

Dr. Crick's Sunday Morning Service

"Our own subjective inner life, including sensory experiences, feelings, thoughts, volitional choices, is what really matters to us as beings."

--Benjamin Libet

The time has come to take stock of where the problem stands. We have seen how complex the visual system is and how visual information is processed in a semihierarchical manner that is only partly understood. I have sketched a few ideas about the neural basis of visual awareness and outlined a few experiments that might help to unscramble its mechanisms. Clearly we have not solved the problem, so what has been achieved ?

What Christof Koch and I are trying to do is persuade people, and especially those scientists intimately involved with the brain, that now is the time to take the problem of consciousness seriously. We suspect that it is our general approach that will be found useful. Rather, they constitute work in progress. I believe that the correct way to conceptualize consciousness has not yet been discovered and that we are merely groping our way toward it. This is one reason why experimental evidence is important. Now results may suggest both new ideas and also alert us to errors in old conceptions.

Philosophers are right in trying to discover better ways of looking at the problem and in suggesting fallacies in our present thinking. That they have made so little real progress is because they are looking at the system from outside. This makes them use the wrong idiom. It is essential to think in terms of neurons, both their internal components and the intricate and unexpected ways they interact together. Eventually, when we truly understand how the brain works, we may be able to give approximate high-level account and more compact manner, and will replace the fuzzy folk notions we have today.

Many philosophers and psychologist believe it is premature to think about neurons now. But just the contrary is the case. It is premature to try to describe how the brain really works using just a black-box approach, especially when it is couched in the language of common words or the language of a digital programmable computer. The language of the brain is based on neurons. To understand the brain you must understand neurons and especially how vast numbers of them act together in parallel.

The reader might accept all this but could well complain that I have talked all around the topic of consciousness, with more speculation than hard facts, and have avoided what, in the long run, is the most puzzling problem of all. I have said almost nothing about qualia - the redness of red – except to brush it to one side and hope for the best. In short, why is the Astonishing Hypothesis so astonishing? Is there some aspect of the brain's structure and behavior that might suggest why it is so difficult for people to conceive of awareness in neural terms?

I think there is. I have described the general workings of an intricate machine – the brain – that handles an immense amount of information all at once, in one perceptual moment. Much of the content of this rich body of coherent information is constantly changing, yet the machine manages to keep various running records of what it has just been doing. We have no experience (apart from the very limited view provided by our own introspection) of any machine with all these properties, so it is not surprising that the results of that introspection appear so odd. Johnson-Laird has made a similar point. If we could build machines that had these astonishing characteristics, and could follow exactly how they worked, we might find it easier to grasp the workings of the human brain. The mysterious aspect of consciousness might disappear, just as the mysterious aspects of embryology have largely disappeared now that we know about the capabilities of DNA, RNA, and protein.

This leads to the obvious questions: Will we be able, in the future, to build such machines and, if we did, would they appear to possess consciousness? I believe that in the long run this may be possible, although there may turn out to be technical limitations that are almost impossible to overcome. In the near future I suspect that any machines we can construct are likely to be very simple in their capabilities compared to the human brain. Because of this will probably appear to have only a very limited form of consciousness. Perhaps they will be more like the brain of a frog or even that of a humble fruit fly. Until we understand what makes us conscious, we are not likely to be able to design the right sort of artificial machine or to arrive at firm conclusions about consciousness in lower animals.

It is important to emphasize that the Astonishing hypothesis is a hypothesis. What we already know is certainly enough to make it plausible, but it is not enough to make it as certain as science has done for many new ideas about the nature of the world, and about physics and many new ideas about the nature of the world, and about physics and chemistry in particular. Other hypotheses about man's nature, especially those based on religious beliefs, are based on evidence that is even more flimsy but this is not in itself a decisive argument against them. Only scientific certainty (with all its limitation) can in the long run rid us of the superstition of our ancestors.

A critic could agree that, whatever scientist may say, they really do believe in the Astonishing Hypothesis. There is a restricted sense in which this is true. You cannot successfully pursue a difficult program of scientific research without some

preconceived ideas to guide you. Thus, loosely speaking, you “believe” in such idea. But to a scientist these are only provisional beliefs. He does not have a blind faith in them. On the contrary, he knows that he may, on occasion, make real progress by disproving one of his cherished ideas. That scientists have a preconceived bias toward scientific explanation I would not deny. This is justified, not just because it bolsters their morale but mainly because science in the past few centuries has been so spectacularly successful.

The next thing to stress is that the study of consciousness is a scientific problem. Science is not separated from it by some insurmountable barrier. If there is any lesson to be learned from this book it is that we can now see ways of approaching the problem experimentally. There is no justification for the view that only philosophers can deal with it. Philosophers have had such a poor record over the last two thousand years that they would do better to show a certain modesty rather than the lofty superiority that they usually display. Our tentative ideas about the workings of the brain will almost certainly need clarification and extension. I hope that more philosophers will learn enough about the brain to suggest ideas about how it works, but they must also learn how to abandon their pet theories when the scientific evidence goes against them or they will only expose themselves to ridicule.

The record of religious beliefs in explaining scientific phenomena has been so poor in the past that there is little reason to believe that the conventional religions will do much better in the future. It is certainly possible that there may be aspects of consciousness, such as qualia, that science will not be able to explain. We have learned to live with such limitations in the past (e.g., limitations of quantum mechanics) and we may have to live with them again. This does not necessarily mean that we shall be driven to embrace traditional religious beliefs. Not only do the beliefs of most popular religions contradict each other but, by scientific standards, they are based on evidence so flimsy that only an act of blind faith can make them acceptable. If the members of a church really believe in a life after death, why do they not conduct sound experiments to establish it? They may not succeed but at least they could try. History has shown that mysteries which the churches thought only they could explain (e.g., the age of the earth) have yielded to a concerted scientific attack. Moreover, the true answers are usually far from those of conventional religions. If revealed religions have revealed anything it is that they are usually wrong. The case for a scientific attack on the problem of consciousness is extremely strong. The only doubts are how to go about it, and when. What I am urging is that we should pursue it now.

There are, of course, educated people who believe that the Astonishing Hypothesis is so plausible that it should not be called astonishing. I have touched on this briefly in the first chapter. I suspect that such people have often not seen the full implications of the hypothesis. I myself find it difficult at times to avoid the idea of a homunculus. One slips into it so easily. The Astonishing Hypothesis states that all aspects of the brain's behavior are due to the activities of neurons. It will not do to explain all the various

complex stages of visual processing in terms of neurons and then carelessly assume that some aspect of the act of seeing does not need an explanation because it is what “I” do naturally. For example, you cannot be aware of a defect in your brain unless there are neurons whose firing symbolizes that defect. There is no separate “I” who can recognize the defect independent of neural firing. In the same way, you do not normally know where something is happening in your brain because there are no neurons in your brain whose firing symbolizes where they or any other neurons in your brain are situated.

Many of my readers might justifiably complain that what has been discussed this book has very little to do with the human soul as they understand it. Nothing has been said about that most human of capabilities – language – nor about how we do mathematics. Or problem solving in general. Even for the visual system I have hardly mentioned architecture, and so on. There is not a word about the real pleasure we get from interacting with Nature. Topics such as self-awareness, religious experience (which can be real enough, even if the customary explanations of them are false), to say nothing of falling in love, have been completely ignored. A religious person might aver that what is most important to him is his relationship with God. What can science possibly say about that?

Such criticisms are perfectly valid at the moment, but making them in this context would show a lack of appreciation of the methods of science. Koch and I chose to consider the visual system because we felt that, of all possible choices, it would yield most easily to an experimental attack. The book shows clearly that while such an attack will not be easy, it does appear to have some chance of success. Our other assumption was that, once the visual system is fully understood, the more fascinating aspects of the “soul” will be much easier to study.

Only time will show if these judgments are correct. New methods and new ideas might make other approaches more attractive. The aim of science is to explain all aspects of the behavior of our brains, including those of musicians, mystics, and mathematicians. I do not contend that this will happen quickly. I do believe that, if we press the attack, this understanding is likely to be reached someday, perhaps some time during the twenty-first century. The sooner we start, the sooner we shall be led to a clear understanding of our true nature.

Of course, there are people who say that they do not wish to know how their minds work. They believe that to understand Nature is to diminish her, since it removes the mystery and thus the natural awe that we feel when we are confronted with things that impress us but about which we know very little. They prefer the myths of the past even when they are in clear contradiction to the science of the present. I do not share this view. It seems to me that the modern picture of the universe – far, far older and bigger than our ancestors imagined, and full of marvelous and unexpected objects such as rapidly rotating neutron stars – makes our earlier picture of an earth-centered world seem far too cozy and provincial. This new knowledge has not diminished our sense of awe but increased it immeasurably. The same is true of our detailed biological

knowledge of the structure of plants and animals, and of our own bodies in particular. The psalmist said, "I am fearfully and wonderfully made," but he had only a very indirect glimpse of the delicate and sophisticated nature of our molecular construction. The processes of evolution to one of great complexity and precision. One must be dull of soul indeed to read about it and not feel how marvelous it is. To say that our behavior is based on a vast, interacting assembly of neurons should not diminish our view of ourselves but enlarge it tremendously.

It has been reported that a religious leader, shown a large drawing of a single neuron, exclaimed, "So that is what the brain is like!" But it is not the single neuron, wonderful thought it is as an elaborate and well-organized piece of molecular machinery, that is built in our image. The true description of us is the complex, ever-changing pattern of interactions of billions of them, connected together in ways that, in their details, are unique to each one of us. The abbreviated and approximate shorthand that we employ every day to describe human behavior is a smudged caricature of our true selves. "What a piece of work is a man!" said Shakespeare. Had he been living today he might have given us the poetry we so sorely need to celebrate all these remarkable discoveries.

It is unlikely that the Astonishing Hypothesis, if it turns out to be true, will be universally accepted unless it can be presented in such a way that it appears to people's imagination and satisfies their need for a selection is likely to be unbiased, since their views are predetermined by a selection is likely to be unbiased, since their views are predetermined by a slavish adherence to religious dogmas.

There seem to me to be several root causes of this obstinate clinging to outmoded ideas. General ideas, especially moral ones, impressed on us at an early age often become deeply embedded in our brains. It can be very difficult to change them generation to generation, but how did such ideas originate in the first place, and why do they so often turn out to be incorrect?

One factor is our very basic need for overall explanations of the nature of the world and of ourselves. The various religions provide such explanations in terms the average person finds easy to relate to. It should always be remembered that our brains largely developed during the period when humans were hunter-gatherers. There was strong selective pressure for cooperation within small groups of people and also for hostility to neighboring, competing tribes. Even in this century, in the forests of the Amazon, the major cause of death among the competing tribes in the remote parts of Ecuador is from spear wounds inflicted by members of rival tribes. Under such circumstances a shared set of overall beliefs strengthens the bond between tribal members. It is more than likely that the need for them was built into our brains by evolution. Our highly developed brains, after all, were not evolved under the pressure of discovering scientific truths but only to enable us to be clever enough to survive and leave descendants.

From this point of view there is no need for these shared beliefs to be completely correct, provided people can believe in them. The single most characteristic human ability is that we can handle a complex language fluently. We can use words to denote not only objects and events in the outside strikingly human characteristic, one that is seldom mentioned: our almost limitless capacity for self-deception. The very nature of our brains – evolved to guess the most plausible interpretations of the limited evidence available – makes it almost inevitable that, without the discipline of scientific research, we shall often jump to wrong conclusion, especially about rather abstract matters.

How it will all turn out remains to be seen. The Astonishing Hypothesis may be proved correct. Alternatively, some view closer to the religious one may become more plausible. There is always a third possibility: that the facts support a new, alternative way of looking at mind-brain problem that is significantly different from the rather crude materialistic view many neuroscientists hold today and also from the religious point of view. Only time, and much further scientific work, will enable us to decide. Whatever the answer, the only sensible way to arrive at it is through detailed scientific research. All other approaches are little more than whistling to keep our courage up. Man is endowed with a relentless curiosity about the world. We cannot be satisfied forever by the guesses of yesterday, however much the charms of tradition and ritual may, for a time, lull our doubts about their validity. We must hammer away until we have forged a clear and valid picture not only for this vast universe in which we live but also of our very selves.