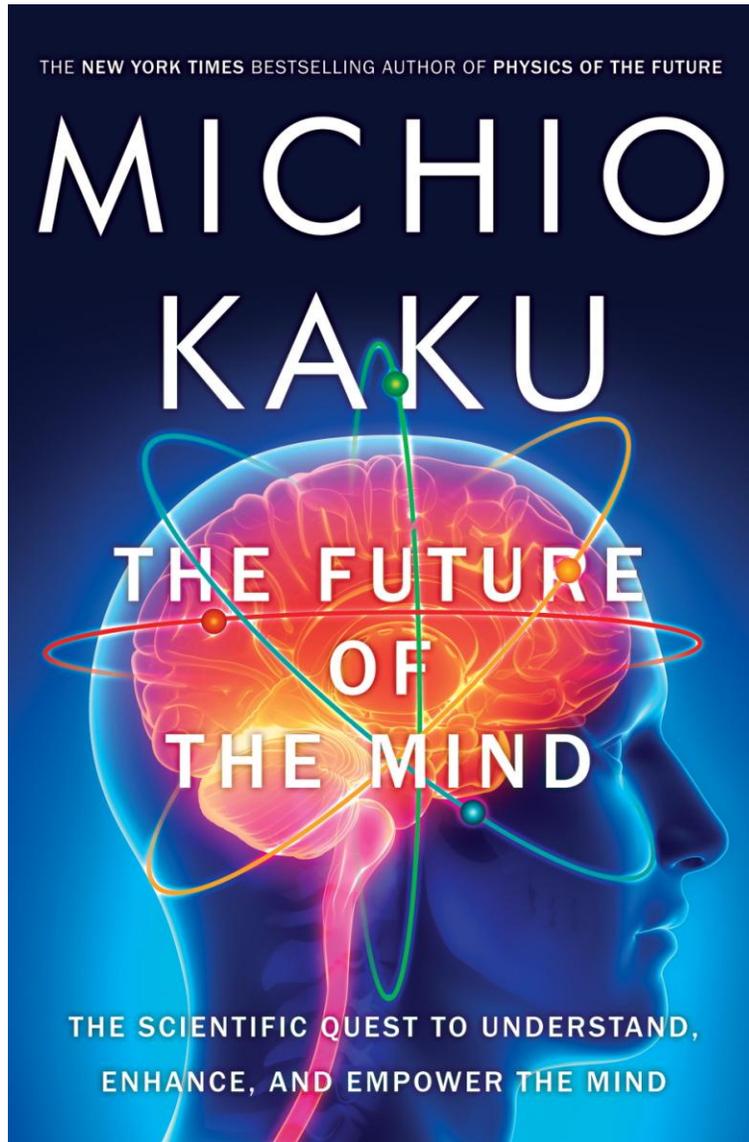


Welcome to the Machine

Review: *The Future of the Mind: The Scientific Quest to Understand, Enhance, and Empower the Mind*

By Jerome Kagan, Ph.D.



*In Jerome Kagan's review of *The Future of the Mind* by physicist and futurist Michio Kaku, Kagan leans on his own experience as co-director of the Harvard Mind/Brain/Behavior Interfaculty Initiative to explore a book that imagines a world where we will have the power to record, store, and transmit signals of brain activity, and where interchangeable thoughts and self-aware robots will be part of everyday life.*

The first humans probably wondered about the same phenomena that puzzled the 600 generations that followed: Where do the objects in the sky come from? What is the difference between living and inanimate forms? Why does like beget like? How could tiny drops of fluid become a fully formed infant? What are the origins of thoughts and feelings?

Scientists exploited appropriate technologies to provide preliminary answers to the first four questions but could not begin to determine how mental events emerge from the brain until magnetic resonance imaging (MRI), positron-emission tomography (PET), magnetoencephalography (MEG), and electroencephalographs (EEGs) became available in university laboratories. The promise of the technology's power motivated serious brooding on what has become the question sitting at the top of the stack: How does a material brain generate immaterial mental products?

Freeman Dyson, the noted theoretical physicist and mathematician, divided natural scientists into the hawks that fly above the confusing particularity of nature and the frogs that muck around in the messy details. Michio Kaku, a theoretical physicist at the City University of New York, is a high-flying hawk. The primary audience of *The Future of the Mind* is likely to assume, incorrectly, that this book will tell them how activity in neuronal collections gives rise to plans, feelings, beliefs, and actions. The book's primary mission, however, is to persuade readers of what might be possible when future machines can record the electrical and magnetic signals accompanying a person's thoughts and emotions, store them on a disc, and transfer them to a robot or to sensors in another person's brain. One day, Kaku imagines, a young bride might send a computer the brain signals she was

generating on her honeymoon so that years later her grown daughter could pick up a disk with these signals and relive her mother's happy moments. This book is intended not for skeptics but for the curious nonscientist who, like Kaku, enjoys Star Trek movies and H. G. Wells's *The War of the Worlds*.

Kaku's narrative ignores the initial phases of the cascade that begins with an event generating a brain profile followed by an initial psychological outcome. These are the events many neuroscientists hope to understand. Kaku's interest, however, is in the cascade that follows the initial brain state brought on by an event or thought that leads, in turn, to a sequence of psychological outcomes and new brain states.

The first two chapters of *The Future of the Mind* contain lean summaries of the brain, the new technologies, and a discussion of consciousness, which Kaku defines as a model of the world designed to accomplish a goal. He posits three levels of consciousness, ranging from reptiles who occupy Level I to mammals at Level II and humans at the highest level. A level is defined by the number of feedback loops required for an animal to interact with other members of its group. Kaku illustrates this metrical conception by asking readers to imagine a group of 10 wolves who can display any of 15 responses when they interact with another animal. Because the product of 10 by 15 is 150, he assigns a value of Level II: 150 to each wolf's consciousness.

Kaku's simple drawings of brain circuits that are presumed to be the foundations of select psychological processes resemble Freud's hand-drawn illustration locating the ego in the prefrontal cortex, the id in the posterior cortex, and the superego in the temporal lobe. He supports his bold ideas with cherry-picked studies that ignore alternative explanations as well as failed replications.

Kaku's arguments rely heavily on the interpretations of blood-flow profiles generated by functional

magnetic resonance imaging (fMRI) scanners. However, he fails to tell readers that many experts remain unsure about the causes and meaning of these profiles. Nor does he acknowledge that adults watching the same film generate distinctive blood-flow patterns in the frontal lobe because of idiosyncratic interpretations of the scenes.

Kaku's prediction that the brain signals produced by one person's thoughts would generate the same thoughts in another individual whose brain received these signals is seriously flawed because the chemistry of the recipient's brain makes a critical contribution to his or her resulting psychological state. Hence, if the neurochemistry of the sender and the recipient were different, which is likely, the latter would not duplicate the mental state of the former. I am afraid no woman will be able to experience the pleasures of her mother's honeymoon.

The author's indifference to inconvenient facts that would weaken his argument reminds me of quantum physics pioneer Wolfgang Pauli's irritation with young Werner Heisenberg, who had told Pauli that he had a unified theory of matter that was missing only a few details. The next day Pauli sent several friends a single piece of paper containing a blank rectangle in the shape of a frame for a painting, along with the sentence, "This is to show that I can paint like Titian; only the technical details are missing."

The remaining 13 chapters are optimistic predictions of the consequences of an increasing power to record, store, and transmit signals of brain activity. The clearly written prose covers the transmission of memories from one person to another, robots controlled by thoughts, and transcranial magnetic stimulation (TMS) used to control brain states and thoughts. These paragraphs are interrupted, often abruptly, with brief forays reflecting Kaku's positions on dreams, genes, optogenetics, intelligence, savants, Einstein's brain, and mental illness. These sidebars,

designed to provoke moments of awe, will do so in readers who do not have a deep understanding of neuroscience.

Psychiatrists will be unhappy with Kaku's claim that "mental illness is caused by the disruption of the delicate checks and balances between competing feedback loops that simulate the future." This atypical definition is accompanied by a table, which locates paranoia in disrupted loops in the amygdala and prefrontal cortex, schizophrenia in disruptions in the left temporal lobe and anterior cingulate, bipolar disease in the loops connecting the hemispheres, and obsessive-compulsive disorder in compromised feedback loops in the orbitofrontal and cingulate cortices. Surprisingly, Kaku fails to acknowledge that the best predictor of most mental illnesses, across varied societies, is spending one's childhood years with parents who are not well educated and poor.

Throughout the book, Kaku is loyal to the late British mathematician Alan Turing's suggestion that if an observer cannot tell whether an outcome—say, a particular move in a chess game—is the product of a machine or a person, it is reasonable to assume that machines and people rely on the same mechanisms. Two photographs of the Empire State Building, one taken with a Leica that used film and one with a digital camera, reveal the flaw in that premise. Most viewers could not distinguish between pictures that were the products of different mechanisms.

Such a lively narrative dealing with a domain that is foreign to the author's training has to have some errors. For instance, Kaku has Nobel Prize winner Eric Kandel working with the late German theoretical physicist Max Planck in Tübingen and asserts that area V1 of the visual cortex represents whole objects.

I suspect that before submitting the final galleys, Kaku realized, or may have been told by an editor, that he was too accepting of a deterministic materialism that made each human a slave of his or her

neurons. Perhaps that is why the last sentence of the appendix contains a caveat: “In the end we are still masters of our destiny.” Thank you, Professor Kaku.

Bio: Jerome Kagan, Ph.D.

Jerome Kagan, Ph.D., emeritus professor of psychology at Harvard University, was co-director of the Harvard Mind/Brain/Behavior Interfaculty Initiative. He is a pioneer in the study of cognitive and emotional development during the first decade of life, focusing on the origins of temperament, and is the author or co-author of more than 20 books, including the classic *Galen's Prophecy: Temperament in Human Nature* (Basic Books, 1994; Westview Press, 1997).