

# Consciousness: a brief review of the riddle

PETER T. WALLING, MD

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A synopsis of the enigma of consciousness is presented. Should the medical community become more involved in the search for answers?

Star light, star bright  
Do you appear in my dendrites?

Do you float upon brain waves, where you can  
Surf on my encephalogram?

Or are you in my salty neurons  
Some of the billions which we all own?

I guess you could be in my axons  
Giving my brain the thoughts to act on.

Or is it just synaptic fusion  
That helps create your strange illusion?

Can brain transmitters from the nerves  
Produce the images we observe?

I believe it is the case  
That you twinkle in phase space!

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As I look at the full moon on a clear night, light travels between the moon and me in just over 1 second, enters my eyes and is focused on my retina, stimulating the photoreceptors, and . . . stops! That is as far as the moonlight goes. From here on, information about the moon travels the optic pathways of cranial nerves and brain—3 pounds in weight, 2 billion neurons, and upwards of 500 trillion synapses. Silently and in total darkness, a visual image is produced and projected back into space to clothe the object of my gaze so that it seems that the light shines directly from the moon into my mind's eye. This illusion is so exquisite that I hardly recognize it as such.

The moon now exists in my visual consciousness. But where is this awareness and where am "I"? More important, am "I" an observer of this occurrence or an integral part of it? Dualists claim mind and brain to be separate while materialists argue that the mind is the brain and that man has no immaterial part. Dualists and materialists have been dueling for centuries. At the present time, materialists seem to have the upper hand, but the fight is far from finished and the final answer may turn out to be a surprise for everyone.

## THE PAST

Ever since humans have been sentient and self-reflecting, they have wondered about their own minds. In Proverbs we read,

"A person's thoughts are like water in a deep well, but someone with insight can draw them out" (20:5). This may be the first reference to deep thoughts.

The nature of reality was of great interest to Greek philosophers. For example, in ancient Greece, Democritus the Atomist (460–370 BC) proposed that qualities like smell come into being only when the atoms of an object interact with the atoms of the human nose (1). Atoms were "uncuttables"—tiny things that could be "cut" no further—otherwise matter could not exist. Here Democritus had both the intellect and the senses arguing about what is real:

Intellect: "Ostensibly there is color, ostensibly sweetness, ostensibly bitterness, actually only atoms and the void."

Senses: "Poor intellect, do you hope to defeat us whilst from us you borrow your defense? Your victory is your defeat" (1).

This paper cites several references (1–4) to Plato's (427–347 BC) theory of forms, in which he argued the existence of another dimension in addition to the 3 of space and 1 of time with which we are all familiar. This extra dimension was closer to reality than the secondhand experience of the senses and was attainable via the intellect. It boasted perfect harmonies and proportions. He likened the appreciation of this dimension to a person's emerging from a cave of shadows into the normal world of sunlight and solid shapes. This idea has been attacked over the centuries, but it still has some staunch adherents—usually mathematicians, who are sometimes able to meet and communicate on this plane. The concept of a supersensible reality may once again generate interest as hyperspace and higher dimensions are explored as possible repositories for consciousness.

A few hundred years later on the North African coast, Saint Augustine of Hippo (354–430) wrote:

Now when a material thing is thus seen in the mind's eye, it is no longer a material object but the likeness of such an object; and the faculty which perceives this likeness in the mind is neither a material body, nor the likeness of a physical object (5).

The *likeness* and the *faculty* exemplify the view of the fifth-century dualist.

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From the Department of Anesthesiology and Pain Management, Baylor University Medical Center, Dallas, Texas.

**Corresponding author:** Peter T. Walling, MD, Department of Anesthesiology and Pain Management, Baylor University Medical Center, 3500 Gaston Avenue, Dallas, Texas 75246.

According to Chesterton, St. Thomas Aquinas (1225–1274) considered that “everything in the intellect has been in the senses” (6). He argued that the mind was lit by the 5 windows of the senses. He proposed that before sensation was understood, even before a child knew that self was self, the child was aware of *being*. This is an important proposition, for once there is an *is*, its contradiction—an *is not*—is possible; there is a false and true. It was upon this sharp pinpoint of reality that his vast theological arguments started.

Moving forward to the 17th century, René Descartes (1596–1650) suggested that the only certain realities were one’s own thoughts—thus, *cogito ergo sum* (I think, therefore, I am) (1). He championed dualism, proposing that mind and brain interaction occurred in the pineal gland. Gottfried Wilhelm Leibniz (1646–1716) supported the antimaterialist position. He proposed a thought experiment in which he was shrunk to the size of a tiny mite. On an imaginary trip around the human brain, no thoughts or ideas would be seen amongst the machinery. Thus, he argued, the mind and brain must be separate.

As the scientific age dawned, interest was focused on the mind/brain problem in its own right rather than its link to the nature of reality. Frustration mounted early in the 20th century, largely because of the difficulty in categorizing what and where the “mind” was. Near the end of his career, the psychologist William James (1842–1910) authored a paper titled “Does consciousness exist?” Sir Charles Sherrington is quoted by Erwin Schrödinger:

Mind, the anything perception can compass, goes therefore in our spatial world more ghostly than a ghost. Invisible, intangible, it is a thing not even of outline; it is not a “thing,” it remains without sensual confirmation and remains without it forever (7).

In 1949, Gilbert Ryle (1900–1976) strenuously attacked Cartesian dualism, scoffing at Descartes’ idea of a ghost in the machine (8). Thus, the mind/brain problem was largely consigned to the ivory towers of philosophers and the spires of theologians. Medical schools hardly gave it a thought.

The brain has been extensively mapped by correlating deficits caused by trauma, disease, or neurosurgery. In the 1940s and 1950s, Wilder Penfield performed many neurosurgical procedures on patients who were awake; thus, he was able to extensively chart the motor and sensory cortex. He concluded that although stimulation of cortical areas may elicit movement or sensation, an intact thalamus and midbrain were also required if conscious awareness or conscious willed action were to occur. If the upper brain stem is the engine of consciousness, the cortex gives us something to be conscious of. This link has been likened to the brain stem’s acting as a spotlight, illuminating the various “pigeon holes” of the cortex in their turn.

## THE PRESENT

Today, it is thought that 7 salient features of human consciousness exist (9).

1. Consciousness involves short-term memory.
2. Consciousness may occur independently of sensory inputs.
3. Consciousness displays steerable attention.
4. Consciousness has the capacity for alternative interpretations of complex or ambiguous data.

5. Consciousness disappears in deep sleep.
6. Consciousness reappears in dreaming, at least in muted or disjointed form.
7. Consciousness harbors the contents of several basic sensory modalities within a single unified experience.

An important system connects almost all areas of the cerebral cortex to the intralaminar nucleus of the thalamus. Ascending and descending pathways fan out to form a large recurrent network—a foundation for storing short-term memory.

Churchland discusses how Rodolfo Llinás used magnetoencephalography and found 40-Hz neural oscillations all over the cerebral cortex (10). Most interesting is the fact that this “buzzing” was phase related, as if all the neurons were tapping time to a common orchestral conductor. During normal consciousness, the 40-Hz activity was overlaid with nonperiodic variations, which were different in different areas. During sleep, the 40-Hz oscillations continued at minimal amplitude and the thalamic neurons were inactive. Furthermore, during rapid eye movement sleep, the activity returned but was not correlated with changes in the environment. Currently, magnetoencephalography studies are comparable to eavesdropping on a conversation within a football crowd, but they have great potential for the future.

Although bilateral damage to the intralaminar nucleus of the thalamus produces profound and irreversible coma, large areas of the cerebral cortex may be destroyed without consciousness being lost. In a recent review of visual consciousness, Zeki and Bartels suggested the existence of brain nodes belonging to different parallel processing systems (11). Microconsciousness may occur within, and normal visual perception result from the binding together of these nodes. Anatomical evidence fails to demonstrate any final integrator station in the brain, one that receives input from all visual areas.

What is thought to be the neural correlate of consciousness today? Neuroscientists believe that, in humans and mammals, the cerebral cortex is the “seat of consciousness,” while the midbrain reticular formation and certain thalamic nuclei may provide gating and other necessary functions of the cortex (12). Even if scientists could provide a job description for every neuron, the enigma would remain. Is a subjective phenomenon explainable by science, “which aims at nothing but making true and adequate statements about its object” (13)? How can one be objective about the subjective? A stoplight emits electromagnetic waves in the 760-nm range; this tells us absolutely nothing about the *redness* of red. Redness is a quality known only through the subjective or first-person point of view. This is referred to as “the hard problem,” to distinguish it from easier problems of memory, attention, learning, and so forth.

## THE FUTURE

An interesting concept to help understand sensorimotor control has been suggested by Paul and Patricia Churchland and may offer a working model for the possible location of consciousness (14). Imagine a crablike critter struggling to evolve about 500 million years ago. His eyes register food straight ahead, but his pincer is out on a limb in left field. The direction of the food must be converted to an angle of sight, and the angle must be transformed to a different angle for pincer use as the grabbing apparatus is moving in from the left.

The visual angle is represented in *visual phase space*. For any position of food in external space, there will be a corresponding angle or coordinate to locate the food in visual phase space. The visual coordinates or angles represent the position of the real food, because of the existence of a systematic relation between the real world and where in visual phase space it is. The claw and pincer have a different but corresponding motor phase space, and the conversion from seeing to grabbing is accomplished by a coordinate transformer called a tensor. Although this imaginary critter was used to illustrate the possible evolution of sensorimotor control, the same argument for the use of phase space may be made for the gradual evolution of consciousness to help coordinate sensorimotor control. (When phase space exists in >3 dimensions, it is called hyperspace.)

There is a long way to go. As the frontier of knowledge expands, so does the appreciation of our ignorance. Why should the medical community be more interested in the study of consciousness? First, advances in basic physiology have almost always been rewarded with corresponding advances in medicine. Second, more studies are needed on awake humans. This requires equipment and knowledge that are to be found only in large modern hospitals like Baylor University Medical Center. Third, the study of consciousness is fun! Think about it.

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