman's words, pragmatists view minds as "dynamic structures that result from actions into the world," stressing the importance of action and of active perception. He traces their roots from Aristotle through Aquinas, Heidegger, Merleau-Ponty, and Gibson. While pragmatists may be represented in the previous paragraph's list of authors, they'd surely be rare. Perhaps, among them, only Baars (personal communication) and Edelman (1987) explicitly reject the computer metaphor. Freeman himself subscribes firmly to this pragmatist view, as we'll see in the rest of this review.

But before exploring some of the ideas central to Freeman's quite modern and scientific form of pragmatism, I feel compelled to warn the reader of my bias, which will surely influence this exploration. I consider Freeman's seminal introduction of a non-linear dynamical systems model to explain how a rabbit distinguishes between the odor of a carrot and the odor of a fox (e.g., Skarda & Freeman 1987) to be an extraordinarily significant contribution to neuroscience, one deserving of a Nobel Prize. I suspect that such models, involving decisions made by means of trajectories of brain states falling into particular basins of attraction, will prove increasingly effective in explicating various cognitive processes. Going even further out on the limb, I suspect they may prove to be the only suitable models for many of these processes. But, on to Freeman's ideas.

Written in a leisurely and engaging style for the intelligent layperson, this little book is exceptionally well titled. It's about how brains make up their minds, in other words, about how the brain decides what the organism should do next. In my view this is "the only question there is," in the sense that every animal, indeed every autonomous agent (Franklin & Graesser 1997), spend its life ("life") continually answering it moment by moment (Franklin 1995). Let's go on to explore Freeman's account of how brains and their minds continually answer this question.

True to the pragmatic tradition, action in the world is central to the book, which is concerned with describing "a neural basis for goal-directed action." We select a goal-directed action by forming the intention to act. This intention directs the "action toward some future goal." This intention is formed by a process called assimilation, during which "meanings arise as a brain creates intentional behaviors and then changes itself in accordance with the sensory consequences of those behaviors." Thus meanings are internal, unique to each person, arising from our choices and actions. But, what about books, movies, gestures, courtship displays, etc? While these may represent meanings, "[b]rains alone have meanings". All this fleshes out the view propounded by Oyama in her *Ontology of Information* (1985). Freeman views perception as the "organization of sensations and the construction of meanings."

And, just where in the brain does all this choosing of goals, forming of intentions and developing oof meanings take place? Essentially, everywhere. "The entire

hemisphere constructs goal states…" "…I propose that every neuron and every [local domain of cortex] participates in every experience and behavior, even if its contribution is to silence its pulse train or stay dark in a brain image." Or more technically, "[m]eaning emerges in sequences of global [amplitude-modulation] patterns of oscillatory neural activity coordinating the neuropil of an entire cerebral hemisphere."

Without backing off of this global pattern hypothesis, Freeman does pay particular attention to the role of the limbic system. "The limbic system is essential for all intentional actions, including perception and most forms of learning." "…the limbic system is the principal director of action in space-time." "…these pathways [between primary sensory areas] help to shape what I call global activity patterns, which occupy the entire forebrain, but that the most significant aspect of limbic architecture is the multisensory convergence in the entorhinal cortex, followed by spatial localization of events and temporal sequencing of them in the hippocampus, which is required by other areas to form multisensory perceptions, or Gestalts, and to learn, remember and recall them."

Early in the book, Freeman gives the reader a preview of "ten building blocks that allow us to understand how neural populations sustain the chaotic dynamics of intentionality…" Here are two examples, chosen to be more understandable in light of what has already been said here:

7. The embodiment of meaning in amplitude-modulation patterns of neural activity, which are shaped by synaptic interactions that have been modified through learning (Figure 14).

10. The formation of a sequence of global amplitude-modulation patterns of chaotic activity that integrates and directs the intentional state of an entire hemisphere (Figure 18).

Based on the results of a half-century of research in Freeman's laboratory at UC Berkeley, "[these building blocks are heavy and difficult to grasp, but they are essential for understanding how brains make up their minds." The rest of this small book is essentially devoted to the leisurely explication of these ten building blocks.

Based on at least some of these building blocks, computational models of Freeman's theories, called K-sets, were constructed by Freeman (1975) and extended by Kozma (2001, Kozma et al 2003). These exceedingly complex and recursive neural network models have been successfully applied to classification problems (Kozma & Freeman 2001), and are being applied to robot navigation. None of this is mentioned in the book.

Moreover, Freeman continues to make up his mind in new directions. He now sees "meaning" as existing not in brains (Freeman & Rogers 2003), but in the interactions of individuals with the world and among themselves, so that he replaces his prior use of the word "meaning" with the word "knowledge".

This little book is exceedingly well written with carefully chosen examples and helpful analogies to ease the way of the reader. Still, I found the going tough in places, even on second reading, due to the technical nature of the subject and the intricacies of the interactions described. Was it worth the effort? Absolutely! Though I've read, enjoyed, and profited from each of the books on mind and brain mentioned in an early paragraph above, had I to pick only one to recommend, it would surely be Freeman's. It's a must read for anyone who seriously wants to understand how brains make up their minds.

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