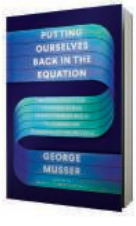
CONSCIOUSNESS

Chasing an equation for awareness

A writer seeks connections between consciousness and fundamental physics

By **Chaz Firestone** and **Ian Phillips**

Science begins with mystery. What causes lightning? How did this mold stop bacterial growth? Why do we age? Arguably, the two greatest mysteries are the cosmos and consciousness—the vast world out there and the vibrant world within. Scientists captivated by one can be called to study the other, seduced by the thought that these mysteries are connected. Science writer George Musser's book *Putting Ourselves Back in the Equation* reviews their progress: Can physics unlock the mystery of consciousness? Does consciousness underlie fundamental physics?



Putting Ourselves Back in the Equation
George Musser
Farrar, Straus and Giroux, 2023. 336 pp.

The result is an ambitious but ultimately disappointing tour, peppered with breathless encounters with well-known scientists. Representative of the cast is MIT's Max Tegmark, who tells Musser: "If you look at the problems that we're still stumped on in foundational physics, pretty much all of them trace back to consciousness."

One puzzle is the quantum measurement problem. The basic formalism of quantum mechanics describes a world of superpositions: combinations of states represented by a wave function. Consider Schrödinger's celebrated cat. The relevant equations pronounce it both dead and alive; but when we open its box, it looks either dead or alive, never both. Multiplicity collapses into singularity—how? A radical solution is that consciousness is the culprit. "The mind reaches out," writes Musser, "grabs particles that are poised between possibilities, and tells them, Choose!"

Other solutions avoid such mental magic. "Many-worlds" interpretations—favored by many contemporary physicists, including Tegmark himself—eschew collapse entirely, eliminating the mind's putative role. Musser charges these views with incoherence (even comparing them to conspiracy theories) but does too little to substantiate his case.

The book's primary theme is how physicists are contributing to understanding the mind, continuing "a long history of physicists colonizing other fields." The metaphor is apt. It recalls an episode from Barbara Kingsolver's *The Poisonwood Bible*, where an American colonial missionary ignores the local horticultural expertise of his Congolese housekeeper. The upshot? A nasty rash from poisonwood sap and a flooded garden.

Musser integrates physics with neuroscience, economics, botany, chemistry, philosophy, mathematics, ornithology, and more. Yet a key source of local expertise is notably absent—psychology, the science of the mind. An early example: Musser rightly applauds physicists' contributions to artificial neural networks but is overly credulous of their implications, declaring that "ChatGPT and DALL-E are already able to do things that seem to be coming from deeply felt experience" and "are starting to demonstrate a generalized intelligence like that of humans." Interviewing more psychologists—experts in both feelings and intelligence—could have exposed the considerable gulf remaining (*1*, *2*).

What about consciousness itself? Why some states associated with felt experience (the pain of a headache, the sight of a sunset) and others not? Musser's focus is integrated information theory, or IIT. IIT begins with five allegedly self-evident "axioms" of awareness: consciousness exists, and it is structured, specific, unified, and definite. It then derives "postulates" concerning the causal structure of conscious systems, identifying consciousness with integrated information—information that cannot be reduced to that in a system's parts. Finally, IIT offers a mathematical measure of this quantity, Φ: an equation for awareness.

However, despite its enthusiasts, IIT has profound problems. Its axiomatic basis is specious (those that are not trivial are not self-evident), and grave doubts surround its testability and Φ's definability (*3*–*5*). Musser belatedly mentions Scott Aaronson's influential critique—that IIT implausibly assigns vast amounts of consciousness to DVD players and inactive logic gates—but seems unconcerned by this (devastating) result.

Of course, a theory of consciousness must do more than distinguish humans from DVD players; it must detail when, why, and to what degree we are conscious. Here, psychology's absence is most glaring. Over the last century, psychological research has revealed innumerable phenomena of consciousness, from paradigms that alter awareness (attentional blink, inattentional blindness) to methods that render stimuli unconscious (masking, flash suppression); from extraordinary disorders of consciousness, such as blindsight or neglect, to rigorous studies of metacognition ("awareness of awareness").

Although controversial, such phenomena are the data that any scientific theory of consciousness must account for. That is why all serious theories say something about them, including global neuronal workspace theory, higher-order theories, and recurrent theories. Yet these phenomena and ideas are almost nowhere in the book. Of course, psychology has not solved consciousness; but one cannot hope to unravel awareness without confronting these data.

Consciousness is genuinely mysterious. So is fundamental physics. But hoping that physics can solve consciousness while excluding other approaches is only a recipe for more mystery, not less. ■

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