DISCOVER

MIND

Your Brain Is Not a Computer. It Is a Transducer

A new theory of how the brain works — neural transduction theory — might upend everything we know about consciousness and the universe itself.

By Robert Epstein | Aug 25, 2021 7:00 AM

People are going back and forth
across the doorsill
where the two worlds touch.
–Rumi (1207-1273), “Don’t Go Back to Sleep”

Let's start with my 95-year-old mom. Her memory is unreliable, but she's still lucid, churns out sarcasm like a pro, and plays a lightning-fast game of double solitaire. Today I finally quit after she won seven games in a row, and, yes, I was trying my best.

She also hears music continuously, and it's not the kind of music that drives us nuts when we can't get a tune out of our head. She mainly hears *original* music, and she will sometimes try to hum or sing what she's hearing. She says it's coming from the neighbors downstairs, and it doesn't bother her, she says, because some of it isn't bad and because it helps her fall asleep. The fact that other people can't hear it doesn't bother her either. She simply smiles slyly and says, "Maybe you should get your hearing checked."

Am I concerned? Well, just a bit — not about the music but about its source. As I told my mom the other day, I would be more comfortable if the inconsiderate neighbors lived *upstairs*. She laughed and said, "I see what you're getting at, but don't worry. I'm *not* going to hell." Very determined, my mom. Was she planning to negotiate the issue with a hand of double solitaire?

Where is all this original music coming from? My mother has never composed music, and she insists she would be incapable of doing so "no matter how much you paid me." That's mom-speak for *case closed*.

In case you haven't noticed, we are surrounded by mysteries like this. Some, in my view, are highly suspect, such as demonic possession and communication with spirits. Others are undeniably real: dreams, daydreams, hallucinations, the *déjà vu* experience, and so on. My staff recently came up with a list of *58* such phenomena. You don't have to look far to find them.

Are we doomed to remain in the dark about these mysteries, or is there a way to peel back the veil? What if spirits, dreams, and my mom's music could all be accounted for by a relatively simple idea about how the brain works — an idea that might even be testable?

The idea, which is quite simple on its face, is that the brain is a bidirectional transducer.

Transduction Is All Around Us

A few inches to the left of the laptop computer on which I am now typing stands an imposing Sennheiser microphone that I use mainly when someone is interviewing me for a radio or TV

show. A thick black cable protrudes from the back of the microphone and snakes its way to a boxy analogue-to-digital converter, which links to my computer via a bright red USB cable.

My computer links wirelessly to a router in the next room, and the router connects to AT&T, my internet service provider, through a telephone cable that runs from the router to a wall socket. That cable leads to dozens of other transition points through which crude representations of my voice pass before some semblance of it is finally heard by a talk-show host in, say, London.

If I'm speaking to a host of a BBC radio program, representations of his or her voice are also traveling in the other direction from his or her microphone through dozens of transition points until they finally activate a tiny speaker in my ear bud, through which I hear a semblance of his or her voice. If we're also using video to communicate, cameras are sending images to screens, again through many transition points, and again in both directions.

Representations of these images and sounds might be passing not only through multiple transition points but also through thousands of miles of copper or fiber optic cables, or are perhaps being transmitted to satellites hundreds of miles above the earth and then re-transmitted to receivers on the ground. Long ago, pathways like this could accommodate only one conversation at a time, with communications running in only one direction at a time, but now such pathways are bidirectional and are often shared simultaneously by thousands of different conversations.

Remarkably, when everything is working smoothly, my conversation with the London host is as seamless as it would be if we were in the same room. Even though I'm 5,500 miles away in San Diego, I can't detect any time gaps between my ramblings and the host's reply. Those gaps exist, but they're so short that neither I nor the host can perceive them.

What's happening here? Is my voice actually traveling 5,500 miles? Definitely not. If you were the proprietor of a 19th century mansion, you might have been able to shout into a speaking tube that snaked its way through your home and carried your voice all the way to the servants' quarters. In that case, the sound of your voice was literally carried to its destination by the air in the tube.

But when I speak into my microphone, the pattern of sound waves produced by my voice — a distinctive, non-random pattern of air pressure waves — is being *converted* by the microphone into a similar pattern of electrical activity. The better the microphone, the more accurately it duplicates the original pattern, and the more I sound like me at the other end.

That conversion process — the shifting of a meaningful, non-random pattern of activity — from one medium (say, the air in front of the microphone) to another medium (say, the wire at the back of a microphone) is called *transduction*.

And transduction is all around us, even in organic processes. Our bodies are completely encased by transducers. Our sense organs — eyes, ears, nose, tongue, and skin —transduce distinctive properties of electromagnetic radiation, air pressure waves, airborne chemicals, liquid-borne chemicals, textures, pressure, and temperature into distinctive patterns of electrical and chemical activity in the brain. Organic compounds can even be used these days to create new kinds of transducers, such as OECTs: **organic electrochemical transistors**.

Evolution didn't just create millions of new species of organisms, it also created millions of new types of transducers, and engineers are now using both organic and inorganic materials to create thousands more.

To repeat (because this is important): Transduction is all around us — forms of transduction that have evolved over eons and new forms of transduction that humans are inventing right now.

The Ultimate Transducer

What if evolution, at some point, produced a special kind of transducer that could shift signals from the physical world as we know it to a very different kind of world?

Nearly all religions teach that immaterial realms exist that transcend the reality we know. For Christians and Muslims, those realms are Heaven and Hell. One of the simplest and clearest statements of such a concept comes from ancient Greek mythology: As long as the deceased had the required toll in hand — well, actually in mouth — he or she would be transported by the ferryman Charon across the river Styx to Hades, the land of the dead — quite literally, to the *Other Side*. (I'll call it the OS from this point on.) Unfortunately, not everyone was eligible to make the crossing. If no one thought to bury you or to put that coin in your mouth, you were doomed to roam *this* side of the river as a ghost.

The idea of a realm transcending the one we experience directly has taken on many forms over the centuries. George Griffith, England's most prominent and prolific science fiction writer of the late 1800s, published a prescient novel about this realm in 1906: ***The Mummy and Miss Nitocris: A Phantasy of the Fourth Dimension***. The book's protagonist, professor Franklin Marmion, is a distinguished mathematician and physicist who anticipates discoveries and concepts that real quantum physicists would eventually propose decades later. Over the course of the story, Marmion not only reluctantly accepts the fact that a higher dimension must exist, he also acquires the power to shift his body there, learning, among other counterintuitive things, that multiple objects can occupy the same space at the same time.

Griffith might have been aware of a contemporary of his, William James, a prominent Harvard philosopher and also arguably America's first psychologist. In 1898, James published a short book entitled ***Human Immortality: Two Supposed Objections to the Doctrine***, in which he

praised his contemporaries for boldly using scientific methods to investigate "providential leadings [sic] in answer to prayer, instantaneous healings, premonitions, apparitions at time of death, clairvoyant visions or impressions, and the whole range of mediumistic capacities."

James asserted that a universe-wide consciousness beamed human consciousness into our brains "as so many finite rays," just as the sun beams rays of light onto our planet. Our brains, being limited in their capabilities, he said, generally filter and suppress real consciousness, while sometimes allowing 'glows of feeling, glimpses of insight, and streams of knowledge' to shine through. He called this idea 'transmission-theory.'

Ideas like James's have been around for thousands of years. In his 2006 book, *Life After Death: The Burden of Proof*, alternative medicine guru Deepak Chopra says that ancient Hindu texts teach that the material world we know is nothing but a projection from the universal consciousness that fills all space. From this perspective, death is not an end; it is a merging of a relatively pathetic human consciousness with that of the dazzling universal one. To add gravitas to this idea, Chopra does what many recent authors have done: he suggests that modern formulations of quantum physics are consistent with his belief in a universal consciousness.

The connection between physics and modern theories of mind and consciousness is **tenuous at best**, but modern physicists do take the idea of parallel universes seriously. They debate the details, but they can hardly ignore the fact that the mathematics of **at least three** of the grand theories at the core of modern physics — inflation theory, quantum theory, and string theory — predict the existence of alternate universes. Some physicists even believe that signals can leak between the universes and that the existence of parallel universes **can be confirmed** through measurements or experiments. In a recent essay, physicist **A. A. Antonov** argues that our inability to detect the vast amount of dark energy that almost certainly exists in our own universe is evidence of the existence of parallel universes, six of which, he speculates, are directly adjacent to our own.

Again, setting the details aside, physicists agree that the three-dimensional space we experience is simply not the whole picture. As theoretical physicist Lee Smolin put it recently, "**Space is dead**."

Evidence for Transduction?

Hard evidence that supports a neural transduction theory is lacking at the moment, but we are surrounded by odd phenomena that are at least consistent with such a theory. And, no, I'm not talking about the claims that best-selling authors have made over the decades about proof that telepathy, out-of-body experiences, and communication with the dead are real. No such proof exists, in my view, but other well documented phenomena are difficult to brush aside.

When I was a graduate student at Harvard, I noticed a stranger roaming the hallway near my office and offered to assist her. Doris, it turns out, had heard voices for years, and she was hoping she could find someone in the psychology building — William James Hall — to help her eliminate them because they "caused trouble." I didn't have the heart to tell her that Harvard, at the time, had no clinical psychology program and that I was doing behavioral research with pigeons. If her voices had sent her there, they were troublemakers indeed.

When internal perception goes awry, people can be overwhelmed by hallucinations, visions, or distortions of reality so extreme they have to be hospitalized, and Doris had been hospitalized at times.

But is Doris that different from the rest of us? After all, even the healthiest among us hallucinate several times each night — we call it dreaming. And we all have at least two highly disorienting experiences each day called "hypnogogic states" — those eerie, sometimes creative interludes between sleeping and waking.

I have sometimes dreamt intricate full-length movies that seemed as good as any Hollywood film. Alas, most of the time, no matter how hard I try, I can't seem to hold on to even a shred of a dream during the few seconds when I'm staggering from my bed to the bathroom.

Where does all this content come from, and why do we have so little control over it?

In recent years, researchers have explored what they have clumsily labeled "paradoxical lucidity," or, even worse, "*terminal* lucidity." These labels refer to what some of us know as "the last hurrah" — the burst of mental clarity that sometimes occurs shortly before people die, even people for whom such clarity should be impossible.

For more than two centuries, medical journals have published credible reports of highly impaired, uncommunicative people who suddenly became lucid for a few minutes before they died. There are documented cases in which people with dementia, advanced Alzheimer's, schizophrenia, and even severe brain damage —– people who have not been able to speak or to recognize their closest relatives for years — suddenly recognized their loved ones and spoke normally.

A 2020 study summarizing the observations of 124 caregivers of dementia patients, concluded that in "more than 80 percent of these cases, complete remission with return of memory, orientation, and responsive verbal ability was reported by observers of the lucid episode" and that '"[the] majority of patients died within hours to days after the episode." The periods of lucidity typically lasted 30 to 60 minutes.

Some of the historical reports of lucid episodes are truly extraordinary.

Here is one of many cases **reported by the German biologist Michael Nahm** and his colleagues in 2012:

In a case published in 1822, a boy at the age of 6 had fallen on a nail that penetrated his forehead. He slowly developed increasing headaches and mental disturbances. At the age of 17, he was in constant pain, extremely melancholic, and starting to lose his memory. He fantasized, blinked continuously, and looked for hours at particular objects.... He remained in the hospital in this state for 18 days. On the morning of the 19th day, he suddenly left his bed and appeared very bright, claiming he was free of all pain and feelings of sickness.... A quarter of an hour after the attending physician left him, he fell unconscious and died within a few minutes. The front part of his brain contained two pus-filled tissue bags the size of a hen's egg (Pfeufer, 1822)....

And another:

Haig (2007) reported the case of a young man dying of lung cancer that had spread to his brain. Toward the end of his life, a brain scan showed little brain tissue left, the metastasized tumors having not simply pushed aside normal brain tissue but actually destroyed and replaced it. In the days before his death, he lost all ability to speak or move. According to a nurse and his wife, however, an hour before he died, he woke up and said good-bye to his family, speaking with them for about five minutes before losing consciousness again and dying.

If the brain is a self-contained information processor, how can we explain the sudden return of lucidity when the brain is severely damaged? For that matter, think about the variability that occurs in your own lucidity over the course of 24 hours, during which you are, at various times, completely unconscious, partially conscious, or fully conscious. If you add drugs and alcohol to the picture, the variability is even greater, and it can be quite bizarre.

The variability problem is addressed in an **intriguing paper** published by Jorge Palop and his colleagues in *Nature* in 2006, who note that patients suffering from a variety of neurodegenerative disorders often fluctuate over the course of a single day between states of extreme confusion and relatively normal mental states. Such radical changes, they note, "cannot be caused by sudden loss or gain of nerve cells." They speculate about changes in neural networks, but that doesn't solve the problem.

What if the variability is not caused by changes in processing power in the brain but rather by transduction effects? By changes occurring not in our local universe but in the OS? Or by minor changes occurring at the point of connection? Or by changes occurring in brain structures that are essential to signal transfers?

I've also been intrigued by what appear to be credible reports about visual experiences that some congenitally-blind people have had when they were near death. Experiences of this sort were first summarized in a **1997 paper** by Kenneth Ring and Sharon Cooper, later expanded

into a book called *Mindsight* (1999). The paper and book describe the experiences of 14 people who were blind from birth and who had near-death experiences (NDEs), some of which included content that appeared to be visual in nature. Soon after Vicki U. was in a near-fatal car accident at age 22, she remembered "seeing" a male physician and a woman from above in the emergency room, and she "saw" them working on a body. Said Vicki:

I knew it was me.... I was quite tall and thin at that point. And I recognized at first that it was a body, but I didn't even know that it was mine initially. Then I perceived that I was up on the ceiling, and I thought, "Well, that's kind of weird. What am I doing up here?" I thought, "Well, this must be me. Am I dead?"

Vicki had never had a visual experience before her NDE, and, according to the researchers, did not even "understand the nature of light." While near death, she also claimed to have been flooded with information about math and science. Said Vicki:

I all of a sudden understood intuitively almost [all] things about calculus, and about the way planets were made. And I don't know anything about that.... I felt there was nothing I didn't know.

Several aspects of Vicki's recollections are intriguing, but the most interesting to me are the visual experiences. How can someone who has never had such an experience "No light, no shadows, no nothing, ever," according to Vicki — suddenly have rich and detailed experiences of this sort? Ring and Cooper found others like Vicki – congenitally blind people who not only had visual experiences when near death but whose NDEs were remarkably similar to some common NDEs of sighted people.

Just recently, an Australian woman **made the news** worldwide when, post surgery, she woke up with an Irish accent. Her strong Australian accent was completely gone. Called 'the foreign accent syndrome', this sudden switch in accents is rare but real. The shift doesn't make sense given the framework of reasoning we usually apply to the world, but what if it's a transduction error?

And why can't we remember pain? We can remember facts and figures and images, and we can even get choked up remembering strong emotions we've felt in the past — but *we can't remember pain*. Are sensations of pain getting filtered out by transduction pathways? Could that be why our dreams are pain free? That begs a question that is both eerie and obvious: Is the OS a kind of pain-free Heaven?

And have you ever met a stranger who made you feel, almost immediately, that you had known him or her your entire life? And sometimes this stranger has the same feeling about *you*. It's a strong feeling, almost overwhelming. We can try to explain such feelings with speculations about how a voice or physical characteristics might remind us of someone from

our past, but there is another possibility — that in some sense *you had actually known this person your whole life*. If the brain is a bidirectional transducer, that is not a strange idea at all.

In fact, when viewed through the lens of transduction theory, *none* of these odd phenomena — dreams, hallucinations, lucidity that comes and goes, blind vision, and so on — looks mysterious.

And All That Jazz

This brings me, reluctantly, to the recent rise of "postmaterialist" science, or at least postmaterialist psychology. The latter is marked by — or perhaps blemished by — the founding of the journal *Spirituality in Clinical Practice* by the American Psychological Association (APA) in 2014 and the founding of the Association for the Advancement of Postmaterialistic Sciences in 2017. (Disclosure: I have been a full member of the APA since 1983.)

Postmaterialism is all about controlled experiments that have supposedly proved, or at least supported, claims that mediums can communicate with the dead, that ghosts will happily comply when we ask them to climb into little boxes in a laboratory, that people can send their thoughts to strangers in another room telepathically, and that future events can somehow travel backward in time to impact people's current behavior.

I am *so* tempted here to start naming names and tearing down reputations, but my musical mom raised me better than that. I will say this: One of the early papers published in that new APA journal — a paper that was accepted without peer review — demonstrated thinking so shoddy it startled me.

Fortunately, I don't *need* to tear apart shoddy thinking or flawed experiments to advocate for transduction theory. In fact, if this theory proves to be valid, every fantasy of the postmaterialists will be fulfilled — every fantasy except one, that is, and that is *the postmaterialist claim itself*. That's because parallel universes are not wispy, physics-free spiritual entities; according to many mainstream physicists, they are just non-obvious material companions of the material universe in which we happen to live.

A Better Brain Theory

Let's set aside both the mundane and the exotic reasons we should take transduction theory seriously and get to the heart of the matter: The main reason we should give serious thought to such a theory has nothing to do with ghosts. It has to do with the sorry state of brain science and its reliance on the computer metaphor. One of my research assistants recently calculated that Beethoven's thirty-two piano sonatas contain a total of 307,756 notes, and that doesn't take into account the hundreds of sections marked with repeat symbols. Beethoven's scores also include more than 100,000 symbols that guide the pianist's hands and feet: time

signatures, pedal notations, accent marks, slur and trill marks, key signatures, rests, clefs, dynamic notations, tempo marks, and so on.

Why am I telling you about Beethoven? Because piano virtuoso and conductor Daniel Barenboim memorized *all thirty-two of Beethoven's sonatas by the time he was 17*, and he has since memorized hundreds of other major piano works, as well as dozens of entire symphony scores — *tens of millions* of notes and symbols.

Do you think all this content is somehow *stored* in Barenboim's **ever-changing, ever-shrinking, ever-decaying brain**? Sorry, but if you study his brain for a hundred years, you will never find a single note, a single musical score, a single instruction for how to move his fingers — not even a "representation" of any of those things. The brain is simply *not* a storage device. It is an extraordinary entity for sure, but not because it stores or processes information. (See my *Aeon* essay, "**The Empty Brain**," for more of my thinking on this issue, and for a truly great thrill, watch Barenboim play the third movement from Beethoven's 14th piano sonata **here**.)

Over the centuries — completely baffled by where human intelligence comes from — people have used one metaphor after another to 'explain' our extraordinary abilities, beginning, of course, with the divine metaphor millennia ago and progressing – and I use that word hesitatingly — to the current information-processing metaphor. I am proposing now that we abandon the metaphors and begin to consider substantive ideas we can test.

To be clear: I am *not* offering transduction theory as yet another metaphor. I am suggesting that the brain is truly a bidirectional transducer and that, over time, we will find empirical support for this theory.

Recall that Einstein's Special Theory of Relativity, published in 1905, and then his General Theory of Relativity, published in 1915, received no direct and convincing empirical support for years — first regarding predictions his equations made about the perihelion precession of Mercury's orbit, then about the bending of light around the sun (observed by Sir Arthur Eddington in 1919), and then about the gravitational redshift of light. It took a full century before his predictions about gravity waves were confirmed.

If we can cast some aspects of transduction theory into formal, predictive terms (I'm working on that now and am looking for collaborators), we might be able to make specific predictions about transduction — about subtle variations in reaction times, for example, or about how transduction errors might help us explain schizophrenia. We might also be able to predict quantitative aspects of dreams, daydreams, hallucinations, and more.

Ignore It at Your Peril

If transduction theory has merit, let's think about what happens if we ignore it. If we transported a 17th century scientist to the present day and showed him or her how well we

can converse with someone using a cell phone, he or she would almost certainly want to look inside the phone. The remote voice must be *in* the phone, after all. To put this another way, a Renaissance scientist would naively view the phone as a self-contained processing unit, much as today's brain scientists naively view the brain.

But that scientist will never find the remote voice inside the phone, because it is not there to be found.

If we explain to the scientist that the phone is a transducer, however, he or she will now examine the phone in a different way, searching for evidence of transduction, which he or she — aided by appropriate instruments and knowledge — will eventually find.

And here is the problem: If you *never* teach that scientist about transduction, he or she might *never* unravel the mysteries of that phone.

This brings me to the claustrum, a small structure just below the cerebral cortex that is **poorly understood**, although **recent research** is beginning to shed some light. Many areas of the brain connect to the claustrum, but what does it do? If the claustrum turns out to be the place where signals are transduced by the brain, *you will probably never discover this remarkable fact if transduction is not on your list of possibilities.* (If you're a history buff, you might also be aware of another small brain structure — the pineal gland — that could conceivably be a transduction site. In his first book, *Treatise of man*, written in the early 1600s, French philosopher René Descartes identified this gland as the seat of the soul. Remarkably, in the late 1900s, **scientists discovered** that tissue in the pineal gland responds to electromagnetic radiation.)

If modern brain scientists begin to look for evidence that the brain is a transducer, they might find it directly through a new understanding of neural pathways, structures, electro-chemical activity, or brain waves. Or they might find such evidence indirectly by simulating aspects of brain function that appear to be capable of transducing signals. They might even be able to create devices that send signals to a parallel universe, or, of greater interest, that *receive* signals from that universe. Comparative studies of animal brains, which could conceivably have limited connections to the OS, might help move the research along.

Efficient and clear transduction might also prove the key to understanding the emergence of human language and consciousness; here is a possible explanation for what might have been the relatively sudden appearance of such abilities in humans (see Julian Jaynes's 1976 book, *The Origin of Consciousness in the Breakdown of the Bicameral Mind*). Neural transduction might also prove to be the mechanism underlying Carl Jung's concept of the "collective unconscious." Even Noam Chomsky's theory of universal grammar could get a boost from transduction theory; it would hardly be surprising that most or all human languages share certain grammatical rules if languages are all constrained by signals emanating from a common source. And then there's that 'flow' state my friend Mihaly Csikszentmihalyi taught everyone

about. When I'm in a hyper-creative mode – now, for example, as I'm writing – I have almost no awareness of this world or of the passage of time. Is the OS the source of our creativity?

It might take decades for us to see significant advances in transduction research, but with vast resources already devoted to the brain sciences, we could conceivably move much faster. And if you're worried that transduction theory is just another one of those inherently untestable theories — like string theory or theories about parallel universes — think again. With neural transduction theory, we have an enormous advantage: *The transduction device is available for immediate in-depth study*.

Implications and Final Notes

Will transduction theory finally clear up the old consciousness problem? That I doubt, because I don't think there *is* a consciousness problem. Consciousness is just the experience we have when we're observing ourselves or the world. It seems grand simply because we're part of the system we're observing. It's a classic example of how difficult it can be to study a system of which one is an integral part; think of this problem as a kind of Gödel's theorem of the behavioral sciences. (For my whole spiel on this issue, see my 2017 essay, "**Decapitating Consciousness**.")

If transduction theory proves to be correct, our understanding of the universe and of our place in it will change profoundly. We might not only be able to make sense of dozens of odd aspects of human experience, we might also begin to unravel some of the greatest mysteries in the universe: where it came from, what else and who else is out there — even whether there is, in some sense, a God.

If you are as skeptical about flimsy theories as I am, by now you might be thinking: Has Epstein lost his mind (and, if so, where did it go)? Let me assure you that I am as hard-headed as ever. I won't believe in ghosts until Casper himself materializes in front of an audience and pushes me off the stage. But I am also acutely aware of how little we actually know, both about ourselves and our universe. If one simple idea — brain as transducer — might stimulate new kinds of research and might also bring order to what seem to be scores of unrelated, bizarre, and highly persistent human beliefs, I'm all for it.

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