

Atlas on our shoulders

The Body has a Mind of its Own: How Body Maps in Your Brain Help You Do (Almost) Everything Better

by Sandra Blakeslee and Matthew Blakeslee

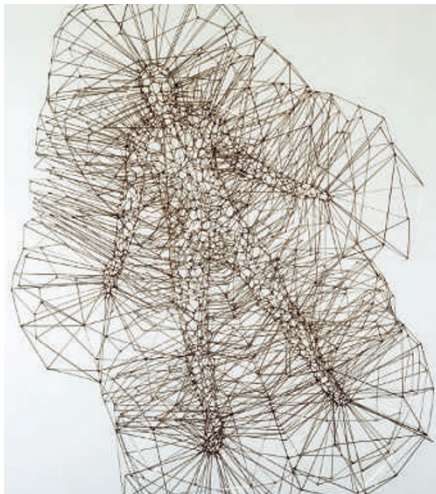
Random House: 2007. 240 pp. \$24.95

Edvard I. Moser

Like an atlas, the brain contains maps of the internal and external world, each for a distinct purpose. These maps faithfully inform the brain about the structure of its inputs. The body surface, for example, is mapped in terms of its spatial organization, with the same neural arrangement flashed through successive levels of processing — from the sensory receptors in the periphery to the thalamus and cortex in the brain. Meticulous mapping also takes into account the hat on your head and the golf club in your hand, and separate systems encode the space through which your body moves. As V. S. Ramachandran has remarked: God must be a cartographer.

In *The Body has a Mind of its Own*, Sandra and Matthew Blakeslee — who represent the third and fourth generations in a family of science writers — use this emerging knowledge about brain maps as a springboard for presenting some of the most exciting discoveries in neuroscience. The unifying theme is the idea that the way our body is mapped by neural circuits in the brain can account for a range of our experiences and perceptions. Using a readable and inspiring format, the authors showcase new and classic research on neural representations, without compromising accuracy.

The stories are refreshingly up-to-date, covering, for example, the emerging appreciation of the dynamic borders between maps for body and external space, and new insights



Sculptor Antony Gormley also explores how the body relates to surrounding space.

into how our own location in space is mapped by specialized cells called grid and place cells. Anecdotes and ideas from sister disciplines, including neurology, psychiatry and cultural anthropology, mix comfortably with laboratory observations. New discoveries titillate our curiosity, explaining common phenomena such as yo-yo dieting and contagious yawning as well as some more bizarre neurological abnormalities such as alien-hand syndrome and supernumerary-limb perception. Also covered are why you cannot tickle yourself, why some people have 'out-of-body' experiences, and why babies in Mali walk earlier than those anywhere else in the world.

The chapter on mirror neurons discusses their possible implications for social transmission and cultural learning. Mirror neurons fire when a monkey peels a banana, say, and when it observes another monkey peeling a banana.

They may therefore be part of the neural basis of intention, promoting learning by imitation. The authors explain how mirror neurons could participate in a wide range of primate brain functions, for example in shared perception and empathy, cultural transmission of knowledge, and language. At present we have few, if any, clues as to how mirror neurons compute or how they interact with other types of neuron, but the Blakeslees draw our attention to social neuroscience as an emerging discipline.

It is important to keep in mind that the map concept is not explanatory. We need to define what a map is to understand how perception and cognition are influenced by the spatial arrangement of neural representations. The classical maps of the sensory cortices are topographical, with neighbouring groups of neurons representing neighbouring parts of the sensory organ and thus the outside world. Other maps, such as those of the brain's spatial-representation system, are distributed with no striking correlation between firing properties and anatomical location. Both are maps in the sense that they link a feature of the external world with the activity of a neuron, but the functional implications of the map arrangements are likely to be vastly different. More complex wiring diagrams may be needed to maintain coherent localized representations in a distributed network than in a topographic system.

To the non-specialist, it may not matter whether a map is a map or not. *The Body has a Mind of its Own* is a thought-provoking book of wide appeal. It is a striking example of how complex issues in contemporary research can be presented to entertain everyone. ■

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Ups and downs of a senator scientist

The Volterra Chronicles: The Life and Times of an Extraordinary Mathematician 1860-1940

by Judith R. Goodstein

American Mathematical Society/London Mathematical Society: 2007. 310 pp. \$59

Salvatore Coen

Vito Volterra was an extraordinary mathematician. He was also a pioneer of biological modelling — a research tool that has increased in popularity by leaps and bounds since the publication of his seminal 'predator-prey' model in 1926. Volterra lived at a time when Italy was undergoing bouts of political upheaval, as a child in the wake of the

Risorgimento — the country's unification in the 1860s — and then under Benito Mussolini's fascist regime. As a senator, Volterra withheld his support for the regime and was therefore expelled from the University of Rome in 1931 and from all Italian academies in 1934. *The Volterra Chronicles* is a rich biography set amid this turmoil.

Author Judith Goodstein captures the human, political and social environment of the age. The story of Volterra's life stems from his very close Italian Jewish family, with their strong patriotic sentiments. He was born in Ancona in May 1860, when the town belonged to the Church, and grew up in a country still deeply affected by the ideals of

the *Risorgimento*. He graduated in physics from the University of Pisa and became a professor there when he was only 23 years old. Later he moved to the University of Turin, then to the University of Rome, where he married his young cousin Virginia Almagià.

The Volterra Chronicles describes the early research done by the young Volterra and his deep and precocious interest in mathematics and its applications. His papers on real and complex analysis, on mathematical physics, hydrodynamics, electrostatics, elasticity, differential, integral and integro-differential equations are still classics. In addition, he is considered a father of functional analysis, one of the main branches of contemporary

mathematics. But he never lost contact with the experimental sciences, and the final chapter of the book covers his ground-breaking incursions into biomathematics.

Volterra was a key participant in scientific organizations in Italy and worldwide. He was president or vice-president of important research institutes including the International Bureau of Weights and Measures (1921–40) and the International Research Council, and founder of, among other things, the Italian National Research Council and the Italian Society for the Progress of Science.

His family has generously donated several archives to the Accademia dei Lincei in Rome, which are now fully catalogued. This biographical material has been invaluable for scholars, and important contributions about Volterra have been published during the past decade or so — for example, by Giorgio Israel and Ana Millán Gasca in 2002 and Rita Levi-Montalcini in 1996.

The Volterra Chronicles is different from these other works in that it is a dedicated biography of Volterra, based on original documents, which invites us into the mathematician's intimate circle. Short passages translated from his correspondence provide insight into his intense relationships with the most prestigious mathematicians of his time, which were always grounded in mutual scientific and personal respect. The book reveals his knack for spotting talent in young scientists, including Tullio Levi-Civita, André Weil,



Vito Volterra modelled predator-prey dynamics.

Griffith Evans, Marcel Brelot, Enrico Fermi and Joseph Pérès, whom he helped in various ways or with whom he collaborated. The characters of his family and friends, including Carlo Somigliana and the physicist Antonio Ròiti, and of his teachers Ulisse Dini and Enrico Betti are perceptively drawn.

Volterra was resolutely in favour of mili-

tary intervention by Italy during the First World War to fight alongside France, Britain and Russia. He volunteered at the age of 55 when he was a senator and a member of many illustrious academies. During the conflict, he was involved in military action and scientific research, and cooperated closely with scientists in allied countries, particularly France.

He was a fierce opponent of fascism. In 1924, still a senator, he cast a no-confidence vote in Mussolini as head of the government and in 1931, he refused to sign a loyalty oath professing allegiance and devotion to king, country and the Fascist regime. This refusal cost him his university post and academy memberships, as well as the support of most of his colleagues. He also faced persecution under racial laws issued in 1938. But the regime allowed him to keep his passport and he continued to travel until his death in October 1940, four months after Italy joined the Second World War.

One of three appendices (the others being translations of his most important speeches) to *The Volterra Chronicles* reproduces a touching and sensitive obituary written by the distinguished English mathematician Edmund Whittaker. It is a fitting end to a biography of an outstanding scientist, which is remarkable for its accuracy and scholarly rigour, and — unlike its predecessors — for its potential to engage a wide readership. ■

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Oceanography fathomed

To Follow the Water: Exploring the Ocean to Discover Climate

by Dallas Murphy

Basic Books: 2007. 288 pp. \$26

Arnold Gordon

The ocean covers nearly 71% of our planet, providing food, minerals, energy, transport, even recreation. It is also crucial in governing our climate system. Indeed the 29% of solid land, which depends on the sustained health of the entire environmental system, is arguably itself anchored in the ocean.

In *To follow the Water*, Dallas Murphy gives the general reader and the specialist an ocean view beyond the confines of the laboratory or computer model. He rolls from topic to topic in a readable and scientifically astute narrative that touches on the oceans' many aspects — from their exploration over the centuries to their current impact on climate — and their study as a quantitative science today.

Fundamental discoveries await oceanographers, but observations are difficult; the oceans are vast and controlled experiments are impossible. I entered physical oceanography decades



Remotely operated vehicles, controlled from aboard ships, measure the ocean's fluctuations.