Beautiful Minds

On Consciousness: Science and Subjectivity: A Q&A with Bernard Baars

Here's a chat with Baars about his latest thinking on the scientific study of consciousness

By Scott Barry Kaufman on May 26, 2020

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Far from being some free-floating cloud around our heads, sensory consciousness is profoundly embedded in biology, anatomy, physiology, and above all, in adaptive functions that serve us in every waking second of life. This is not some philosophical speculation. It is now supported by numerous findings published in peer-reviewed journals that are easily found in web archives.

One of my favorite thinkers and researchers on this topic is Bernard Baars. Baars fundamentally changed the scientific study of consciousness over 30 years ago and he has done it again in a stimulating update on consciousness called *On Consciousness: Science & Subjectivity — Updated Works on Global Workspace Theory*. In his new book he proposes novel predictions and draws on the latest research in cognitive science. This magnum opus is really incredible and should be on the bookshelf for anyone seriously interested in wrestling with the paradoxes and mysteries of human consciousness. In this interview with Baars, we discuss his new book and his latest thoughts on the scientific study of consciousness.

Q. How did you get interested in the scientific study of consciousness?

I couldn't avoid it. I was interested in philosophy, where every major voice had something to say about consciousness. Then I read A.J. Ayer, a famous logical positivist, who made the case that English and American philosophy since Bertrand Russell was essentially a non-empirical enterprise. I was a newbie, so maybe I got that totally wrong, but I became a psychology major and lucked out. My brilliant introductory professor had us read George A. Miller's beautiful little history book, *Psychology: The science of mental life*.

That did it for me, because under the professional strictures of behaviorism you were not supposed to talk about "mental life," and Miller made the case (in a very polite way) that the radical behaviorists were wrong. I had no idea at that time that the Harvard Psychology Department had actually split in two in the 1950s over that debate. The half called "psychology" was known for B.F. Skinner's radical behaviorism, and the new Social Relations department had the most famous sensory psychologist of the time, S.S. (Smitty) Stevens. A very famous article by C.P. Snow, a British scientist-novelist, had publicized what was called the "split culture" pitting the sciences against the traditional humanities. Historians still view that as a disaster.

So I had fabulous professors who were sincere and eager to communicate, and who privately wondered about the same things. Almost everything I've written since then had its beginnings in the research programs of my undergrad and grad professors. Even B.F. Skinner changed his mind about radical behaviorism in his two-volume autobiography in 1976, called *Particulars of my Life*. That's a Shakespeare quote, and it came from his four-year undergraduate quest to become a stream of consciousness novelist.

I'm interested in all aspects of human nature. When I started in 1980 as a cognitive scientist, behaviorism was still powerful and nobody wanted to study consciousness directly. It was considered to be career suicide. Cognitive science in the 80s was a much more broad-minded approach to psychology than the others at the time — where we incorporated artificial intelligence, linguistics, anthropology, neural networks, and language science — I enjoyed it immensely.

When you ask how I wandered into the lone forest of consciousness and the brain, which is now a coherent field of science, I have to blame the whole history of Western ideas going back to classical Greece. But that even looks arbitrary these days. Now that we have another thousand years of ancient history it's obvious that the Indus Valley Civilization had a flourishing trade with Sumer, which was part of the Fertile Crescent, where people carried on constant trade and had early cuneiform alphabets, enormous archives of them. On top of that, the Greco-Buddhist Empire of Ashoka imported Greek sculptors, and the Indo-European languages were already spoken across most of the Eurasian landmass. So the whole idea of East is East and West is West and never the twain shall meet is an intentional joke, because Rudyard Kipling knew all about the Greco-Buddhist Empire.

In every wisdom tradition I know, subjectivity (aka consciousness) is a central topic, perhaps because it combines the individual with the social group in such an obvious way. Our individuality is a function of the cortex, which is now proven by brain studies to be "the organ of consciousness." Wilder Penfield discovered that in 1934 via open-brain surgeries in fully awake patients, who were able to talk with him and gesture. Over three decades he studied about 1,200 patients at the Montreal Neurological Institute. That surgery is still being done, and the biomedical archives are full of direct evidence. Just do a search on "conscious" AND "brain" and it pops up.

Anyway, as you know, consciousness had been neglected for about 100 years since William James. This was an enormous opportunity and challenge, of course, and I could see ways of scientifically addressing it.

Scientific work may look humdrum to outsiders, but many scientists experience it as a kind of creative struggle, filled with practical and conceptual challenges that have never before been solved. We only need to look at the growth in genomics today for endless examples. But what can the creative aspect of science tell us about our mindbrain? This term 'mindbrain science' comes from neuroscientist Jakk Panksepp's wonderful books on emotion, and I think he wanted to emphasize that mind and brain are not separate, they are profoundly linked.

So, in 1982, I was able to combine the idea of a global workspace architecture with the stream of consciousness. In a way, it combined the novel idea of "swarm computing" with the evidence we had about the limited capacity of the conscious stream. The empirical theory was

called Global Workspace Theory, or GWT.

GWT continues to grow with more and more evidence. The idea has since entered mainstream science.

Consciousness is a fundamental concept, like mass and energy, entropy and life. Scientists can't avoid it, so we use any number of pseudonyms. People call it "perception" or "attention" or even "knowledge." Those terms capture part of the truth, but they are by no means the whole network of empirically anchored concepts.

The empirical anchors of conscious events are emerging even today, with some real progress on cortical markers for conscious events that are comparable to experimentally matched unconscious ones. This is an emerging field, but it is being developed in a very reliable way by excellent researchers.

Q. What is Global Workspace Theory?

Global Workspace Theory is an effort to understand the biggest empirical paradox that I know of in the very broad field of psychobiology (stretching from consciousness all the way to deep biology). I call this well-known puzzle a “paradox,” because I don’t know the answer. But GWT is an effort to make some sense out of it.

Global Workspace Theory came out of the realization by people like Alan Newell, Herbert A. Simon, Donald Norman, and Daniel Kahneman that the narrowness of the stream of consciousness seemed to conflict with the enormous capacity of unconscious “memories,” or “automatisms,” or whatever people called them. You have this fabulous “memory” domain that no one has any quantitative estimate of, and it’s all run by this “tiny rivulet,” as William James called it. He couldn’t figure it out either, but he knew the evidence.

Alan Newell’s group at Carnegie-Mellon University had the insight that none of the available algorithms could solve the ARPA challenge of identifying 1,000 spoken words. So they found a kind of swarm-computational answer: If you put a hundred crummy algorithms together and let them share hypotheses and vote on the most popular one, it turns out that very inadequate algorithms could jointly solve problems that no single one could solve.

People had been thinking about parallel computers, and parallel-interactive problem solving, and a small group of neural network pioneers somehow arrived at a very similar view, perhaps from considering the many layered arrays in the brain.

That turned into Global Workspace Theory as a way to organize a lot of evidence about

closely similar conscious and unconscious brain processing. We studied dichotic listening, where the subject wore headphones with two input channels, left and right, and had to say the heard syllables as fast as possible. It was called "shadowing" the input. People can do that extremely well, the only cost being the fact that the "Unattended" ear is totally unconscious. But I read a beautiful experiment by Donald G. MacKay, who discovered that an ambiguous word in the conscious (attended) channel could be changed by an unconscious word at the same moment in the "unconscious" channel. The phenomenon of unconscious brain events shaping conscious ones is now routinely studied, although it is still described in behavioristic terms.

Now we have fabulous brain instruments and we can actually observe signal processing in vision and hearing, not with "ground truth" precision, but good enough to test hypotheses. I had the good fortune to work with Gerald Edelman on these questions, and by now it's very clear that the cortex is the perfect brain structure for a "dynamic" global workspace.

My current research extends the Global Workspace (GW) theory of conscious experience to brain evidence, particularly the role of the cortex and thalamus. While cortex and thalamus look separate to the naked eye, they act as an integrated system (Llinas and Pare, 1991; Edelman and Tononi, 2000; Steriade, 2006; Freeman, 2007).

Conscious state studies typically compare waking to slow-wave sleep, coma, general anesthesia, and the epilepsies. Studies of conscious contents compare conscious vs. unconscious cognition during the waking state, using binocular rivalry, the attentional blink, backward masking, and attentional manipulations. Both conscious and unconscious stimuli trigger sensory volleys that can be traced well into the cortex (Gaillard et al., 2009; Panagiotaropoulos et al., 2012).

Brain imaging experiments have supported the best-known GW prediction of "widespread integration and broadcasting" (Dehaene and Naccache, 2001). That is, conscious stimuli typically evoke cortical activity that is more widespread, intense, and correlated than matched unconscious stimuli.

Part IV of my latest book *On Consciousness: Science & Subjectivity* develops GW dynamics, suggesting that conscious experiences reflect a flexible "binding and broadcasting" function in the brain, which is able to mobilize a large, distributed collection of specialized cortical networks and processes that are not conscious by themselves. Note that the "broadcast" phase proposed by the theory should evoke widespread adaptation, for the same reason that a fire alarm should evoke widespread responding, because the specific needs for task-relevant responders cannot be completely known ahead of time. General alarms are interpreted according to local conditions.

A brain-based GW interacts with an "audience" of highly distributed, specialized knowledge sources, which interpret the global signal in terms of local knowledge (Baars, 1988). The global signal triggers reentrant signaling, resonance is the typical activity of the cortex.

Q. What is the proposed biological function of consciousness?

A great body of evidence suggests that conscious sensation and cognition provides the leading edge of moment-to-moment adaptation to the sensory, social, and conceptual world. Darwinian evolution occurs over generations, and by epigenetic expression it also regulates life development. But animals encounter very fast changes in the world, which are novel and ambiguous. To adapt to fast and ill-defined dangers and opportunities we need the brain.

Cortical sensory consciousness is believed to operate around 10 Hz, which is the theta and alpha range of brain oscillations. If you're a rabbit confronted with a potential snake, you first have to run to safety, and then try to evaluate what you saw. The 100 ms domain (10 Hz) is a very useful dwell time for sensory input, and it's also the sniffing rate of small, ancestral mammals. Biologically the 100 ms domain makes a great deal of sense, and consciousness is clearly biological. It has to have plausible bio-functions.

New evidence now also implicated the slower delta range. It is possible that these slow oscillations are modulated by beta and gamma oscillations that carry content, along with spatial arrays that are linked point-to-point by "labeled line" connections. This is a very exciting frontier.

Q. What does Global Workspace Theory predict about conscious cognition?

Like any other theory, it has numerous implications. I address just this question in my newest book, *On Consciousness: Science & Subjectivity - Updated Works on Global Workspace Theory* (The Nautilus Press, 2019), laying out a framework for the role of conscious and unconscious experiences in the living brain.

The most novel prediction of GWT is the idea of a global broadcast linked to conscious — but not unconscious — events in the brain. It has received substantial corroboration from several laboratories.

Q. How does modern science go about studying consciousness?

Consciousness is a part of nature, and we now have clear evidence about the "organ of the conscious mind," the cerebral cortex, which fills 80 percent of the cranial volume. Broadly, sensory perception is conscious, while "stored memory traces" are not. Endogenous senses

like inner speech and visual imagery are also conscious, perhaps more vividly in children.

The most revealing studies compare matched conscious and unconscious conditions, aka "contrastive analysis," and that has allowed us to pinpoint the location and processes that give rise to visual consciousness, for instance.

Q. Has there been scientific progress?

Yes, an enormous amount. When I first proposed GWT in 1982 all we had was psychological evidence and a new understanding of "parallel-interactive processing." Both were vital. But now we can look directly at the living brain at high spatio-temporal resolution, we can trace the fiber system, and we can see how cortex is wired to allow "global integration and broadcasting."

We also understand why the cortex is so enormously flexible, and we have new experimental tools.

Cortex can be traced via the fossil record to come even before the mammals. The current weight of evidence suggests that all "cortical" animals are at least sensorily conscious. Humans have the added advantage of spoken language and more precise use of meanings, which depend on the association areas of cortex. There are alternative proposals for the biological basis of consciousness, but they don't have the enormous bandwidth of cortex.

As you know, there are some simple and informative ways to study the stream of consciousness (SoC). The subjective world is not inaccessible. People can tell us an enormous amount about their conscious inner lives. You can study spontaneous fantasy, creativity, and post-traumatic intrusions. The cortex is essentially never "at rest" as long as it is awake, so the term "resting state" is misleading. The conscious component of cortex is always active, even in dreams, and it is simply part of the causal network of nature. It's not something that lives in some other metaphysical space.

Now that we have amazingly good brain instruments, we can also study sensory processes at the level of neurons. What is new, I believe, is what I've called "contrastive analysis," which is the precise experimental comparison between closely matched conscious and unconscious events. It allows us "to treat consciousness as an empirical variable." And then we test hypotheses that are falsifiable, in a Karl Popper fashion.

This has been worked out very beautifully in two ways: sensory competition (like binocular rivalry), and what is called the Attentional Blink (AB). Both methods allow close experimental comparisons between nearly-identical conscious and unconscious threads in

the brain. The conscious ones we know, because we can describe them; and the matched unconscious conditions are not reportable, but they can be studied via direct cortical recording. Now we can ask, What makes conscious brain activities different from all the others? And there we get a growing family of global workspace (GW) theories.

In science the trick is to pinpoint the empirically answerable questions. Around 1900 physics realized that the "cosmic ether" was not testable, so they dropped it. In biology they dropped the "life force" of Henri Bergson, because it was not testable. Even Einstein gave up on trying to understand quantum phenomena in classical terms. Empirical testability allows us to sweep away speculations, and this simplifies things immensely.

I'm particularly fond of work done at the CNRS in Paris by Stanislas Dehaene and Jean-Pierre Changeux, first-rate scientists, and by the Max Planck research group in Tuebingen, Germany, led by Nikos Logothetis and Fanis Panagiotaropoulos et al. (2012) building on almost two decades of findings from intracranial recordings in the macaque. They used an experimental technique called "flash suppression," involving a long-lasting type of binocular rivalry between the conscious (perceived) and matched unconscious (unperceived) sensory input. This method allows for "contrastive analysis" of conscious vs. unconscious contents with identical stimulus presentation to the two eyes.

I'm glad that this work broadly confirms a prediction I made in 1982, the "global workspace" hypothesis, which is kind of an "integration and broadcasting" function in the visual brain, exactly where you would expect it: in areas IT/MTL where visual input is integrated into coherent Gestalts.

IT/MTL is where we organize visual information into "people, buildings, and scenes." So it is an area of high-level integration and broadcasting of visual information. The "broadcast" or "ignition" appears to be propagated to other parts of cortex.

The area called MTL is the hippocampus, which now appears to be the first experiential "holding buffer" for memories that will later be spread to cortex and other regions. It takes the traces of moment-to-moment experiences and turns them into vast numbers of synaptic connections. The conscious cortex is the leading edge of moment-to-moment adaptation to new and significant events in the world. It is not some floating halo around the head.

Q. What about the "Hard Problem" of mind versus the physical world?

With apologies to my friend David Chalmers, the "Hard Problem" has no supportive evidence. Neither does the new proposal of panpsychism, which is not falsifiable as it is described. Science can only use empirically testable hypotheses.

The "mind-body" question, in various guises, is ancient, but it is posed as an all-or-none dichotomy, as if mind must be the basis of brain, or vice versa. This is like asking which came first, the chicken or the egg? You divide the world into two halves and expect a sensible answer. It doesn't work. What you need is to study the genome and its phenotypical expressions; this is very complex and the answer is never "one causes the other." It's always a set of interactions. The Hard Problem tries to shoehorn all that into simple categories and it's not testable.

I make a rule of ignoring any ideas that are untestable empirically, and of focusing on the testable ones. A very old practice in the history of science, which allows us to filter out empty scholasticism — following Karl Popper's rule that empirical hypotheses have to be falsifiable, or they are useless. This was crucial to physics and biology in the 20th century.

It seems to be very difficult for people to think of consciousness as a natural phenomenon. But now we have decades of evidence and some theory that points to that idea.

Q. How are you pursuing these ideas today?

There's a huge task of communicating the new science. My editor Natalie Geld and I are constantly working together to reach out to educated audiences, via our latest book, On Consciousness: Science & Subjectivity, talks, virtual seminars, and our new Podcast On Consciousness with my co-host, neuroscientist David Edelman. I'm exploring other cortical hypotheses and answering some new questions with mathematicians.

ABOUT THE AUTHOR(S)

Scott Barry Kaufman, Ph.D., is a humanistic psychologist exploring the depths of human potential. He has taught courses on intelligence, creativity, and well-being at Columbia University, NYU, the University of Pennsylvania, and elsewhere. He hosts The Psychology Podcast, and is author and/or editor of 9 books, including *Transcend: The New Science of Self-Actualization*, *Wired to Create: Unravelling the Mysteries of the Creative Mind* (with Carolyn Gregoire), and *Ungifted: Intelligence Redefined*. In 2015, he was named one of "50 Groundbreaking Scientists who are changing the way we see the world" by *Business Insider*. Find out more at http://ScottBarryKaufman.com. He wrote the extremely popular *Beautiful Minds* blog for *Scientific American* for close to a decade. Follow Scott Barry Kaufman on Twitter
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