Some Speculations on the Functions of Consciousness

Introduction to Psychology: The theory of human behavior. Is there a split between mind and body, and, if so, which is better to have? Special consideration is given to a study of consciousness as opposed to unconsciousness, with many helpful hints on how to remain conscious.

From *Getting Even* by Woody Allen

Why bother with consciousness at all? The last two chapters dealt with sensory-motor agents in healthy and brain-damaged people. I emphasized the rapid and flawless manner in which they execute learned, stereotyped behaviors. The existence of these agents raises troubling questions. If so much processing can go on in the dark, without any feelings, why is a conscious mental life needed at all? What evolutionary advantage favored conscious brains over brains that are nothing but large bundles of zombie agents?

Consciousness is a property of particular types of highly evolved biological organs.¹ So phenomenal experience very likely serves a purpose. In a fiercely competitive world, consciousness must give the organism an edge over non-conscious zombies.

Within the last two decades, novelists, philosophers, scientists, and engineers have written extensively on the function of consciousness. Most of these speculations adopt a computational stance, identifying one or several information processing tasks as critical to and for consciousness.

¹Not all complex and highly evolved organs are sentient, of course. The liver isn't, nor is the immune system. The enteric nervous system—100 million or more neurons that line the intestinal walls in your bowel—appears to operate nonconsciously (if the gut has a mind of its own, it is not telling the brain). And this is a good thing too, for the sparse signals it does provide are responsible for the feeling of a bloated stomach or of nausea (Gershon, 1998).
The list of putative functions is substantial, including:

- promoting access to short-term memory,
- perceptual categorization,
- decision making,
- planning and control of action,
- motivation,
- setting long-term goals,
- learning complex tasks,
- detecting inconsistencies and anomalies in the world and the body,
- labeling the present moment,
- implementing top-down attentional selection,
- creativity,
- forming analogies,
- self-monitoring,
- making recursive models,
- working with noncomputable functions,
- inferring the state of other animals or people,
- and the use of language.

Because some of the most advanced computers are based on parallel computer architectures, the artificial intelligence pioneer Marvin Minsky thinks consciousness emerges out of the complex interactions of a large number of autonomous and fairly simple-minded agents. The cognitive scientist Johnson-Laird sees consciousness as an operating system that controls a hierarchical but parallel computer made up of many individual modules. It calls on some routines and inactivates others, but is also powerful enough to generate a model of itself, giving rise to self-consciousness. All in all, this is quite a motley collection of proposed functions, though some may be more relevant than others in explaining the functions of evolved consciousness.²

A word of warning: Up to this point the book has, by and large, remained close to the facts, focusing on the relevant work in psychology and the brain sciences. This chapter is different in that I will share with the reader Francis's and my speculations about the functions of consciousness and of qualia. What is perhaps different from many of the proposals outlined in the previous chapters is that our perspective leads to some specific and empirically verifiable predictions. If you don't like such speculations, then jump directly to Section 14.7.

14.1 CONSCIOUSNESS AS AN EXECUTIVE SUMMARY

In our earliest published work on consciousness, Francis and I felt it was premature to speculate as to its purpose without a better understanding of how and where it acted in the brain. We reconsidered this position a few years later and stated our hunch as to its function as follows:

Our ... assumption is based on the broad idea of the biological usefulness of visual awareness (or, strictly, of its neural correlate). This is to produce the best current interpretation of the visual scene, in the light of past experience either of ourselves or of our ancestors (embodied in our genes), and to make it available, for a sufficient time, to the parts of the brain that contemplate, plan and execute voluntary motor outputs (of one sort or another).³

The central nervous system, like so many people in today's hyperconnected world, suffers from information overload. So much data about the constantly changing environment is streaming in along the sensory pathways that the brain is unable to process all of it in real time. Recall from Chapter 3 that millions of bits of information are transmitted along the optic nerve every second. Your body moves continuously and adjusts its position, sending spikes into the brain that encode the joint angles, the extension of muscles, and so on. You are embedded in clouds of odor molecules that float about and interact with the mucus in your nose. A symphony of sounds constantly impinges on your ears. Out of this melee of sensory events only a few privileged events make it into phenomenal feelings, while the rest are discarded into an experiential limbo.

Natural selection pursued a strategy that amounts to summarizing most of the pertinent facts about the outside world compactly and sending this description to the planning stages to consider the organism's optimal course of action. Such a summary inevitably means that information is lost. In a dynamic environment populated with predators, however, it is usually better to come to some conclusion rapidly and act, rather than to take too long to find the best solution. In a world ruled by the survival of the fittest, the best can be the enemy of the good.

These few items, labeled with qualia, are then sent off to the planning stages of the brain to help decide a future course of action. For example, you may see a dog in front of you, baring its teeth and growling, and an open door to your right. At that moment, everything else is irrelevant.

²For a more thorough discussion, see Johnson-Laird (1983), Minsky (1985), Velman (1991), Mandler (2002), and Chapter 10 in Baars (1988). Thinking of the brain/mind as a parallel computer is just the latest in a long line of technological metaphors that extends back from parallel and von Neumann computers, telephone switchboards, steam engines, clocks, and waterworks, all the way back to wax tablets in ancient Greece.

This function of consciousness is related to the strategy that many leaders of large organizations adopt, namely, "I need a concise summary of all the relevant facts and I need it now." Former U.S. President Ronald Reagan was famous for demanding that his aides reduce any topic that he had to consider, from tax reform to strategic missile defense, to a single page. This executive summary was then used to make final policy recommendations. Vastly more background information on each topic can be supplied by assistants or by accessing databases, but frequently time pressures force a decision to be made based on this sparse collection of opinions and facts and the experience of the chief executive.

We argue that a similar situation applies to the brain. A single, compact representation of what is out there is presented, for a sufficient time, to the parts of the brain that can choose among different plans of action. This is what conscious perception is about. Since only a few items are represented in this manner, the information can be dealt with quickly.

The purpose or purposes for which consciousness originally arose in the course of evolution might be complemented or even supplanted by other functions in the meantime. There is no question that consciousness is important for language, for artistic, mathematical, and scientific reasoning, and for communicating information about oneself to others. Furthermore, once information is consciously accessible, it can be used to veto and suppress zombie behaviors, actions, or memories inappropriate to the situation at hand. However, as the birth of conscious creatures probably predated the arrival of modern humans by millions of years, these higher aspects of consciousness—limited to hominids—could not have been the decisive factor favoring the evolution of conscious phenotypes over zombies.

All animals with thousands or more visual, tactile, auditory, and olfactory receptors are faced by the same onslaught of sensory information and would benefit from an executive summary that enables them to plan what to do next.

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4Though, much reasoning can occur without consciousness (Chapter 18).

5Waiting impatiently at a red traffic light, your instinct is to gun your car forward as soon as it turns green; but this impulse must be checked if a pedestrian is still crossing the street. Evidence of the suppression of memories and behaviors is offered in Anderson and Green (2001) and Mitchell, Macrae, and Gilchrist (2002).

6In The Origin of Consciousness in the Breakdown of the Biocultural Mind, psychologist Julian Jaynes (1976) sees consciousness as a learned process that originated somewhere in the second millennium B.C. when humans finally realized that the voices inside their heads were not the gods speaking to them but their own internalized speech. The book is highly readable, full of interesting archeological, literary, and psychological observations, yet devoid of any brain science or testable hypotheses. Its central thesis is certainly totally wrong. The philosopher W.V. Quine asked Jaynes what it was like for people to have experiences before they "discovered consciousness" and he is reputed to have replied that in those days, people had no more experience than a table! (Ned Block, personal communication).

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14.2 CONSCIOUSNESS AND THE TRAINING OF SENSORY-MOTOR AGENTS

Our hypothesis is quite compatible with the existence of a multitude of stereotyped sensory-motor behaviors that bypass consciousness. A pool of specialists, however, can't deal easily with novel or surprising situations. This is where awareness comes in. Because the NCC correspond to some sort of sustained activity that projects selectively but widely throughout the forebrain, lots of computational and memory resources become available once an event is consciously registered. Moreover, motor systems stand by to execute the desired action. Thus, consciousness can deal with the many real-world tasks encountered in daily life with their often conflicting demands (such as quickly orienting yourself in an unfamiliar neighborhood).

But the price to be paid for this is that it takes several hundred milliseconds for a sensory event to give rise to consciousness—a fraction of a second that may spell the difference between life and death in the fight for survival.

Fortunately, given the amazing ability of brains to learn, a zombie agent can be trained to take over the activities that used to require consciousness. That is, a sequence of sensory-motor actions can be stitched together into elaborate motor programs by means of constant repetition. This occurs when you learn how to ride a bicycle, sail a boat, dance to rock-and-roll, climb a steep wall, or play a musical instrument. During the learning phase, you are especially attentive to the way you position and move your hands, fingers, and feet. You closely follow the teacher's instructions, take account of the environment, and so on. With enough practice, however, these skills become effortless, the motion of your body fluid and fast, with no wasted effort. You carry out the action beyond ego, beyond awareness, without giving any thought as to what has to be done next. It just comes naturally.

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This is not to say that all learning requires consciousness. A substantial body of research investigates implicit learning, in particular the nonconscious learning of motor sequences (Cleeremans et al., 1998; and Destrebecqz and Cleeremans, 2001).
At this stage, paradoxically, consciousness often interferes with the smooth and rapid execution of the task. If you compliment your tennis opponent on her impressive backhand, her subsequent attention to her return may cause her performance to diminish over the next few ball exchanges. A similar thing happens when performing a highly practiced piece of music that you haven't played in a while. It's best to let the "fingers do the playing," because thinking about the individual motifs and sequences of notes can lead you astray.

A baseball player might spend hour after hour in fielding practice, improving his eye-hand coordination, until catching the ball and throwing it to first base becomes "mindless." He is actively wiring up a zombie agent. Circuits in the posterior parietal and medial prefrontal cortex are initially involved, in conjunction with the basal ganglia and the cerebellum. Once training is complete, the prefrontal cortex loses its importance, because the striatum and other basal ganglia structures have taken over the routine, goal-directed behavior. These coordinate the interplay of muscles, optimizing performance and avoiding the delays inherent in depending on the output of the conscious, planning stage. That's why athletes, warriors, and performance artists rehearse over and over for situations where a fraction of a second spells the difference between victory and defeat.

Pick up a training manual for any sport and you'll read words to this effect. A wonderful example is to be found in one of the gems of contemplative literature, Eugen Herrigel's Zen in the Art of Archery. Toward the end of this slim volume, Herrigel explains how mastery in the art of swordsmanship is achieved:

The pupil must develop a new sense, or, more accurately, a new alertness of all of his senses, which will enable him to avoid dangerous thrusts as though he could feel them coming. Once he has mastered the art of evasion, he no longer needs to watch with undivided attention the movements of his opponent, or even of several opponents at once. Rather, he sees and feels what is going to happen, and at that same moment he has already avoided its effect without there being "a hair's breadth" between perceiving and avoiding. This, then, is what counts: a lightning reaction which has no further need of conscious observation. In this respect at least the pupil makes himself independent of all conscious purpose. And that is a great gain.

Humans revel in and glorify these kinds of achievements. Keep in mind, however, that this level of proficiency is only useful within a narrow context (except for those fortunate few at the top of their profession who make a living exploiting such situations). That's why a more general-purpose mechanism for dealing with novel or infrequently encountered situations is needed. It provides access to planning, intelligent reasoning, and decision-making. Their action is more flexible but, unfortunately, also slower.

14.3 | WHY THE BRAIN IS NOT JUST A BUNDLE OF ZOMBIE AGENTS

If these sensory-motor, on-line agents are so fast and efficient, why not dispense with consciousness altogether? Perhaps the organism would come out ahead in the long run if the slower, conscious planning stage were replaced by a bundle of nonconscious agents. The disadvantage would be the lack of any subjective, mental life. No feelings whatsoever!

Given the many senses—eyes, ears, nose, tongue, skin—that flood the brain with information about the environment, and given the diverse effectors controlled by the brain—eyes, head, arms and fingers, legs and feet, the trunk—breeding zombie agents for all possible input-output combinations is probably inefficient. Too many would be required as well as something that coordinates their actions, in particular when they pursue conflicting aims. Such a nervous system would, in all likelihood, be bigger and less flexible than a brain that follows a hybrid strategy of combining zombie agents with a more flexible, conscious module.

I am not claiming that such an Über-zombie could not exist or could not be built by artificial means. I don't know about that. What I am claiming is that natural selection favored brains that make use of a dual strategy. A helpful analogy can be found in embedded digital processors. These small, fast, and low-powered microprocessors are dedicated to one particular task and are ubiquitous in mobile phones, video game machines, washing machines, personal digital assistants, and automobiles. Contrast these with the bigger, more expensive and power-hungry, but also more powerful, processors for personal computers. A truly adaptive robot or other artifact will make use of both. And so it may be with our brains.

14.4 | DO FEELINGS MATTER?

None of the preceding ideas makes the central aspect of the mind-body problem any more comprehensible. Why should planning, indeed, why should any function go hand-in-hand with feelings?

Most thinkers through the ages have accepted the existence of sentience and qualia as given facts of life. But many are still stumped when it comes to assigning a function to consciousness. They therefore conclude that consciousness must be an epiphenomenon, with no causal powers, like the noise

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If evolution on this planet had not brought forth conscious creatures, you and I could not be wondering about consciousness. In this sense, the situation may be analogous to the anthropic principle in cosmology, the postulate that the physical laws in the universe appear to strongly favor the emergence of life (Barrow and Tipler, 1986).
the heart makes as it beats. The sound is useful to a cardiologist when diagnosing a patient, but is of no consequence to the body. Thomas Henry Huxley, the British naturalist and defender of Darwin, expressed this belief memorably as follows:

The consciousness of brutes would appear to be related to the mechanism of their body simply as a collateral product of its working, and to be completely without any power of modifying that working as the steam-whistle which accompanies the work of a locomotive engine is without influence upon its machinery.\(^9\)

The belief that phenomenal consciousness is real but impotent to influence events in the physical world continues to be remarkably widespread among modern philosophers. While this belief cannot, at this point, be shown to be false, it can be undermined since it is based on a trick, a sleight-of-hand.

All functional aspects of consciousness are lumped into one category, called access consciousness by the American philosopher Ned Block. The ability of consciousness to attend to and flag special events, to plan and then decide, to remember situations and so on, are all examples of access consciousness. Because these processes have a function, it is—in principle—straightforward to imagine how nervous systems carry out these functions (although practical, instrumental, and conceptual limitations will extend the process of discovery over decades). This is why Chalmers considers them to be part of the Easy Problem of consciousness. If you think of a new function, fine, just move it into access consciousness.

What remains are feelings—phenomenal consciousness. This is the raw experience of the haunting, sad vibes of Miles Davis's *Kind of Blue* or the ecstatic, near-delirious feeling of dancing all night. These qualia exist, but they serve no function. The fact that yesterday's root canal treatment makes you want to crawl under the covers of your bed belongs to the access realm of consciousness, while the ineffable, bad quality of pain—the subjective part—is phenomenal. Chalmers famously refers to the problem of how the physical world at large generates qualia as the Hard Problem, arguing that since qualia have no function, there will never be a reductionist explanation of the Hard Problem in terms of the Easy Problem.\(^10\)

To do so, I need to tackle the related problem of meaning. The neuron illustrated in Figure 2.1 responds to a twisted paperclip seen by the monkey from one vantage point. The neuroscientist knows this by looking at the experimental setup, the paperclip in front of the animal, the cell's response, and so on; but how do the neurons in the monkey's brain that receive input from this cell know this? This is the problem of meaning (what philosophers also refer to as the problem of intentionality).

Meaning has traditionally been addressed within the context of linguistic semantics. Given the rise of symbolic logic and theories of computation in the past hundred years, meaning has usually been analyzed in terms of linguistic representations. Questions such as “How can the word ‘lion’ actually mean the real lion out there?” have been endlessly debated, analyzed, and re-analyzed. Yet the representations for language must have evolved out of spatial, visual, and auditory representations that are shared by humans and animals alike. From the standpoint of understanding how brain states can be about something, or can refer to something, the nearly exclusive concern with logic and language has been a comparatively barren enterprise. Fortunately, it is now slowly giving way to neurosemantics, which focuses on how meaning arises out of brains shaped by evolution.\(^11\)

Two key problems stand out. First, where in the world does meaning arise? Second, how is meaning instantiated by squishy neurons?

\(^9\)This quote comes from a remarkable speech that Huxley delivered in 1884 to the British Association for the Advancement of Science. He took issue with Descartes's belief that animals were mere machines or automata, devoid not only of reason but of any kind of consciousness. Instead, Huxley assumed that for reasons of biological continuity, some animal species did share certain aspects of consciousness with humans. He was at a loss, though, when it came to the function of consciousness.

\(^10\)Block (1995) introduced the distinction between access and phenomenal consciousness (see also Block, 1996). The volume edited by Block, Flanagan, and Global (1997) expands on this

\(^11\)The literature on intentionality, meaning, and mind stretches back more than two thousand years to the Stoics in ancient Athens. By and large, how meaning emerges out of the brain is something that has occupied scholars only within the last decades (Dennett, 1969; Eliezer, 2000; and Churchland, 2002).
On the Sources of Meaning

There are many sources of meaning in the world. One set is genetically predetermined dispositions. Infants are not born as blank slates, with empty minds. They seek pleasure, such as sucking milk from their mother's breasts, and avoid pain. Getting the basic hedonistic drives right by specifying them in an innate fashion is clearly useful for survival.

A second, richer source of meaning is the myriad sensory-motor interactions you have constantly engaged in since the day you were born. These give rise to tacit expectations that inform everything you think, do, or say. If your head moves, your visual brain expects the image on the retina to shift accordingly. When you reach for something that looks like a hammer, you expect it to be reasonably heavy and adjust your muscles accordingly. You know that when you pick up a glass filled with water, you must be careful lest you spill its contents. Your nervous system learned these expectations in the past with the aid of experience-dependent learning rules and projects them, implicitly, into the future. A purely sessile organism, or somebody who was born completely paralyzed, couldn't experience this aspect of meaning.

A third source of meaning comes from the fusion of sensory data within and across modalities. A rose is red, with a particular fragrance, and the thorns on its stem can prick you. When you look at somebody talking, you expect the movement of their lips and jaw to be synchronized to their voice. When this doesn't happen, as in a movie that has been dubbed in another language, it's disconcerting. Fancy brains, with more sensory input and motor output modalities, thus have richer meanings than simpler nervous systems.

In humans, meaning also derives from abstract facts about the world and from your autobiography. On stage, for example, Brutus betrays his trusting friend Julius Caesar; in geometry, \( \pi \) is the ratio of the circumference of a circle to its diameter; in your childhood, your grandfather held you in his arms. Such unspoken facts and memories weave the tapestry, the cognitive background, on which your life plays out.

How Can Neurons Mean?

How is meaning instantiated at the neuronal level? Francis and I believe that this takes place in the postsynaptic connections made by the winning coalition, the NCC, onto other neurons outside this assembly.

Consider the "Clinton" neuron of Figure 2.2, which is a member of the coalition responsible for the percept of seeing former President Bill Clinton. If its axon terminals were poisoned, preventing the release of synaptic vesicles, it would continue to generate action potentials but it wouldn't contribute any-

thing to awareness because it couldn't affect any of its targets. If the output of the entire coalition in your head were blocked in this manner, you would have difficulty quickly identifying President Clinton or imagining him and you might have trouble thinking of related concepts. A neurologist might diagnose you as suffering from a specific and limited form of what could be called a-cognitiv.

The meaning associated with any one conscious attribute is part of the post-NCC activity emanating from the winning coalition. Coalition members are highly networked with each other but also establish outside contacts with nonmembers. For instance, the Clinton neuron and others like it will excite cells that represent the concept of the "presidency" or the "White House," that are linked to neurons that recall the unmistakable voice of President Clinton and so on. These associated neurons make up the penumbra of the NCC.

This implies that a brain with more explicit representations for sensory stimuli or concepts has the potential for a richer web of associations and more meaningful qualia than a brain with fewer explicit representations. Or, expressed at the level of cortical regions, the more essential nodes, the richer the meaning (Section 2.2). The extent any one attribute is represented in an explicit manner can be assessed by probing individual neurons within a cortical column. Such an operational means would permit, in principle, the meaningfulness of any one conscious experience to be measured and compared within different sensory modalities, across time in the same individual, or across species.

The penumbra expresses the various associations of the NCC that provide the perceived attribute with meaning, including past associations, the expected consequences of the NCC, the cognitive background, and movements (or at least possible plans for movement) associated with NCC neurons. A coalition representing a rope, for example, influences plans for climbing. The penumbra is outside of the NCC proper, although some of its elements may participate in succeeding NCC (for instance, when your train of thought moves from President Clinton to the current President of the United States).

I do not know whether mere synaptic activation of the penumbra is sufficient to generate meaningful or whether the NCC need to trigger action potentials within the cells making up the penumbra. The answer probably depends on the extent to which projections from the penumbra back to the NCC support or maintain the NCC.

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12 It is not impossible that the immediate loss of one such cell might lead to subtle behavioral differences that could be picked up with a sufficiently sensitive test.

13 This term, suggested to us by Graeme Mitchison, was used in this context already by William James (1890).
The penumbra is not, by itself, sufficient for consciousness, though part of it may become part of the NCC as the NCC shift. Neurons within the penumbra that project back to the NCC may help to sustain the underlying coalition. The penumbra provides the brain with the meaning of the relevant essential nodes—its aboutness.

14.6 | QUALIA ARE SYMBOLS

The preceding discussion emphasized that any percept, such as my son's face, is associated with an enormous amount of information—its meaning. For the most part, these associations are not made explicit in the brain at that point in time, but are there implicitly, in the penumbra. How he looks, when I last saw him, what I know about his personality, his upbringing and education, the sound of his voice, his dry sense of humor, my emotional reactions to him, and so on; these are all present in the penumbra. A staggering amount of detailed information, as well as more general knowledge, is all there. This data is not necessarily expressed as an active representation, in terms of neurons firing away, but in a more passive form, as elevated calcium concentration or dendritic depolarization at pre- and post-synaptic terminals, that may or may not lead to postsynaptic spiking.

To handle this information efficiently, the brain has to symbolize it. This, in a nutshell, is the purpose of qualia. Qualia symbolize a vast repository of tacit and unarticulated data that must be present for a sufficient amount of time. Qualia, the elements of conscious experience, enable the brain to effortlessly manipulate this simultaneous information. The feeling associated with seeing purple is an explicit symbol for the rush of associations with other purple objects, such as the purple cloak of Imperial Rome, an amethyst, the Purple Heart military decoration, and so on.

In motion-induced blindness (page 14) you don't see the yellow disks for a while since they are suppressed by the perceptually dominant cloud of moving blue dots. In this state, the informational impact of the yellow disks is very low. Once you see them, the underlying neuronal coalition activates the penumbra for a sufficient amount of time that you become conscious of the yellow color. The symbol for this state, lasting some minimal amount of time, is the associated quale (I shall discuss different aspects of qualia in Section 18.3).

Given the large number of discrete attributes that make up any one percept and the even larger number of relevant relationships among them, phenomenological feelings have evolved to deal with the attendant complexities of handling all of this information in real time. Qualia are potent symbolic representations of a fiendish amount of simultaneous information associated with any one percept—its meaning. Qualia are a peculiar property of highly parallel, feedback networks, evolved to efficiently represent an onslaught of data. Out of the firing activity of the NCC for purple and the associated penumbra emerges the quale for this hue.

Why Do Qualia Feel Like Anything?

But why do these symbols feel like anything at all? Why can't the brain summarize and encode this information without any sensations, as in a conventional computer?

Chalmers has surmised (Section 1.2) that phenomenal states are a fundamental property of any information-processing system, a universal primitive, like mass or charge. On this account, a roundworm or even a single-celled Paramecium would be conscious (without necessarily being very intelligent or even self-conscious). This sort of exuberant panpsychism has a charming metaphysical appeal—since it would make experience ubiquitous—but seems impossible to verify. A more sober hypothesis is that subjective states are limited to information-processing systems possessing a particular computational architecture, range of behavior, or minimal complexity. In any case, an answer as to why feelings are associated with these symbols may emerge out of an information-theoretical formulation of first- and third-person perspectives.

These are deep waters, with little agreement among scholars. Given today's limited ability to intervene in the brain in a delicate and directed manner, empirical means to verify or refute these ideas seem quite remote. For now, it is more profitable for my quest to focus on the NCC and not worry too much about these foundational issues.

It is a thought-provoking exercise to speculate on the extent to which qualia are unique to brains. Can computers or robots have feelings? Is it possible that, for reasons beyond our current understanding, a serial machine, even if powerful, could never execute the relevant operations to represent all the different aspects of an object or event and all the possible relationships among them, in this fashion?

14 Unconscious priming is likely to occur at the synapses linking the NCC with the penumbra. This means that the associated concepts may be easier to activate in the immediate future.


16 Such a focus has worked well elsewhere. The inability to satisfactorily answer the question, "Why is there nothing rather than something?" has not measurably impeded the progress of physics.
Why Are Qualia Private?

Happily, not all aspects of the mind-body problem appear so daunting. Take the problem, often remarked upon by poets, of why it is impossible to convey an exact experience to somebody else. Why are feelings private? The answer, I believe, is straightforward and has two components.

First, the meaning of any one sensation depends on the genetic makeup of the individual and on his or her previous experiences and life history. Since these are never exactly alike in two individuals, it is not easy to reproduce a feeling in another brain.

Second, any subjective percept is encoded by multi-focal activity at essential nodes. If I want to tell you about my experience of seeing a glorious purple, the relevant information needs to be transmitted from these nodes to the parts of the brain involved in speech, and onward to the vocal cords and tongue. Given the massive sideways and feedback connections characteristic of the cortex, this information is, of necessity, re-encoded during the course of this transmission. The explicit information expressed by the motor neurons animating my speech muscles is therefore related, but not identical, to the explicit information at the essential node for color.

That's why I can't convey the exact nature of my color experience to you (even if we have the same set of wavelength-sensitive photoreceptors).\(^{17}\)

It is, however, possible to convey the difference between percepts, such as the difference between orange and yellowish-red, because a difference in firing activity in the color area can still be associated with a difference in firing pattern in the motor stages.\(^{18}\)

14.7 WHAT DOES THIS IMPLY ABOUT THE LOCATION OF THE NCC?

In Section 14.1, I remarked that speculations about the biological usefulness of the NCC are only helpful insofar as they reveal something about its elusive nature. Let me expand upon this.

The front of the cortex is concerned with contemplating, planning, and executing voluntary motor outputs of one sort or another. By and large, premotor, prefrontal, and anterior cingulate cortices actively maintain sensory or memory information, help retrieve data from long-term memory, and manipulate all of this data for planning purposes. Evidence for this comes from careful

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\(^{17}\)This explanation does not rule out the possibility of a future technology that would allow an outside observer to directly tap into my essential nodes for color.

\(^{18}\)It is probably a general rule that the nature of anything—Kant's famous Das Ding an sich—is never expressible, except in its relationship to other things.
damage to the dorsolateral prefrontal cortex, well away from the regions at the back of the cortex. In general, prefrontal patients do not complain of severe losses in conscious perception. However, neither do patients whose brains have been severed along the midline (Chapter 17). Likewise, patients who lost color perception in part of their visual field do not report seeing the world in gray in that part and in color everywhere else (footnote 9 in Chapter 8). It is quite remarkable how often dramatic deficits go unnoticed, a sad testament to the limited power of the human mind for veridical introspection.

The executive summary hypothesis has an interesting and nonintuitive corollary. The primary visual cortex in the macaque monkey has no direct projections past the central sulcus. V1 doesn’t send its axons much beyond V4 and MT and certainly not into the premotor or prefrontal cortex. Franci and I therefore concluded in 1995 that activity in V1 does not directly enter into consciousness—that the NCC for seeing can’t be in V1, even though a functioning V1 (as well as intact retinae) is needed for normal seeing.

As explained in Chapter 6, V1 cells in the monkey fire exuberantly to things the monkey doesn’t see. Aftereffects involving invisible stimuli implicate post-V1 stages as critical for perception. The only evidence that speaks against our thesis is fmri data, which has been shown to show that human V1 does follow the subject’s percept. However, this conclusion is based on one particular interpretation of the fmri signal that is being questioned (see Section 16.2).

14.8 Recapitulation

As consciousness is a property of highly evolved biological tissue, it must have one or more functions. This rather speculative chapter deals with this topic.

Francis and I proposed the executive summary hypothesis: The NCC are useful because they enable an organism to summarize the present state of affairs in the world, including its own body, and to make this terse summary accessible to the planning stages. It is the attributes of this summary that are labeled with subjective feelings. These qualia are the raw material out of which conscious experience is built. They influence the general-purpose, flexible, and deliberate reasoning and decision-making machinery in the frontal lobes.

Research and common experience suggests that the acquisition of rapid, effortless zombie behaviors requires consciousness. This is particularly true of the ritualized sensory-motor activities humans love to engage in—rock climbing, fencing, dancing, playing the violin or piano, and the like. Once a task is sufficiently rehearsed, conscious introspection interferes with its smooth execution. True mastery requires a surrendering of the mind, a letting go of the aim so ardently pursued, in order for the body and its senses to take over.

Could there be organisms like us but devoid of any conscious mental life? Possibly. But given the large array of sensors and the range of output effectors accessible to higher animals, evolving sensory-motor zombie agents to deal with all possible combinations of input-output arrangements for all possible behaviors is awkward. Far better to complement the array of rapid but limited sensory-motor agents with a somewhat slow, but flexible, strategy for summarizing what is out there and planning the future accordingly.

This account, however, is insufficient to explain why it should feel like anything to be conscious. One popular explanation is that these feelings, qualia, serve no useful purpose, that they are epiphenomenal. This appears questionable. Qualia are too structured to be an irrelevant byproduct of the brain. I favor the idea that qualia are closely tied up with meaning.

The NCC derive their meaning from their synaptic relationships with other groups of neurons that may or may not be active themselves. They encode the many concepts and experiences associated with any one conscious percept—its penumbra. Qualia are a potent symbolic representation of the vast storehouse of simultaneous information inherent in this meaning (a shorthand to codify all of these data). Qualia are a special property of massively parallel networks. This framework also explains why qualia are private and why their full content can’t be communicated to others.

It follows from our executive summary hypothesis that the NCC must be intimately linked to the planning stages, located within the premotor, prefrontal, and anterior cingulate cortices. Francis and I therefore concluded that the NCC neurons must directly project into the front of the cortex. In the monkey, there are no direct connections from V1 to any frontal areas, so it seems reasonable to assert that the NCC can’t be in V1 (as emphasized in Chapter 6).

Let me now return from the speculative realm to the more concrete. I will consider next the microstructure and dynamics of visual consciousness. Studying the evolution of an individual percept provides critical cues to the circuits that underlie consciousness.