

# My synapses, myself

Do our synaptic connections make us who we are?

Synaptic Self: How Our Brains  
Become Who We Are

by Joseph LeDoux

Pan Macmillan: 2002. 400 pp. £20 (UK).

Viking: 2002. \$25.95 (US)

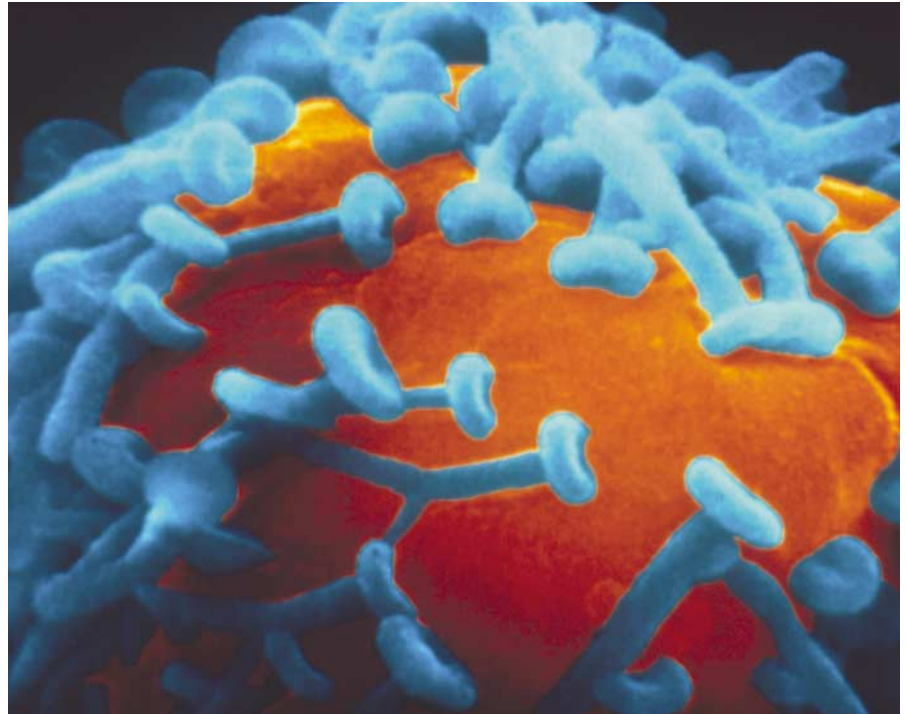
William Calvin

The self, Joseph LeDoux tells us, is “the totality of the living organism”. Most disciplines in the natural sciences focus on only one or two levels of organization. Indeed, Dmitri Mendeleev figured out the periodic table of the elements without knowing any of the underlying quantum mechanics or stereochemistry. There are, however, at least a dozen levels of organization within the neurosciences — and, if we use a metaphor, we temporarily create yet another. This leads to considerable confusion and arguments at cross purposes over whether learning is an alteration at the level of gene expression, ion channels, synapses, neurons or circuits.

Each neuron has thousands of synapses, which produce currents that summate to form an impulse train. But only rarely is the activity of a single neuron sufficient to cause a perception or trigger an action. Neurons usually act as members of ‘committees’ — what Donald Hebb in 1949 called cell-assemblies. Just as in academia, one individual may function in different committees on different occasions. A concept, including any explicit memory that we can talk about, is probably formed by such a committee. Implicit memories (the ones you can’t talk about) are less differentiated — they are part of the ‘feltwork’, together with motivations and emotions, that biases the choice of one’s next act.

In this well-written 400-page appreciation of behavioural neuroscience, LeDoux argues that synapses are the seat of self. He says, in effect, that you are your memories; that it is the uniqueness of an array of synaptic strengths that distinguishes one twin from another. Fair enough, but why not instead focus on one’s unique array of ion channels? Or neurons, because a neuron is the closest thing we have to a computational unit (synapses have to reach a threshold before they have any influence at all)? Or one’s unique arrangement of those overlapping, redundant hebbian committees?

None of these make for a catchy book title, but relating other things to the synapses proves to be a good way of covering a lot of fascinating material at the overlying levels, including a few updates to LeDoux’s earlier book *The Emotional Brain* (Simon & Schuster, 1996). “Our hopes, fears, and desires influence how we think, perceive, and



Committee members? Axons (blue) from many neurons form synapses to one cell body.

remember. A science of mind needs to account for and understand these complex processes,” he writes.

The chapter “Building the brain”, which includes a knowledgeable critique of the selectionist aspects, is about how brains are wired up diffusely and then tuned and pruned by experience. LeDoux addresses memories (and false memories) as studied by psychologists, the amnesias studied by neuropsychologists, the ‘nomadic memory’ theories for how memories ‘move’ from the short-term hippocampus to the long-term neocortex, and then the increasingly understood neurobiological mechanisms for modifying synaptic strength. He devotes three chapters to the mental trilogy of thinking, emotion and motivation, centred on working memory (not really a memory so much as a limited workspace) and executive functions.

The chapter “Synaptic sickness” is more about slow neuromodulators and second messengers than quick synapses. It is a nice history of biological psychiatry and how it now complements psychotherapy. LeDoux points out that there is “an imperfect set of connections between cognitive and emotional systems in the current stage of evolution of the human brain. This state of affairs is part of the price we pay for having newly evolved cognitive capacities that are not yet fully integrated into our brains.” For

those who appreciated the skill with which Antonio Damasio pulled things together in his final chapter on consciousness in *The Feeling of What Happens* (Heinemann, 2000), LeDoux’s final chapter might disappoint; although it covers more ground, it has the feel of a convergence of black boxes rather than the neurophilosopher’s profundity.

At whom is this book aimed? My guess is psychologists — but by covering much of behavioural neuroscience in respectable detail (no one goes unnamed), LeDoux has shifted the focus. Certainly neuroscientists of all sorts will find the book quite useful; those who arrive from molecular and genetic backgrounds are particularly in need of such a book. It could easily be used as a textbook, and is far more readable than most. But the long sections on who did what, when and where are suited only to those breaking into behavioural neuroscience or to historians of science, not to a more general scientific audience. The non-professional reader of psychology, in search of a coherent view of the self, will find it harder going.

Someone, alas, made an obvious effort to ‘jazz up’ the book to appeal to more general readers. But it is only cosmetic: “Golgi and the gap” may be a useful title for the discussion of how reticulated webs were reconceptualized as distinct units separated by synaptic clefts, but “Chemicals are oozing and sparks flying constantly” will mislead the reader who

doesn't realize that the biggest charge in the brain is a mere tenth of a volt — not the stuff that sparks are made of. ■

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## A complete history of astronomy

*Storia dell'astronomia: dalle origini al duemila e oltre* by Giacomo Leopardi & Margherita Hack *Edizioni dell'Altana: 2002. 646 pp. 37 euros. In Italian*

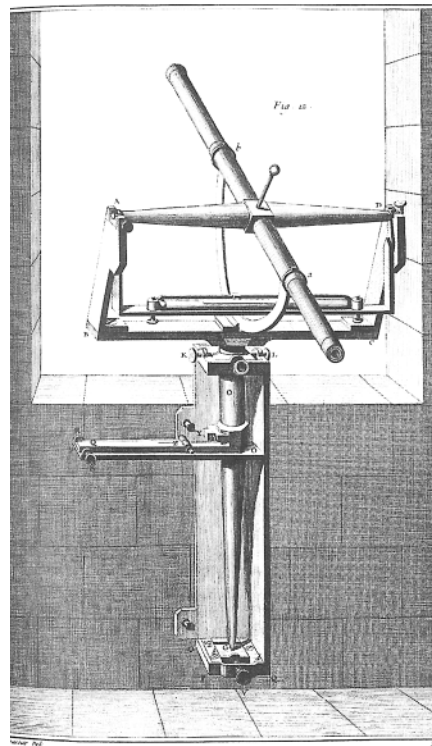
Giovanni F. Bignami

In the introduction to his *Why Read the Classics*, Italo Calvino mentions only one Italian author, Giacomo Leopardi (1798–1837). Calvino does not praise Leopardi as the author of the *Canti*, which is one of the greatest poetic works of the nineteenth century, but instead refers to the unique education that the young genius received in his father's castle. Count Monaldo had a well-organized, 16,000-volume library in Recanati, a small town in central Italy, where young Giacomo used to sit and study in its central room, writing at a small table with his back to the east.

In 1811, while aged just 14 to 15, Leopardi wrote a 300-page history of astronomy, the *Storia dell'astronomia*. It contains more than 1,700 footnotes and references, and an organized bibliography of 300 works spanning two millennia and in many languages, both modern and ancient. He presumably had access to these in the astronomy corner of Monaldo's library. He refers to almost 2,000 astronomers, philosophers, poets and other authors, frequently in the original language. The new edition of his book, updated to the present day by the Italian astronomer Margherita Hack, includes translations of the Greek passages; young Leopardi assumed that his readers would not need them.

However, even at such a tender age, Leopardi was not merely trying to show off his immense erudition. His deep poetic and philosophical mind surfaces frequently in a sea of arid facts, dates and quotations. Consider, for example, his comment on the Latin translation of the Greek poem *Phenomena* by the little-known astronomer Aratus (circa 272 BC). The translation, they say, is by Cicero (yes, the illustrious one), and Leopardi goes off on a tangent on the poetic qualities of the great Roman. Along the way he entirely forgets the original subject — perhaps it was too boring.

Or take the story of the 'mechanical astronomical clock', sent in around AD 800 by the Arabic scientist al-Mansur to Charlemagne,



**Big future: improvements to telescopes since the eighteenth century led to astronomical advances.**

and Gian Domenico Cassini's observations of Jupiter, showing the giant planet's fast rotation. Leopardi interprets these as implying that man learns to understand what is outside and far away better than what he is sitting on (namely, the copernican debate on the rotation of Earth) or what goes on inside his soul.

In the new, elegant edition of the book, Hack takes over where Leopardi ends. She had a daunting task because so much more has happened in astronomy in the past two centuries than in the previous two millennia. She does a splendid job of presenting an accurate and balanced account, even of today's accumulating, sometimes contradictory and always diverse discoveries. To keep the size of the book manageable, she had to keep within 200 pages, compared with the 300 of Leopardi. She spares us any debate on Cicero's poetics, but has an obvious soft spot for Sir Arthur Eddington, who added so much to our knowledge of the structure of stars, from whom we get ample quotes. However, in a philosophical vein akin to that of Leopardi, Hack ends her contribution with an enlightening reflection on the weak and strong anthropic principles. A difficult but important subject, this is where today's astronomy and philosophy converge to provide a coherent understanding of today's cosmology as it emerges from both ground- and space-based observations.

Hack was one of only a few women astronomers when she began her career, and she has campaigned hard for the place of women in science. The revered elder of

Italian astronomy, she is now an important public and political figure, and celebrates her 80th birthday this week. Happy birthday, Margherita. ■

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## Portraits of our family tree

*The Human Fossil Record. Volume 1: Terminology and Craniodental Morphology of Genus Homo (Europe)* by Jeffrey Schwartz & Ian Tattersall *Wiley: 2002. 400 pp. \$125, £92.95, 147.10 euros*

Jacopo Moggi-Cecchi

Interpretations of the human evolutionary process often differ among specialists. The contrasting opinions are in some cases based on a discordant reading of the fossil evidence — the morphological features of the bones and the teeth of our ancestors. Anatomical details described as 'thick', 'broad' or 'deep' by one scholar are not necessarily perceived as such by a second or third scholar and defined using a corresponding term. And this, in turn, may affect the final interpretation.

This book, the first volume in a series of four, was conceived with this issue in mind and is based on an apparently simple idea: to provide a detailed description of the most relevant fossil specimens attributed to the genus *Homo* from all over the world, following a consistent protocol and accompanied by basic photographic documentation. Giving shape to this idea made the project a "Herculean task" (in the authors' own words). The scale of the task and the significance of the book lie in the method used: nearly all of the fossil specimens have been described by the authors, using the same procedure throughout. As a result, readers can be assured that the adjectives used to describe morphological features are applied consistently for each description presented. This, in turn, allows easier, direct comparisons between specimens for each anatomical detail. The descriptive protocol applied and the terminology used are accurately explained, region by region, in the first part of the volume, together with drawings showing the anatomical features mentioned in the text.

The descriptions, arranged by site, range from an isolated tooth to the most representative specimens of large collections, and include recent discoveries up to the two skulls from Georgia. Photos of the specimens (not all of them in sharp focus) have been taken mostly by one author. You won't