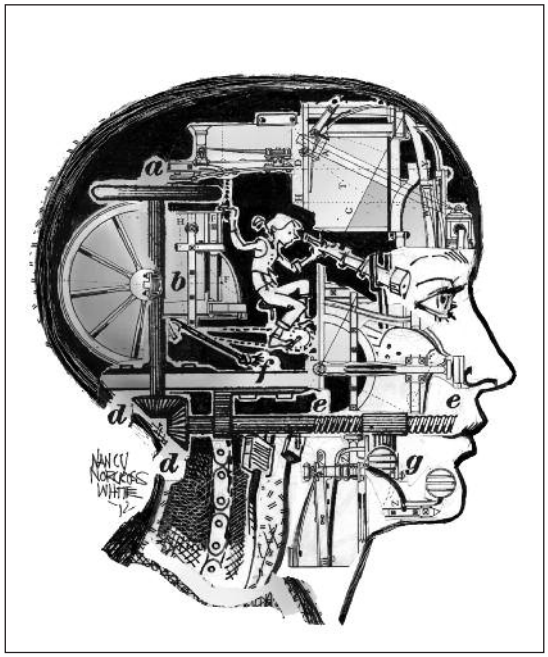
Free Will and Autonomous Will

A Physicist's Perspective on How We Are Accountable for Our Actions

BY VICTOR J. STENGER

In a recent short book neuroscientist Sam Harris pulls no punches on one of humanity's oldest philosophical problems: "Free will *is* an illusion."[1] We don't exist as immaterial conscious controllers, Harris claims, but are instead entirely physical beings whose decisions and behaviors are the fully caused products of the brain and body.



Drawing by Nancy Norcross-White

Even having an immaterial soul as many suppose, Harris notes, would not give us free will: "The unconscious operation of a soul would grant you no more freedom than the unconscious physiology of your brain does." He thus concludes: "We are not the authors of our thoughts and actions in the way people suppose… The idea that we, as conscious beings, are deeply responsible for the character of our mental lives and subsequent behavior is simply impossible to map onto reality."[2]

After centuries of disputation philosophers have identified several different positions on the question of free will. *Incompatibilists* hold that free will conflicts with determinism—the idea that our behavior is fully determined by antecedent causes such as fate, acts of God, or laws of nature.[3] Incompatibilists are themselves split into two camps. *Libertarians* hold that we have free will since humans transcend cause and effect in ways that make us ultimately responsible. In an actual situation as it occurred, we could have done otherwise.[4] *Determinists* hold that we do not have free will, either because determinism is true (we could *not* have done otherwise in an actual situation as it played out) or indeterminism (randomness) doesn't give us control or responsibility.[5] Both of these groups are opposed by *compatibilists*, who argue that free will is compatible with determinism, or indeterminism for that matter.[6]

A Physicist's Perspective

In this article, I will argue from a physics perspective that although quantum mechanics reveals that the universe is fundamentally indeterministic and that randomness plays a much bigger role in nature than most people realize, the human brain is basically a Newtonian machine. That is, quantum indeterminacy cannot be called up to provide a break with determinism that can be interpreted as some kind of free will. However, we will see that the human brain is performing such complex tasks and has to deal with so much data that it is forced to generate a simplified model of conscious decision-making that feels free. So, while our notion of conscious free will is an illusion, we—defined as both our conscious and subconscious brains—are still responsible for those actions that are not either forced upon us or are the result of brain injury or disease.

The Unconscious Will

Research in neuroscience has revealed a startling fact that revolutionizes much of what we humans have previously taken for granted about our interactions with the world outside our heads: Consciousness is really not in charge of our behavior.

We have generally assumed that our senses take in data from the world and send it to our brains where it is stored in our memories to provide us with a knowledge base for our actions. These actions are then performed consciously by an entity called the "self" or "I" that's thought to be the essence of our personhood. For example, when I lift a fork to my lips

at the dinner table, my conscious self performs a deliberate act by telling my arm and hand what to do. This is, at least, the common understanding of what we call *free will*.

However, laboratory experiments pioneered in the 1980s by physiologist Benjamin Libet have shown that before we become aware of making a decision our brains have already laid the groundwork for that decision.[7] While the interpretation of Libet's original results remains controversial,[8] continuing research has strongly confirmed the main feature of the phenomenon, which is the significant time delay between the brain beginning to shape a decision and our awareness of making that decision, which ranges from a fraction of a second to several seconds in length.[9]

In a recent book, *Subliminal: How Your Unconscious Mind Rules Your Behavior,* physicist Leonard Mlodinow reviews a wide range of psychological experiments that demonstrate the substantial role the unconscious plays in our behavior.[10] While Freud proposed this many years ago, modern data from techniques unavailable to him, such as functional magnetic resonance imaging (fMRI) of the brain, suggest mechanisms that have little to do with Freud's speculations about abstract entities such as the Id and the Ego. Now we can see parts of the brain in action carrying out various functions. You might even say that science has now confirmed what advertising and public relations firms discovered a long time ago: decisions are often determined by factors outside our awareness.

Mlodinow points out that the human sensory system sends the brain about eleven million bits of information each second, while our conscious mind can handle no more than about fifty bits per second. Thus, the unconscious mind does an enormous amount of processing before we even become aware of what has been sensed. One estimate is that we are conscious of only about 5 percent of our cognitive processes while the other 95 percent goes on beyond our awareness.[11] Indeed, consciousness itself appears to be a simplified, stripped down model of the world our brains create to enable us to function in the presence of all this information.

A striking example of the unconscious in action is "blindsight," in which some blind people are able to negotiate an obstacle course without being consciously aware of seeing anything; that is, they report having no visual experience. This occurs when the eyes and the rest of the unconscious visual system remain intact but the part of the brain responsible for conscious visual processing is not functioning because of disease or injury.[12]

The primary role of the unconscious in our behavior and decision-making challenges assumptions about free will and the associated religious teachings about sin and redemption, as well as our judicial concepts of responsibility and punishment.[13] If our brains are making our decisions for us outside conscious awareness, how can we be responsible for our actions and held accountable for them by society? How can our legal system punish criminals or God punish sinners who aren't in full control of their decision-making faculties?

The Newtonian World Machine v. Quantum Indeterminism

But what exactly is determinism? Let's look at it from a physics perspective. Two centuries ago, French physicist Pierre Laplace pointed out that, according to Newtonian mechanics, the motion of every particle in the universe can in principle be predicted from the knowledge of its position, momentum, and the forces acting on it. This is the *Newtonian world machine*. Since, as far as physics is concerned, we are all just particles, then this would seem to make free will an illusion—at least as libertarians define it.

But we now know, with considerable confidence, that the universe is *not* a Newtonian world machine. The Heisenberg uncertainty principle of quantum mechanics showed that, deep down, nature is fundamentally indeterministic. The notion that all physical events, including every human action, were already decided when our universe came into being 13.7 billion years ago is simply falsified by quantum mechanics in its commonly accepted indeterministic interpretation.

There is one exception. In the 1950s, physicist David Bohm proposed an alternative, deterministic interpretation of quantum mechanics that implies superluminal, indeed instantaneous, connections across the universe. Bohm's theory is popular with mystics but is rejected by most physicists since it adds no predictive power and violates the principle of Lorentz invariance, which is fundamental to Einstein's relativity and remains consistent with all observations.[14]

No doubt, much of what we observe on the everyday macroscopic scale seems to follow the rules of cause and effect. But, viewed from a cosmic perspective, many events, perhaps most events, happen randomly. For example, the photons in the cosmic background radiation outnumber all the atoms in the universe by a factor of a billion. And

they move about randomly to one part in a hundred thousand. You could say that most of the universe is in random motion, with a few small pockets of order such as stars, planets, and people.

Similarly, at the submicroscopic scale events appear to happen spontaneously, that is, not the direct result of a preceding cause. Examples include atomic transitions and nuclear decays. Quantum mechanics (including Bohm's version) cannot predict the occurrence of individual events but only their statistical probabilities.

Is the Brain a Quantum Device?

Given the ubiquity of randomness in the universe, let us ask if quantum indeterminacy plays an important role in the brain, perhaps making libertarian free will a possibility. In the 1990s, the prominent mathematician and cosmologist Roger Penrose joined with anesthesiologist Stuart Hameroff in proposing that certain structural components of cells called *microtubules* are the seat of quantum effects in the brain.[15]

However, it is easy to demonstrate that the brain is not a quantum device. The moving parts of the brain are heavy by microscopic standards and move around at relatively high speeds because the brain is hot. Furthermore, the distances involved are large by these same microscopic standards. Although you might need a microscope to see them, they are still in the realm of classical physics.

Let me make this quantitative (my specialty). The entity that carries signals across synaptic gaps is called a *neurotransmitter*. Its mass is typically 10^{-25} kilograms. Its typical speed is 358 meters per second, the average speed of a body of this mass in thermal equilibrium at body temperature, 37 degrees Celsius. Suppose that a neurotransmitter is initially located within a synaptic gap, which is about ten nanometers (10^{-8} meter) wide—about two hundred times the size of a hydrogen atom. The uncertainty in the speed of the neurotransmitter from the uncertainty principle is only 0.05 meters per second or 0.014 percent. It follows that we can use classical Newtonian mechanics to describe the motion of the neurotransmitter with reasonable precision.

This conclusion agrees with a detailed calculation by physicist Max Tegmark, who showed that the coherence between states that is necessary to maintain a quantum system is lost in a tiny period of time in the brain, far too short for any quantum effects to play a role in such things as decision-making or behavior control, which is what we're

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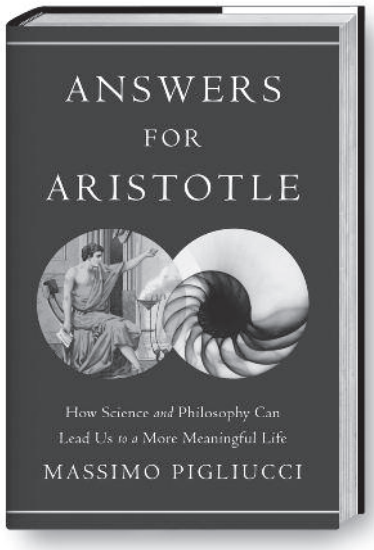

The combination of science and philosophy offers the best possible tool for understanding the world and ourselves

"From ethics to epistemology, from the self to the state, from the hormones of love to the heavens above, Massimo Pigliucci's *Answers for Aristotle* argues for the mutual relevance of science and philosophy in understanding the world in which we live. Enthusiastic, enlightening, and enthralling."

—GLENN BRANCH, Deputy Director, National Center for Science Education

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concerned with when considering the question of free will.[16]

Hameroff and two collaborators have challenged Tegmark's and my conclusions.[17] As mentioned, Penrose and Hameroff proposed microtubules in cells as the source of quantum effects in the brain.[18] Travis John Adrian Chaddock and Jack A. Tuszinski have worked out a detailed quantum mechanical model for microtubules.[19] They found that while quantum effects are possible at low temperatures—below 30 degrees Kelvin (-243 degrees Celsius)—thermal vibrations of the environment at ambient temperatures are more than sufficient to remove any form of collective excitation. Mechanisms have been proposed to shield the microtubules from the environment, however no experiment has produced any evidence for quantum effects in microtubules or, indeed, anywhere in the brain. Besides, why should the microtubules in brain cells be any different from the microtubules in the cells of the big toe?

Hameroff has referred to a paper in *Nature* in which quantum effects were observed in photosynthesis in marine algae at ambient temperature.[20] Now, nothing in physics prevents quantum effects at any temperature. The warm quantum effects that are observed in photosynthesis involve photons, which are quantum objects. Hot photons are just as quantum as cold photons. The basic process of getting energy from light involves photons exciting electrons in atoms, a quantum process. So these results are not surprising nor in violation of any known physics. Furthermore, the quantum coherence observed in the photosynthesis experiment lasted only on the order of 10^{-13} seconds. This is, as Tegmark's calculations confirm, far too short to produce quantum effects in the brain that could play non-negligible roles in higher-level cognition or choice.[21]

We can safely conclude that a quantum brain is not indicated by either theory or experiment. Now, this does not mean that quantum mechanics plays no role *at all* in the brain. Ultimately, everything is quantum mechanical. The brain is made up of the same subatomic particles as a rock, and they all obey the rules of quantum mechanics. The point is, there's nothing special about the quantum mechanics of the brain that enables quantum randomness to play a decisive, substantial role at the level of human choice and action.

So where does this leave us on the question of free will? Libertarians are correct when they say that determinism does not exist, at least at the fundamental physics level. Nevertheless, it is hard to see how physical indeterminism at *any* level validates the libertarian view. As Harris points out, "How could the indeterminacy of the initiating event [of an action] count as the exercise of my free will?"[22] For an action to be *mine*, originated by *me*, it can't be the result of something random, which by definition would be independent of my character, desires and intentions. To originate and be responsible for an action, *I* have to cause it, not something indeterministic. So the libertarian quest for indeterminacy (randomness) as the basis for free will turns out to be a wild goose chase. Neither determinism *nor* indeterminism gets us free will.

The Feeling of Freedom

Even if we don't have free will, the question still remains as to why so many of us *feel* we have it. Although the brain is, as we've seen, a deterministic Newtonian machine, its complexity and nonlinearity put it in a category where *deterministic chaos* might play a role in generating the feeling of freedom. Deterministic chaos is a purely classical phenomenon in which a complex system becomes extremely sensitive to initial conditions—the so-called "butterfly effect." Plenty of "pseudo-randomness" (as opposed to pure quantum randomness) exists in the thermal motions of our brains and in the environment that feeds us data, making our actions unpredictable even to ourselves, at least in any detail. Such unpredictability might contribute to the feeling of having a free will that transcends the cause and effect regularities of natural laws.

Alternatively, or in addition, perhaps it is simply our lack of full conscious awareness of the causes of our decisions that we interpret as free will. Since, as we've seen, consciousness isn't privy to the workings of the brain, it's happy to take credit as the immaterial, causally exempt decider, the brain-independent "I" who thinks it's in control. But, of course, there's no evidence such an entity exists, even though we might feel it does.

Who Are "We"?

So, who are we, essentially? Compatibilists (who, recall, argue that free will is compatible with determinism) make the important point that even if our thoughts and actions are to a great extent the product of unconscious processes, they are still *our* thoughts and actions. In other words, "we" are not just our conscious minds but rather the sum of both conscious *and* unconscious processes.

While others can influence us, no one has access to all the data that participates in a decision

made by our unique brains. Another brain operating according to the same algorithms as ours would not necessarily reach the same decision since the lifetime experiences leading up to that point would be different.

So, although we don't have libertarian free will (the freedom from determinism conferred by being an immaterial conscious controller), if a decision is not controlled by forces outside ourselves, natural or supernatural, but by our normal decision-making capacities (no mental illness or brain disease), then that decision is *ours*.

Autonomous Will

That's what it all boils down to: that I'm in my right mind and in control of my behavior. Calling it "free will" (as compatibilists do) confuses people, since it suggests some form of dualism, supernatural or not; so let's call it "autonomy." Even if free will is an illusion, autonomous will is not.

If you and I are not just some ephemeral consciousness but rather our physical brains and bodies—and the scientific evidence overwhelmingly supports this conclusion—then it is still "we" who make our decisions. And after all, that's what the brain evolved to do, whatever role consciousness might play. Therefore, it is *you* who are responsible for your decisions, and thus society may justly hold you accountable for your actions.

The *manner* in which society holds people accountable through the criminal justice system, however, is open to discussion based on these new scientific findings illuminating human behavior and the fact that we apparently do not have libertarian free will. It could be argued, for example, that the justification for retributive punishment—getting one's just deserts—that is based on the idea that we could have done otherwise in a given situation no longer applies. On the other hand, knowing that humans respond to incentives, both positive and negative, could be the justification for maintaining or even increasing stronger punishments for criminal behaviors, not in the libertarian free will sense but in a behavioral game analysis in which the opportunity to punish cheaters and free riders reduces both cheating and free riding. Either way, a criminal justice system informed by better science is surely more humane and effective.

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