

## NEUROSCIENCE

# The Eternal Silence of Neuronal Spaces

Stanislas Dehaene

Consciousness is, quite literally, mind-boggling. From the objective, third-person perspective of neuroscience, the subject consists of clarifying how three pounds of brain flesh, a mere assembly of molecules, can ever give rise to conscious mental states, feelings, and a sense of self. But every neuroscientist is also a human being, a self with a point of view, who suffers life's miseries and can therefore ponder the mysteries of conscious and unconscious thoughts from a privileged first-person perspective. Whence this unbearable toothache? Why the nostalgia of a lost love? Who is this I, really? Do "I" own my life, or do my genes, my brain, and my habits own me? And if so, what gives my life a meaning?

In *Consciousness*, Christof Koch, a cognitive scientist at Caltech, artfully weaves the two perspectives together. The resulting atypical science book combines a review of top-notch scientific findings with personal memories, musings, and confessions of an active, introspective, and perplexed neuroscientist.

The science itself is generally impeccable. As he has previously demonstrated (1), Koch excels at explaining, in simple and concise terms, the most recent research into the neurobiology of consciousness. Enlightening discoveries abound. With collaborators Itzhak Fried and Rodrigo Quiñero, the author initiated a remarkable search for the neuronal correlates of elementary conscious percepts, capitalizing on the novel capacity to record from individual neurons in epilepsy patients. They discovered that some neurons in medial temporal cortex fire in response to the face or name of a specific person. Critically, even for a constant stimulus, the neurons fire only when the subject reports seeing the picture and not when eclipsed by binocular rivalry or masking (2). Such neuronal observations converge nicely with brain-imaging experiments in normal volunteers to suggest that synchronous and distributed brain activity in specific higher-order brain

areas provides neuronal signatures of conscious brain states (3).

The operational knowledge of consciousness has reached the clinic. In a patient thought to be in a vegetative state, functional magnetic resonance imaging detected complex mental states that reflect a conscious mind (4), and simpler detection devices are now being envisaged. Pursuing consciousness at the cellular and molecular levels, Koch has launched a \$300-million program at the Allen Institute in Seattle to develop "brain observatories" that will dissect the microcircuitry of visual cortices in mice (5).

Koch fearlessly discusses some of the most difficult questions in the field. For instance, are animals conscious? Koch's guess is a resounding yes: his six dogs surely have conscious states—their tails, snouts, paws, bod-

ies, ears, and tongues obviously express a cornucopia of internal feelings. "Indeed," he whimsically remarks, "I often think dogs are closer to true Buddha nature than people are." Here, alas, he offers no experimental data; avowedly, only the dog owner speaks, not the scientist and even less the dog.

From dog to god is a small step. Perhaps the author's most unexpected confession is that he was a long-time devout Christian. Although those days are gone, Koch still feels strongly that life must have a purpose. In the introductory chapter, he confesses, "With perfect hindsight, I now realize that what drew me to studying consciousness was a compelling and entirely subterranean desire to justify my instinctual belief that life is meaningful." Perhaps this stance explains his strong attraction to the philosopher David Chalmers's dual-aspect theory and, especially, to Giulio Tononi's mathematical theory of consciousness as integrated information (6), which he describes as amounting to "a form of property dualism." In a curious move, our romantic reductionist now concludes that the mental and the physical compose "two sorts of properties ... that can't be reduced to each other."

The implications of Tononi's theory fill Koch with uncritical enthusiasm. He expresses his strong faith that the theory

## Consciousness Confessions of a Romantic Reductionist

by Christof Koch

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## BROWSINGS

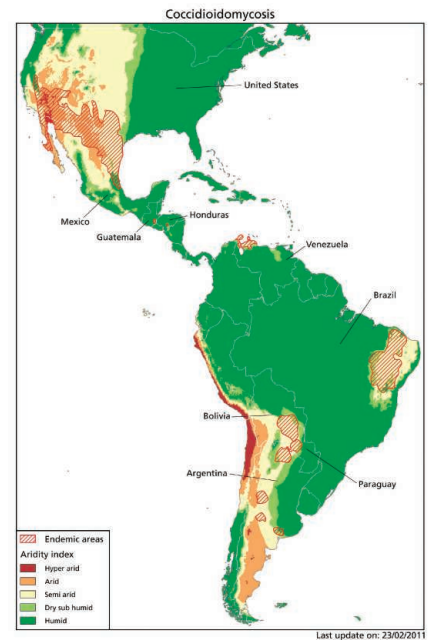
**Atlas of Human Infectious Diseases.** Heiman F. L. Wertheim, Peter Horby, and John P. Woodall, Eds. Wiley-Blackwell, Oxford. 2012. 308 pp. £84.99, \$130, €102. ISBN 9781405184403.

If you're interested in infectious diseases and you like maps, you'll love leafing through the *Atlas of Human Infectious Diseases*. It shows the global distribution of more than 110 diseases, from well-known scourges such as malaria and cholera to oddballs like strongyloidiasis and O'nyong'nyong virus disease. Maps have been available for many diseases, but, Wertheim notes, it's often unclear who made them or what data were used—and they frequently contain errors.

Wertheim (a clinical microbiologist working in Hanoi for the Wellcome Trust and Oxford University) didn't want an electronic atlas but a book you can draw inspiration from as you read it on the couch. The editors took five years to prepare the maps, sifting through data from countless papers, field reports, and other sources. Each map was reviewed by two experts for its particular disease. The atlas also charts underlying factors such as water and sanitation, international travel, and urbanization.

Infectious diseases are nothing if not dynamic, and freely accessible updates will appear on a forthcoming companion website. Meanwhile, Wertheim hopes that the gaps in the maps will inspire researchers to collect more data on where pathogens occur. For many diseases, Africa is epidemiology's terra incognita—as painfully large gray areas in the atlas testify.

—Martin Enserink



**Coccidioidomycosis** (valley fever).