

Conscious Mind, Resonant Brain

How Each Brain Makes a Mind

by Stephen Grossberg, Oxford University Press, 800 pages, \$35

The Magnum Opus of the most important pioneer and current contributor to neural network research

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Overview

- Explores how your mind works, notably how you learn to consciously see, hear, feel, and know things
- Explains how mental disorders can be mechanistically understood on a continuum with normal behaviors
- Creates a computational foundation for the next generation of autonomous, adaptive, and intelligent algorithms, devices, and mobile agents in engineering, technology, and AI

Description:

How does your mind work? How does your brain give rise to your mind? These are questions that all of us have wondered about at some point in our lives, if only because everything that we know is experienced in our minds. They are also very hard questions to answer. After all, how can a mind understand itself? How can you understand something as complex as the tool that is being used to understand it?

This book provides an introductory and self-contained description of some of the exciting answers to these questions that modern theories of mind and brain have recently proposed. Stephen Grossberg is broadly acknowledged to be the most important pioneer and current research leader who has, for the past 50 years, modelled how brains give rise to minds, notably how neural circuits in multiple brain regions interact together to generate psychological functions. This research has led to a unified understanding of how, where, and why our brains can consciously see, hear, feel, and know about the world, and effectively plan and act within it.

The work embodies revolutionary Principia of Mind that clarify how autonomous adaptive intelligence is achieved. It provides mechanistic explanations of multiple mental disorders, including symptoms of Alzheimer's disease, autism, amnesia, and sleep disorders; biological bases of morality and religion, including why our brains are biased towards the good so that values are not purely relative; perplexing aspects of the human condition, including why many decisions are irrational and self-defeating despite evolution's selection of adaptive behaviors; and solutions to large-scale problems in machine learning, technology, and Artificial Intelligence that provide a blueprint for autonomously intelligent algorithms and robots.

Because brains embody a universal developmental code, unifying insights also emerge about shared laws that are found in all living cellular tissues, from the most primitive to the most advanced, notably how the laws governing networks of interacting cells support developmental and learning processes in all species.

The fundamental brain design principles of complementarity, uncertainty, and resonance that Grossberg has discovered also reflect laws of the physical world with which our brains ceaselessly interact, and which enable our brains to incrementally learn to understand those laws, thereby enabling humans to understand the world scientifically.

Accessibly written, and lavishly illustrated, Conscious Mind/Resonant Brain is the magnum opus of one of the most influential scientists of the past 50 years, and will appeal to a broad readership across the sciences and humanities.

Advance Reviews

"Conscious MIND and Resonant BRAIN is a *tour de force* on *How the Brain Works*. It's a *masterpiece* on brain science and neuro-computing that could only be created by Grossberg."

-- Leon Chua, University of California at Berkeley

"Whenever you claim to be 'the first to do' this or that in artificial intelligence, it is customary - and correct - to add 'with the exception of Stephen Grossberg'. Quite simply, Stephen is a living giant and foundational architect of the field."

-- Karl J. Friston, University College London

"This is a breath-taking book authored by a giant pioneer of the brain and mind."

-- Shun-Ichi Amari, RIKEN Brain Science Institute

"Professor Grossberg is a *rara avis*. In an age of increasing specialization, he has a remarkable, unparalleled, gift of seeing connections between seemingly unrelated ideas. And he writes about these with passion, but without compromising accuracy."

-- V. S. Ramachandran, University of California San Diego

"Stephen Grossberg is a true genius, who has discovered and developed many of the most important concepts and theories about how our brains make our minds. His fundamental contributions to science for over 50 years are richly worthy of a Nobel Prize."

-- Leonid Perlovsky, Harvard University

"Stephen Grossberg is a "big picture" thinker who has had a remarkably deep influence on many aspects of several fields. It's difficult to overstate the range of his vision and the depth of his thinking, and I expect this book to be required reading in many courses for years to come."

-- Stephen Kosslyn, Foundry College

"After reading many papers by the author, I always wished that he would present them in a coherent whole. And here it is. A magnificent volume of great science from mind to brain and back, a condensed *ars poetica* of a great scientist."

-- György Buzsáki, New York University

"The current volume charts the remarkable developments that have led Dr. Grossberg to a principled, unified theory of the link between brain and mind. Dr. Grossberg's insights are unparalleled in their breadth and detail, leading us to a scientific understanding of the most remarkable aspect of the mind, consciousness."

-- Michael Mozer, Google Brain, Mountain View, CA

"Stephen Grossberg is one of the most original and influential theorists in contemporary cognitive science and computational neuroscience. In *Conscious MIND Resonant BRAIN*, he takes the reader on an eye-opening tour in which he addresses fundamental problems of mind and brain from his unique theoretical perspective. This is an important book that should be of interest to anyone who wonders how a brain can give rise to a mind.

-- Daniel L. Schacter, Harvard University

"In this book Stephen Grossberg shares the wisdom and encyclopedic knowledge that he acquired over 50 years of research devoted to unravel the mysteries of the human brain. Stephen pioneered the field of theoretical neuroscience and this approach allowed him to discover general principles that govern functions as diverse as visual perception, learning and memory, attention, emotion, decision making and consciousness. It is the essence of overarching principles to be abstract and to sometimes defy intuition, but Stephen succeeds to convey the essential in a language that is readily accessible to the non-expert. He embeds the discussion of neuronal mechanisms in the rich framework of cognitive psychology and elegantly bridges the gap between scientific evidence and subjective experience. He takes the readers by the hand and lets them discover the often surprising philosophical, ethical and societal implications of neurobiological discoveries. For those who enjoy intellectual adventures and wish to explore the boundaries of the known this scholarly written book is a real treasure."

-- Wolf Singer, Max Plank Institute for Brain Research, Frankfurt

"Although a behavioral modeler and not a neuroscientist, I have followed Stephen Grossberg's research closely for many years, because I regard him as one of the very most creative and insightful neuroscience theorists that the field has seen. His book should be a must read for those wanting to understand how the brain produces mind."

-- Richard Shiffrin, Indiana University

"How often do we have the chance to hold a true masterpiece? Grossberg's monumental accomplishments developed over multiple decades now written at an accessible level to a broader audience. What a true privilege!"

-- Luis Pessoa, University of Maryland

"Steve Grossberg is one of the most insightful and prolific writers on biological intelligence. This book is a masterful presentation of fundamental methods of modeling minds, brains and their interactions with the world, many of which are due to the author and his collaborators. The models are presented as mathematical systems, including computing and neural networks. The variables, parameters and functions represent biological and environmental concepts; mathematical conclusions are interpreted as predictions of biological behavior. In many cases these have been verified experimentally. There are illuminating and surprising connections to other disciplines, including art, music and economics. Highly recommended to a general audience."

-- Morris W. Hirsch, University of California at Berkeley

"This comprehensive overview of Grossberg's contributions to our understanding of the mind and brain shows exactly how prescient he, and his colleagues, have been. Whatever one's specific interest, from visual illusions to mental illness, this book

provides a principled treatment of it. The principles flow from Grossberg's early framing of many of the questions that have come to define computational neuroscience – including his early understanding of the centrality of expectations. Kudos to him for pulling it all together here."

-- Lynn Nadel, University of Arizona

"What an ambitious, lucid, eye-opening and engaging book! By using the computational theories he developed, Grossberg attempts nothing less than to integrate our knowledge of how our mind works with our knowledge of how the brain works. The topics he covers range from perception to action, from emotion to memory, and from decision making to love, with consciousness and the mind-body problem figuring prominently throughout. The story he weaves, with many incisive, delightful illustrations, is compelling and accessible. The reader is rewarded with a novel appreciation of the human psyche and artificial intelligence, and is left with admiration for Grossberg's achievement."

-- Morris Moscovitch, University of Toronto

"This book is not for the faint of heart. Stephen Grossberg has been a giant in the field of computational neuroscience for 60 years. In this book he presents his carefully developed, integrative neurobiological theory on how the nervous system generates our conscious lives. It is bold yet self-reflective and therein challenging to all students trying to figure out how the brain does its tricks. A must read."

-- Michael Gazzaniga, University of California at Santa Barbara

"Conscious Mind, Resonant Brain is the *magnum opus* of one of the giants of neural networks. The soaring ambition of this book reflects the career achievements of Grossberg's insatiable appetite for understanding how brains work. It is a must-read for those interested in all aspects of how the mind and brain function in health and disease."

-- Donald C. Wunsch II, Missouri University of Science and Technology

"Grossberg has single-handedly elevated the psychophysics and psychology pioneered by Herman von Helmholtz and William James into a comprehensive mathematical theory of brain and behavior with profound implications and strong empirical support."

-- David Hestenes, Arizona State University

"This book is first and foremost an account of a personal odyssey of one of the great and most prolific scientific minds of our time trying to understand itself. As a graduate student in the new field of 'neuroscience' in the late 70's I was aware of Grossberg's work, but it was largely inaccessible to me because of my limited mathematical training. I was not alone. What we have here at last is a genuine attempt by the author to make his ideas accessible to most readers as "a simple story, without mathematics" (or at least with minimal math). The foundation of this story is the concept of "resonance" in neural systems. Resonance has a certain similarity to Hebb's concept of the cell assembly and its more modern variant, attractor networks. But the resonance concept goes substantially further to capture the idea that when the external input matches the already stored knowledge (expectation and attention) a dynamical structure emerges which can suppress noise and irrelevant details and enable fast and effective responses. When resonance fails, this triggers adaptation. This book is largely a treatise on how the resonance concept can help us understand almost all aspects of sensation, perception, and higher cognition. Even without all the math, this book of 600 plus pages will take considerable dedication to assimilate, but I believe that any student of neuroscience interested in the brain as the basis of mind will find it well worth the effort."

-- Bruce McNaughton

"How a brain makes its mind is one of the most perplexing questions in science. In this book, you will find the most comprehensive account to date by a towering pioneer of brain theory of our time."

-- Deliang Wang, Ohio State University

"Don't read Grossberg in the original—unless you are an adept. Start with this exceptional overview of the lifework of a brilliant cognitive neuroscientist; then, organized and inspired, turn to the journals. Grossberg identifies key phenomena that open windows into the functioning of the brain; identifies the key problems that the brain needs to solve relevant to them; constructs elegant modules that might both solve those problems and give rise to the phenomena noted, and finally assembles them into systems and makes new predictions. This is textbook scientific inquiry, executed by a virtuoso. The book would be a fine component of a seminar, with students selecting the problems and modules for a deeper dive, then explicating them to the class."

-- Peter Killeen, Arizona State University

"An excellent and wide-ranging view of how the brain perceives the world for us by a pioneering brain theoretician."

-- Wolfram Schultz, University of Cambridge