Why is Hearing Not Like Seeing?
The Problem of Sensory Consciousness in an Information System

Abstract: A*n information systems approach to sensory consciousness is developed here. The analysis is based on elementary considerations involving neural anatomy and neural systems operations. The results of this analysis include the suggestion that qualia are transduction level processes involving stimuli rather than cortical or central state phenomena. The implications of this theory are outlined. Considerations are raised concerning the possible value of further scientific and mathematical developments on the problems of sensory consciousness.*

1. The Origins of the Problem

There are many difficulties associated with trying to determine the relationship between the mental and the physical. One problem which has perhaps received less attention than it should is generated by the fact that the nervous system is an information system. The problem is basically this: Sensory experience has a great deal of diversity while neurological activity does not. Why is it then that we have different kinds of sensations and many different sensory experiences? Why do we experience tastes, smells, sounds, all the phenomenon associated with the information provided by different sensory stimuli? I will attempt to show here that the common sense answer, that we have different sensations because we have different sense organs, is actually closer to the truth than has commonly been assumed.[1] But, as it turns out, this answer is not easily established and it has some seldom realized implications

We encounter difficulties in explaining the diversity of sensory experience once we acknowledge the connection between nervous system function and mental phenomena and realize that the nervous system is an information system in the sense that will be developed here. This connection suggests at least two distinct problems of sensory consciousness. These problems are not obvious unless we understand the nervous system as an information system. But, if we grasp this, we can see that sensory experience associated with an information system is problematic at even the most basic levels because information based processes have few if any qualitative aspects while sensory consciousness is qualitatively diverse.

The first problem generated by sensory consciousness in an information system is this: Why is there anything like consciousness or awareness associated with the operation of the system? It is not clear why an information system like the nervous system should have anything more associated with its operations than just the causal influences, the information, it requires to operate. Some would perhaps deny that anything more does exist, but the greater our understanding of the brain the less plausible this view becomes. Is it credible to suppose that there is nothing more to our existence than streams of action potentials running around in neural networks? Proponents of views like this might claim that the concept of consciousness is exhausted by its causative role in

[1] Certain philosophical positions, Central State Materialism for example, sometimes seem to run contrary to the common sense view that the sense organs produce sensation. See for example: ” Identity Theory” at http://www.iep.utm.edu/identity also “Qualia” at http://www.iep.utm.edu/qualia/

behavior. But we know what causes behavior: nervous system activity. Behavior has a physiological origin that requires neurological function but does not necessarily require extra features like conscious experience. The problem here then is that there seems to be something more going on in addition to this underlying neurological activity.

The second problem is that of the variability of experience, both in terms of types and content. We assume that there have to be different experiences because that is the way that human awareness is. But consciousness could be like a powering up operation, like establishing an operating voltage in an electronics system, something required for operation but not in itself generating any other system activity. Imagine that you could turn on your computer without starting the BIOS or operating system, that you could hit a switch and turn the machine on by supplying power but nothing else would happen until you hit another switch. Consciousness could be a phenomenon like that. In this case the conscious entities might only be aware that they are sometimes conscious and sometimes unconscious, sometimes on and sometimes off with no variations in the "on" experience and no qualitative aspects associated with it. Consciousness could also involve variable content without admitting to different types of experience. The senses of touch, smell or hearing could all be experienced as different sorts of visual sensations for example. They could all be manifested as different patterns of flashing colored lights for instance. Instead we have different sensory modalities with different experiences within each modality, all with the same basic underlying neurophysiology. Why is there more to consciousness than just an on/off element, and why do we have different kinds of experiences? One aspect of this problem can be put very simply: Why is it that hearing the violin is nothing at all like seeing it, which is nothing at all like touching it or smelling the varnish on it? The sense organs produce fundamentally different experiences, a fact that is hard to explain at the neurological level, or at least in any theory involving the central nervous system (CNS) alone. Let us call this the problem of inter- modal qualitative difference or the "IMQD" problem.

IMQDs are a problem because once we get beyond the sense organs there seems to be nothing in the nervous system that can explain them. Consider two sorts of experiences here, seeing the violin and hearing it being played. Today we know roughly what this involves physiologically. If I am looking at something and having a visual experience, then the rods and cones, the receptor cells of the eyes, are generating signals that are relayed to the lateral geniculate bodies of the thalamus in the brain. From there the signal goes to the visual cortex where the information is further processed, forms and colors are resolved and the results relayed to other areas of the brain; the pre-motor cortex for example, so that I can react to what I am looking at. The process for hearing is very similar; sound is transduced in the organ of Corti where very small hair cells produce a signal as a result of their vibration in response to the pressure waves impinging on the ear. The signal is relayed to the medial geniculate bodies of the thalamus and ultimately arrives at the auditory cortex where the auditory information is further processed. From there it again goes to other areas of the brain. What's going on in these other areas of the brain is not as yet clear, but it is clear that they are using the same components –neurons and their connecting fibers – and the same processes –neurons producing signals- as the primary

sensory areas of the brain. In fact, even after acknowledging that there are variations in both the CNS structures involved and in the signals being utilized, it can be said, at a systems level, that this is all the CNS is or does.

An information flow description of sensory processes like the above does nothing to explain why seeing and hearing involve qualitatively different experiences. Now there is, of course, much more to be said about what the brain does and how it does it. But is at best unclear whether delving into the details would help explain IMQDs. We could, for instance, consider the overall architecture of the various cortical areas involved in sensation, the Brodmann maps of the cortex for example. We could consider the histology or cytoarchitecture of the different sensory areas. But on what basis could we decide that differences in anatomy or cell type distributions were the reason for different types of sensory experience? We could consider the biochemistry of the brain; there are many different types of neurotransmitters involved in CNS operation. But we face the same problem here also. What sense can be made out of the notion that seeing is different from hearing because there may be different neurotransmitters involved in these two sensory processes?

Whatever differences we know to exist or can even imagine in the anatomy, physiology or biochemistry of different areas of the brain must pass a difficult test of explanatory adequacy if they are to be part of the explanation of conscious experience. They must explain why sensory experiences are as diverse as they are if we think that sensations are CNS phenomenon. The same problems exist for any explanation involving other aspects of neural systems such as network operations or information processing activities. The test for explanatory adequacy is at very best unclear, and likely to be non-existent. It is much easier to conclude that all neurological processes are essentially the same as to imagine that there are differences sufficient to explain the most fundamental aspects of our sensory experiences. The idea that physiology or any empirical science can provide the kinds of insights needed to address the problems identified here is at best highly speculative. Once we look inside our heads it is not at all clear how we can hope to explain why seeing is not like hearing, or even why there are any qualitative variations in experience at all.

The IMQD problem becomes even more obvious if we consider how information is relayed through the CNS and how the type of information being conveyed is determined. Both ends of the nervous system are “hard wired”, i.e., the fibers are permanently connected to either input units or output units. It is generally assumed then that on the input side the type of information being transmitted is determined by ”line labeling”, that is, by the specific fibers that are active. Let us further note here that we also assume the validity of what is sometimes called the “neuron doctrine”, the idea that the neuron is the functional unit of the CNS from a system wide performance perspective. Neurons produce action potentials which convey information into and through the nervous system and which also constitute the output of the system

We might imagine then that the brain can determine the kind of experience we are having because it “knows” the origin of the fibers transmitting the signal. But these transmissions must also somehow include qualitative

differences, or the information required to produce them internally if we think that sensation is only a brain process. However, even if the input patterns are different for each sense organ or the internal information processing activities vary from one sensory modality to another, a fundamental problem remains. We have to account for all aspects of experience in terms of internal information and related processes if we think that sensation is the result of CNS activity. It need not have been this way. Science could have gone into our heads and found light from the eyes and chemicals from our noses instead of information whose type is determined by the functional topography of the fibers that convey it. The CNS need not have been an information based system at all, but it evidently is. This fact alone creates many of the problems of consciousness: Why is there anything more than information associated with the operation of the nervous system, and how can an information based system contain, manifest or generate anything other than just information or information based output activity?

We can view information here as the potential for causation by way of a variable influence. Variations in a causal influence can convey information because of the way that the system receiving the variable influence operates. The system has to be sensitive to the causative influence and be capable of extracting the information from it, that is, capable of variable responses when the causal influence varies. Thus light waves can carry information for the eye, but not for a rock. Human beings are apparently unable to detect low strength, long wavelength electromagnetic waves while radio apparatus can detect them and react to them. Radio waves can then carry information for radios, but not for people. Information is causative not because of the fundamental physical metrics of the transmission or conveyance, e.g., the quantity of energy, momentum, charge etc., but because of some variable aspect of a causative process. Information then involves a coded signal, not simple mechanical, biochemical, or electro-magnetic influences. The nervous system is an information system in the sense outlined here. It operates using bioelectrical signals, streams of action potentials, to effect processes that occur between the input and output sides. There are many other operational aspects of the nervous system, complicated chemical and biological substrata are required for system operations. But these other things are not what the nervous system, viewed as a signal receiver-generator- processor -actuator, does, not what it's about. The CNS operates using action potentials, a single causal variable that represents the entirety of system level function between the input and output sides. It is then an information based system and there are implications resulting from this singular mode of operation.

The problem with information as an explanatory tool, as it exists in any system including the nervous system, is that it has at most only a few defining elements or dimensions, far too few to explain the varieties of experience. It has no attributes other than those that determine the information. Information can vary as to form or format, but as information it is a singular causal influence with no aspects other than those variations in the influence that generate the information. CNS information then cannot contain those aspects of experience or consciousness that are more than just information. Information cannot taste like chocolate; it cannot be bright, loud or feel warm. In the case of sensation, aspects of the external world are introduced into the nervous system by the

process of sensory transduction. The sense organs interact with the external world to generate information to be used by the CNS. This conversion to information means elimination of all things which do not determine the information itself. This is the problem we encounter when trying to explain how an information system like the brain can produce the qualitative elements of sensory experience.

An example may make this clearer. The retina in the eye generally contains three different kinds of color receptors, the red, blue and green sensitive cone cells. Each type of color receptor sends information concerning the level of activity generated by the light impinging on the retina to the brain via a common fiber tract, the optic nerve. The retina then tells the brain about the wavelengths of the light being received and perhaps other information that determines the color that will be ultimately recognized. This is all the brain "knows" or can know about the color of the light. More importantly, this signal is all the brain can have as a result of the ongoing color experience; there are no other aspects, properties or qualities of the current color visual situation which can be manifested internally. The color information generated by the retina and relayed by the optic nerve is all there is.

The brain then, operating only as an information system, cannot somehow generate the qualitative aspects of color vision. If there is anything more to seeing colors than receiving signals like those associated with all other sensory inputs, then internal brain states cannot account for it. Redness, greenness, all color experiences are lost once the stimuli is transduced and the information is sent to the brain. The brain can't generate the experience associated with seeing green with only the information about green light; there is nothing it can use to generate greenness because there are no internal processes that results in anything other than just more information which, as information, cannot be green. The brain only knows which fiber tracts are active and the level and patterns of activity in them; the same sort of information it has for any sensory experience. This is a fundamental problem generated by what we know about both brains and consciousness. Great differences in experience are reduced to variations in information input and processing because the brain is only an information system at the sensory or behavioral level.

The trick in seeing this and understanding an information based system like the CNS is to avoid the tendency to take a "look down" or external view that suggest that the system has more to work with than it really has or that it can do more than it actually can. From an external perspective, looking at the complete system and considering it in its entirety, we understand that a signal coming from the retina is in fact being generated in response to light hitting the retina. It is easy to imagine then that the brain has something more to work with than just the information relayed from the retina because we know what else is going on, the light is hitting the retina. Since we know that this should result in the sensation of seeing with all the qualitative aspects of vision, we might imagine that the brain will know this also and generate the appropriate sensory experience. But if we consider the situation from inside the brain, looking back from the higher brain centers like the visual cortex, we realize that all the brain has to work with is a signal whose only differentiating aspects are its anatomical origin and patterns in

the flow of action potentials. But these are the same differentiating features as those of all the other signals coming from all the other sensory organs. Even if the manner of information transmission is different for every sensory experience, all the brain has to work with for any stimulus is this common form of signaling involving line labeling and action potentials. This is a problem generated by the singular operating mode of the system. It would occur even if the brain used some other method to convey information. If the brain used frequency modulated signals on a carrier wave to transmit information then there would be nothing more than frequency modulation to work with and this again would have no aspects other than the encoded information the signal contains.

This problem then is not specific to either the type of hardware or the method of information conveyance. It doesn't really depend on any particular concept of information either. It is more primitive, it is a problem generated by a change in type. It has to do with the conversion from one form of causal influence to another. It is the problem of encoding. Things may be lost when causal influences are transformed. Everything is lost when causal influences are converted to information, everything, that is, except the information. Yet information in its single invariant form- as streams of action potentials- is all that CNS has to work with. So unless we can believe that variations in the transmission patterns and processing of a single operational variable can explain the full range of sensory experience we are forced to consider the possibility that not every aspect of consciousness is determined by brain activity

The CNS is remote from the action – the world external to the CNS- and constrained physically and functionally from getting any closer to it. The only input connections are through the sense organs and other transducers which convert various kinds of external influences into information; the only thing the internal nervous system can have, know, or experience, however way we might want to put it. Whatever we might imagine them capable of doing; our brains as neural systems are functionally constrained by what they are and what have to work with. But human beings are not just their brains; they are brains plus peripheral organs that feed information into their brains, a fact that is sometimes ignored when considering the problems of sensory consciousness.

2. The Central State Assumption

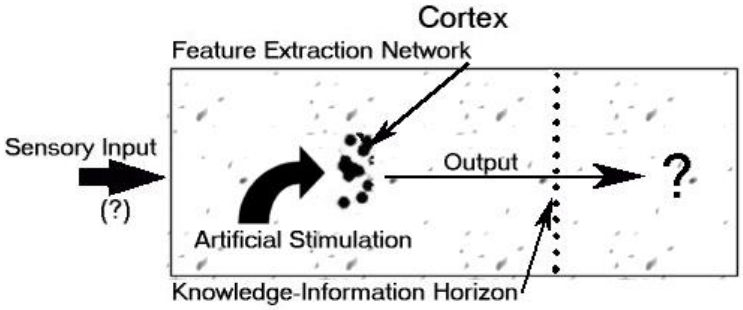
We can see then that the qualitative aspects experience, collectively generally known as qualia, may originate at a level lower than the CNS and might in fact be generated by the way that the nervous system works at the input level. But there is a tendency I believe to address the problems of consciousness, including those associated with the qualitative aspects of experience, with an emphasis on the importance of higher level function, especially cortical function. Searle for example asks: "How is it possible for physiological, objective, quantitatively describable neuron firings to cause qualitative, private subjective experience? How…does the *brain* get us over the hump from electrochemistry to feelings?" (Pg. 28 Italics added.) This approach tends to assume that sensation is a cortical phenomenon, or at very most a CNS phenomenon, and that the explication of higher level activity will somehow lead to solutions for the problems of consciousness. The idea that it's not really the brain but something else that is

producing “feelings” or qualitative experience seems to be rarely if ever considered.

Probably the most important reason we relate consciousness to CNS and cortical activity is the evidence produced by the investigation of abnormal function. We know that diseases and injuries which damage the cortex or CNS subsystems and fiber tracts can interfere with normal cognitive and sensory activities. The neurophysiology literature is full of reports on aphasia, agnosia, cortical blindness etc., many different problems associated with disruptions of normal cortical and CNS function resulting from either injury or disease. We also know that direct brain stimulation can lead to behavior of the type usually associated with sensory experience. Perhaps the most convincing sort of evidence for the importance of the cerebral cortex in consciousness is that like the “experiential response” to stimulation reported by Penfield and his colleagues as a result of direct electrical stimulation of the exposed cortex during brain surgery. Some of these cases involved situations in which “the stream of consciousness was flowing again as it once did in the past’, (Penfield/ Roberts, pg 45) i.e., extremely vivid memories, and Penfield even attributes a “double consciousness” (pg. 45) to some patients who seemed to be simultaneously aware of both past experiences and their current environment. In addition to memories of past events, Penfield was able to generate reports of simple sensory experiences, like tones and flashes of light, when the appropriate cortical areas were stimulated. (pp. 31-33) These, we might at least suspect, had qualitative aspects. It may have been the case that some of these experiential responses were at least in part caused by changes in the patient’s brains due to the disorders that Penfield was trying to correct surgically. Yet, even if abnormal, these observations suggest a relationship between cortical activity and at least some of the qualitative aspects of experience.

This sort of evidence seems to indicate that consciousness is a cortical process, and unquestionably the cortex is active in conscious experience. But is there any reason here to think that the cortex or the CNS is the only part of the nervous system involved in determining the content of consciousness or the qualitative aspects of sensory experience? If we look more closely at the implications of a theory of the brain as an information system, I think we can see that the answer is no. If we accept, if only hypothetically for now, that at least some elements of conscious experience have two components, information and qualitative properties, then CNS activity alone is not enough for all types of consciousness. Moreover, I will argue, these two different elements are separable and are separated in the body as a result of the transduction that occurs at the input level of the system, at the sensory organs. This, a fundamental fact about experience which the information side of the system hides from us precisely because it functions solely with information.

First of all, let us see what direct brain stimulation can really reveal about the role that the cortex plays in experience. Suppose that a patient undergoing direct cortical stimulation were to report seeing or hearing something which they think is caused by a real external stimulus. Let us analyze the situation by considering this model of a cortical region:



Here the left side of the box contains a cortical area normally involved in processing sensory input transmitted from a lower level like the thalamus. The output is going to another cortical area, perhaps a cortical association area. A network in the box is doing some sort of information processing like feature extraction, i.e., processing the incoming information to determine the distinguishing aspects of the stimulus. These are neural network operations and this cortical unit is so constructed either by genetics or previous learning experiences to process the incoming signal and to relay a “seen this” or “heard this” type of message to other areas of the brain at the output level of the network.

Now normally the output transmission would only occur as a result of the appropriate input on the sensory side. But if we directly stimulate the feature extraction network, the output could be produced without the normal sensory input. Those parts of the brain sensitive to only the output signal would know only that it is there, they wouldn’t know why. Thus any motor response area, for example, reacting to the output of this cortical region would not know and would have no way of determining whether or not the active network was generating the signal that was received as it normally does, i.e., as a result of an external stimulus or if instead the activity was artificially produced. Any dedicated motor unit, like the one for example concerned with naming the stimulus, is information determinant, i.e. all systems level function is determined solely by information input, and doesn’t know what else is happening or not happening in the rest of the system.

But every neuron or neural group is information determinant at every level of the system so each has a knowledge or information “horizon” defined by the functional architecture of the system. Neurons past the horizon can only know that the neurons below the horizon are active, they can’t know why. This means that in theory we could create the information content of an element of experience with the appropriate pattern of artificial activation at a higher level of the system and fool the system into thinking there was an external stimulus even if there wasn’t. We could dictate what the subject was experiencing, at least from the standpoint of information, with sufficiently advanced technology and an intimate knowledge of how the subject’s brain worked.[2] The question is then:

[2] There are great technical (and potentially ethical) problems here. It might require many microelectrodes in many different areas to generate a complicated artificial experience that was perceived as a real one. Would the subject notice for instance that the eye movements that usually accompany a visual experience were not there? Would we have to then fool the sensory motor cortex in addition to the visual cortex?

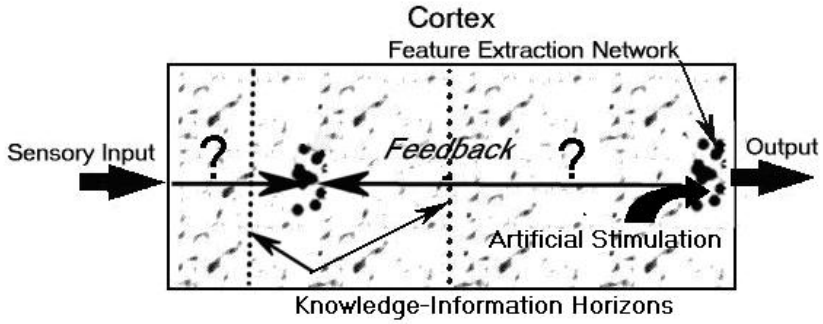
could we or would we create the qualitative aspects of experience normally associated with this information by this artificial activation of the cortex?

The subjects of an artificial stimulation might talk as if they were undergoing normal experiences, complete with qualia, but how would they know if they were? It seems as though we can make them think, talk or otherwise act as though their experiences are normal even if they are not. If we hit the right neurons with the electrical probes we can turn the test subjects into puppets and play puppeteer. We can make them say or do anything we want. Even their thoughts would be suspect if thinking you are having an experience is a cortical process and is different from just having the experience with the associated qualitative aspects. With the appropriate cortical stimulation we could make them think that they are having a real sensory experience even if they lack the qualitative components. Penfield may not actually have done this; in most cases the experiences produced were memories whose specific content was not under his initial control, although he could evidently reproduce a particular memory with repeated excitation of the same spot on the cortex. These recollections of past experiences apparently had some characteristics which marked them as memories to the subjects rather than as current experiences. Now, we may tend to think that memories have some of the aspects of the experiences that formed them, perhaps reduced levels of the qualitative components. This seems to suggest then that there are qualitative aspects associated with the CNS activity generated by direct stimulation and perhaps with recollections produced under normal circumstances as well.

What of the simple experiences produced by direct stimulation of the sensory areas of the cortex? Do these come with qualitative aspects or are they just information? These might seem to be even better evidence for cortical theories of experience. Subjects who say ”I see a blue light” or ”I hear a tone..” may certainly seem to believe that the phenomenal elements of color and sound are there, but they could be wrong. Now some might argue that this is absurd, that honest first person claims about our sensations cannot be wrong. But this idea ignores what we understand about the sequential information based processes that we know are going on in the sensory systems and brain. If the information provided to the CNS is identical to that produced by an external stimulus, then the brain has no way of determining whether or not the signaled experience is the same as that which occurs under normal circumstances i.e., if the qualitative elements are really there. [3] Thus, the issue of whether or not qualia are cortical phenomena cannot be resolved by considering the evidence from direct cortical stimulation or any other process that interferes with normal CNS function. It may just be that we are fooling the brain –and the patients- into believing they are having a normal experience complete with qualia when they are not.

This analysis utilizes a model that is far too simple of course. The figure below introduces another consideration that may be of interest here.

[3] This assumes of course that we can do the artificial stimulation right, which as the previous note suggests is likely to be extremely difficult. It might involve hitting many different spots in the right order and at the right time with the correct level of excitation.



Cortical systems generally involve feedback loops. These loops transmit information back from the higher levels to the lower levels. They might help explain some system operating modes that we may suspect exist. Cortically generated feedback even reaches the sensory level itself. (Brook/ Mandik pg. 392) It is thought that some of this retrograde activity helps control the sensitivity of the sense organs. It may also contribute to the systems requirement for automatic gain control (AGC). Some analysts of network properties think AGC is necessary " to prevent either uncontrollable oscillations (in neural network operations) or premature decay of the reverberating signal" (Deutsch, pg.91). But regardless of why the nervous system feeds back on itself, the fact that this activity reaches down to the sense organs suggest the possibility of a concomitant effect associated with cortical function, namely, activity in the sense organs that mimics in some fashion the activity normally produced by external stimuli. Let us also note here that the knowledge-information horizon probably exists in the backward direction as well. Neurons subject to retrograde activation but not sensitive to the normal stimulus will not know whether this influence is the result of the usual input to the higher level cells or something else, like a higher level artificial stimulation. No level of the system knows more than the information being inputted, it cannot determine why the information is present nor determine if the phenomena normally associated with it are really there.

If cortical or CNS systems can produce activity at the sensory level or influence it by selective retrograde inhibition, then it is tempting to think that we may have a mechanism here to explain any qualitative aspects of CNS initiated activity that we suspect exist. If we think we can dream in color or recollect more that just the informational aspects of past experiences, really relive them with some limited qualitative dimensions, then we might imagine that it is because the CNS can influence at least some of the sensory organs and covert random activity in these systems into something resembling normal sensory output via retrograde control. The problem here as we shall see is that true qualia require something more, an actual stimulus to activate the sense organ. The CNS then cannot generate real qualitative experience under any circumstances. Our impressions to the contrary may be the result of situations in which the brain receives a flow of sensory information without the appropriate stimuli that is similar to that generated by normal sense organ activity. The information then might be comparable even while the experience is radically different.

3. Science and the Problem of Consciousness

"To understand the mind and consciousness we are going to have to understand in detail how the brain works." (Searle, pg. 51)

Searle's contention here is probably representative of much of contemporary thought. Inasmuch as the mind involves cognitive processes or something more than conscious experience then claims like Searle's are true and more science would be useful. Understanding the brain in (greater) detail would involve scientific and/or mathematical progress in certain specific areas. To understand human thought and reasoning for instance we would need theories of cortical network operations which we currently do not have. But claims like this also involve the central state assumption, the notion that consciousness itself, or at least those elements of consciousness like sensory experiences are really cortical or CNS phenomena, a view we might now find problematic at least.

But even if the critique of the central state assumption developed previously is erroneous, how much more can science really help us in understanding consciousness? If we try to imagine what additional knowledge about the nervous system we are likely to develop, or even that which we could theoretically attain, and then ask what this new knowledge might reveal about the problems of consciousness; the results of the analysis might be less promising than is normally assumed. This is not the nineteenth or even early twentieth century when we were first starting to develop our understanding of the nervous system. Today we know the basics of how the nervous system works and to a certain extent, what it does; we just don't know how it does it. We lack experimental data and theories relating to systems level operations, specifically we don't understand how large numbers of neurons work together in neural networks to produce system functions.

We know something about what neural networks are doing, but we really know very little about how they are doing it. Cortical networks do feature extraction, recognition, and produce behavior, all under the control of sub-cortical systems concerned both with motivational influences and the overall level of reactivity or sensitivity of the system. They pick apart the external world, recognize what's out there according to the pieces if the stimulus is familiar and then occasionally generate some behavior. Sometimes they form new memories as a result of these activities. It is hard to imagine how discovering the information based processes that constitute these operations is going to explain the content of consciousness. Neurons are hardware that we understand fairly well, we know a lot about how they work. We also understand how small functionally interconnected groups of neurons work together, like those in the spinal cord for example. We just don't understand how large numbers of CNS neurons function together in a network. This is the major deficiency in our understanding of the brain as an operational information system.

Network theory is probably essential for many areas of psychology, but is there any reason to think that it would shed light on the problems of consciousness? Consider the kinds of questions we might like experimental neural network scientists to answer. Questions like: "What's going on in our

heads at a network level when we are having an experience?" "What's the difference in network operations between visual and auditory experience?" Suppose they came up with definitive answers to questions like these. Imagine network specialists doing experimental work on their own brains. Suppose they could discover and analyze the network operations associated with their own sensory states. Assume that they could even internally generate their own sensations while noting the associated network activity. They would then have direct evidence of correlations between sensory states and various sorts of network operations. But mastering networks means understanding them as information processing subsystems. This would not lead to explanations of why the experiences associated with sensory processes are as they are qualitatively. Why "sweet" and "yellow" are fundamentally different experiences cannot be explained at the level of network operation because their qualitative components are not determined by information which is what networks are about. These annalists are really then only in the same position as the patient undergoing cortical stimulation at the hands of a physician, it's just a different set of hands at the controls. Their knowledge is more direct and detailed, but it is the same type of knowledge with the same residual problems, like IMQDs. Yet this is the most that we can expect laboratory based network science to yield.

There are other possible approaches to understanding neural networks besides laboratory science. Today we have very sophisticated computer programs like COMSOL, ALGOR and others that do multi-science analysis of mechanical, electronic, chemical and biological systems. Essentially these programs do mathematics and we can imagine that in the future they will be adapted to study neurological systems using the appropriate mathematical models.[4] Simulations and analysis done by this sort of software will probably generate the largest part of our knowledge of network operations. But experience with this type of software does not suggest any ways in which it could be relevant to the issues considered here. We would have to interpret the results as somehow reflecting on our concerns here and it is difficult to conceive how sensory experience could somehow be explained by the pages of numbers that computer simulation or analysis produce. Mathematically based approaches to neurological systems might reveal all the quantitative or computational aspects of medical consciousness, issues like the level of alertness or sensitivity of the CNS, but it cannot tell us why there are qualitative differences in sensory experiences.

We might imagine, finally, that the explanation of conscious experience could involve the discovery of some sort of entirely new phenomenon. This analogous to the recent astronomical developments leading to the theorization about dark matter and dark energy. These newly postulated components of the

[4]. COMSOL (www.comsol.com) and ALGOR (www.algor.com) are not like the "artificial neural network" programs that are widely available on the web. They do things like FEA –finite element analysis- a process by which a system or component is divided into many small pieces –the elements – and the effects of an influence on the system are determined by itinerative mathematical analysis. Usually the influence is mechanical, thermal, electro-magnetic or a combination of these depending on the software and the problem. What I envision here is a simulation of a neural network that utilizes something like FEA and incorporates a model of a neuron or columnar unit and its connections to determine the function, operating characteristics and overall behavior of the network.

universe are required under current theory because the universe is expanding at an increasing rate and because there is not enough observable matter in the galaxies to keep them from flying apart. This analogy is flawed, however, precisely because the dark constituents of the universe are required under current theory as a result of new observations. Without an established theory-gravitation in this case- there would be no related requirement for dark matter and dark energy. What are the current deficiencies in scientific theory concerning brain function that requires the postulation or discovery of some new phenomena? Do we have any reason to believe that we can't explain how the brain works in terms of known science? Again, what we are really lacking now is knowledge about network operations, but networks are only functional arrangements of neurons and related nervous system components. Network theory is about how these things work together. But if we can connect millions or billions of transistors in individual computers or functionally integrated systems and understand what is going on without the discovery of something entirely new; why then should we think that we can't do the same with assemblages of biological units as well? Is it, for example, because semi-conductor physics is different from biochemistry? Both are ultimately determined by the same sort of physical principles. We have no reason to think then that current science is not adequate in principle to explain how the brain works.

Suppose, however, that we assume that something entirely new or maybe even dark energy or dark matter is involved in consciousness. We cannot rule out the possibility of new scientific discoveries. But unless these new discoveries falsify the neuron doctrine and the information system corollary we are left with the same old problem; explaining the diversity of experience with a small set of physical parameters and essentially trying to explain qualitative differences in terms of quantitative variations. Moreover, if we seek answers from science we must ask the kinds of questions that science can answer. It is not at all obvious that the sorts of questions about consciousness raised here are the type that allow for scientific answers. The problem, still, is that we lack criteria for determining what counts as an answer. What could possibly count as an explanation of IMQDs? How can we get beyond correlations and concomitant phenomena? Suggestions about these problems follow but let us simply note now that without the right questions we have no hope of scientific answers. Those who think that more science will somehow explain consciousness owe us an explanation in scientific terms of just what they are looking for or what they hope will be discovered. Thus far, science has only produced the problems. Without modern science we could believe in the theater of the mind, the ghost in the machine or what ever passed for an explanation of the mental before the discovery of the neuronal information system. It is not clear then that a scientific approach to anything more than just the medical aspects of consciousness exists at all. Perhaps then our problems here are not really scientific or factual as much as conceptual; maybe we tend to think about these issues in the wrong way.

4. Qualia

We have thus far more or less assumed that there was more to conscious experience than just the causal influence of information. Let us now try to prove this hypothesis. Any information system must be more than just information. The

system requires hardware to physically realize the information and to be able to do anything with it. The information system may or may not require software, that depends on what kind of system it is. But it must have hardware. It must also have other things if it is to do anything at all. It must have operational states. It will must also have processes, which we can view for our purposes here as a succession of operational states. If the system is sensitive to environmental influences and engaged somehow with something other than its own internal states, then some of these processes will occur on the input side of the system and will generate information for the system to utilize. Human beings then, as systems of this type, must and do in fact have these sorts of peripheral information producing processes. But then what are these processes from the standpoint of the system that has them; are they manifested to the system before they produce information, if so, then how? I suggest that as human beings we know them as the qualitative aspects of experience, or more accurately, as will be argued below, they are simply part of what we are at any given moment, things which are sometimes called qualia.

Let us note here that I am not suggesting that these peripheral processes produce qualia, I am saying that sense organ operations and similar transduction events are qualia. Qualia are not something over and above transduction processes. Qualia are processes because transduction events are processes; they are transient events without static or enduring components. While it may seem that a particular experience, seeing red or feeling warm for instance, is a simple event and not a complicated process, this is only because that without scientific insights we lack any understanding of the physical phenomena and sense organ operations that are involved in these experiences. Higher level system operations eliminate subtle variations and details; we may judge an experience to be simple and invariant even though science reveals that the processes that produce it are complicated and variable. (See for example Shepherd's description of vision, pg 348 ff.)

The operational states and processes of a given system, regardless of what type of system it is, are unique to and part of the system that has them. These transient events can not be exported or relocated. Let us call these things "proprietary" elements of the system. They exist only in the given system. It may be the case that there are other identical systems which can have exactly the same operational states as a given system, identical down to the smallest details that can be resolved; but these are still different states in these other systems, even if only because they are spatially distinct. Our sensory processes are proprietary like this; they are private in that no else can have them in the sense just outlined. This does not mean, however, that an external observer can not know anything about them. With suitable technology, say advanced fMRA, outside observers might be able to tell what we are experiencing, or at least be able to determine the information content of our current experiences. But determining the information in a system is not the same thing as being that system and having the operational states and processes of the system.

In particular, one important aspect of a sensory process, the conversion of external influences into information, is unavailable to outside observers who can only have information concerning or resulting from these processes. Those

elements of the system's operations that occur at the earliest stages of information production, the transduction or conversion processes that the system conducts at the interface with the external world are part of the operational states which external observers can know only indirectly by examining the results. And because these processes are integral to the system that has them, proprietary elements of the system which cannot be shared, transferred or externalized; these peripheral operations, here identified as qualia in the case of human beings, are not really something we have, they are something we are, or at least part of what we are at any particular moment.

Once the transduction process has occurred and a stimulus is reduced to neurological activity, those qualitative aspects of the stimulus which made it different from other stimuli of the same kind or from other types of stimuli are gone. This conversion into information involves a loss as we have seen. It is the loss of the differences we are trying to explain. We must therefore conclude that it is the interaction with the external world alone, before the contact event is reduced to information that is the qualitative component of the experience.

The structure of the sense organs makes the transduction possible and allows the experience to be knowable. They have to be configured to be information sensitive, i.e., variably responsive to a particular type of stimulus. Sound waves hitting the eye do not produce the experience of hearing as they do when they hit the ear not just because sound waves are different from light but because the eye and ear are different. Without the functional differences in sense organs the neurological system would lack the multiple interactive capabilities required to produce qualia or to generate information for the higher levels of the CNS.

The only level of a biological system where there are enough differences to explain IMQDs and the diversity of experience is the input level. At this level both stimuli and sense organ sensitivities are different in ways that suggest that this is where we must look to explain the variability of experience. Here, light, sound waves, chemicals etc. are actually present, things sufficiently different to explain why the experiences associated with them are different. But this, as we shall see, is only true if we include the external stimuli in the sensory process and realize that they are part of the system and of the system's operations. Once the conversion occurs- stimuli to neurological activity- we are left with only the neurological results, the information. So qualia exist and differ because of the way the world is, because there are different things in it to which we can be exposed and with which we can interact and because we have different sense organs structured to interact with these various aspects of the external world.

An additional consideration here: We are certainly said to be aware only because of what is going on in our brains. It is for the most part only through brain function that we can manifest any aspect of consciousness or awareness. Further, if knowing you are having an experience or realizing that you are aware of something is different from just having an experience, then individuals themselves must have brain function to realize or know that they are aware of anything. But none of this proves that qualia involve the cortex or even the CNS,

only that knowledge and behavior resulting from the information associated with the qualia involve more than just the sense organs.

Now with respect to our first question: Why is experience associated with information processing in the CNS? Why is there any such thing as consciousness at all? It now seems that consciousness, or at least sensory consciousness exists because there is more to our physical selves than just information processing; there are the events that produce information which are as different and variable as consciousness itself. There is, however, no explanation here of why blue looks the way it does or why any simple sensation is experienced as it is. These are questions with no answers; this is simply the way the world is. At best, all we can hope to explain here is why blue looks different from red, why seeing is different from hearing. The explanations seem obvious, blue and red involve different wave lengths of light and different patterns of receptor activity; light and sound are different physical phenomenon. One is tempted to say for this seeing-hearing difference that it is because eyes are eyes and ears are ears, the plain man's solution. But things are not quite this simple and we must look deeper into sensory processes to more fully understand conscious experience.

Additional insights are provided by Shepherd: "….each sensory modality is based on a superfamily of membrane signaling mechanisms which convert the stimulus energy into allosteric molecular change…" (pg. 232). And: " …recent work suggests that a basic set of operations, comprising detection, amplification, discrimination, and adaptation, applies across all sensory systems in transducing sensory stimuli. The precise neural mechanism for a given operation varies in the different receptor cells, but each basic step is essential in the sequence for transducing a local stimulus into a neural response in a single cell…." (pg. 233). In other words, the inner workings of the sensory processes are basically similar except for "the precise neural mechanism for a given operation …in the different receptor cells". This is the essential reason for regarding the stimulus as an integral element of the experience. Once we get beyond the transducing interface the sensory processes are very much alike except for some variations in the intermediary steps involved in producing information. So if think that qualia are determined by biological components alone we are left with a theory that says, for example, that seeing is different from hearing because allosteric changes in rhodopsin molecules of the eye are different from vibrations in the cilia in the ear and some of the other machinery involved is different as well.

While this might work for inter- modal qualitative differences, it does nothing to explain the many variations in the experiences within a modality since every experience within a given modality is determined by essentially the same processes using at most only a few different receptor- transducer elements and other limited biological variations. It also fails to explain the unity of experience, and why the world in not "pixilated" at the sensory level. Stimuli come in small discrete units like photons, molecules, or peaks and troughs in pressure waves. But they are not experienced with this level of resolution; the world is not resolved into its basic components in sensation. We might think that the brain produces the objects of perception by the integration of sensory data, but this

cannot be the case; the brain works only with information and the qualia of sensory objects are not made of information.[5]

Consider color vision for example. The information in color experiences is normally determined by three different types of cones cells, each type having a different sensitivity due to a specific light sensitive molecule in the cell. Everything past the transduction interface which uses these molecules is information production and processing. Since operations like color discrimination and recognition are internal processes involving information; they cannot produce the qualitative aspects of experience as we have seen and they cannot then produce composites of qualia, the phenomenal objects of visual experience either. While these information dependant activities can use the interactions between cone cells and subsequent biological and information based processes to distinguish between colors, the large number of color qualia can not be explained in terms of the limited number of these information related operations. Processes like these then cannot produce the objects of visual experience either. So without higher level information related activity, if we restrict ourselves to biology, we are left with only the variations within individual cone cells, the differences in the color sensitive molecules alone, to explain color qualia and colored perceptual objects. These would then have to be created at the transduction level using one of only three color detector molecules if think qualia involve only the biological system and exclude all information related activities. Our color experiences then would consist of only three colors, perhaps with variations of intensity, not of hundreds or thousands of different colors and a potentially infinite number of different colored objects. Even if we extend a "biology only –no stimulus component " theory past transduction to include the entirety of the process before the existence of action potentials we are still left with the problem of a very limited number of biological variables and many different color experiences. The stimulus then must be part of the experience; it is required to explain the variability of sensation and the existence of perceptual objects. As to why qualia are integrated into perceptual objects, there are perhaps no explanations beyond those involving the spatial or temporal continuity of the stimuli themselves, we only know that is not due to the internal operations of the nervous system.

Qualia then are neither cortical nor CNS phenomena and they are only partly biological. The personal component of qualitative experience is not in our brains or even in the depths of our sensory organs but even further out at the interface level where we come into reactive contact with the external world. This idea maybe hard to accept, it may tempt us to think that there is something more going on. The theory outlined here suggests that components of experience exist before they produce CNS or even neurological activity. This might lead us to think that there really must be a non-physical mind which is somehow responsible for the apprehension of qualia or even a "ghost in the machine" that has experiences and perhaps even produces behavior while the brain processes information.

---

[5] Higher level recognition units, the "grandmother" cells that recognize faces or other complex stimuli are activated by information in stimuli – they only integrate information streams- and thus cannot generate internally realized sensory objects. If there are no qualia inside our heads then there can be no qualia dependant phenomenon in them either.

The problem boils down to this: The theory presented here suggests that the sensing mind is not entirely in the brain because the qualitative aspects of experience are not in the brain. The mental is not even entirely in the biological system if elements of the external world are part of our experiences. The mental here is not merely reduced to the neurological; the reduction goes even further, down to the level of physical interactions and biomechanical and biochemical processes. There is an integration of the sensing self with the external world at the level of experience. The proposed theory then combines some aspects of the mental with the material world in a manner that is unique. It becomes more difficult to decouple the self from the external world and claim that mind is more than matter with this level of integration. The physical becomes the mental here in a new way, not just at the process level but at the component level as well if stimuli are part of experience. Before if we claimed that mental states were brain states we were really relating complicated and largely unknown processes; now we are incorporating some of the simple components of these processes – the stimuli- in the relationship. Light, sound and chemicals are physical entities and it is difficult to see then how events involving these things, mental processes in which they are an integral part are not also physical phenomenon. It thus becomes far more difficult to maintain that there are any real differences; much less any ontological distinctions, between mind and body or the mental and material if the material is a part of the mental in the case of sensory experience.

Simply put, the view presented is this: At least with respect to sensory experience; I am not in my body; I am my body and its processes as well as various elements of the “external world” i.e., the world external to the CNS. This is a view is supported by the lessons from abnormal neurophysiology as well and which can be extended to include other aspects of the mental by applying them further. The many types of disruption of normal function associated with neurological irregularities tells us that we are only biological systems, and from the standpoint of sensory experience, only neural information systems with transduction hardware on the periphery. It now seems as though every aspect or function of our sensory lives and even more, of our mental lives, can be affected by altering biology, whether by drugs, disease, medical intervention or trauma. If every system function, operating mode or capacity is explicable in terms of biological hardware and its operations, which is what the progress in science suggests, then there is no basis for attributing anything more to the system than it is known to have; the biological hardware and processes we know exist.

These considerations reflect on more than just the notion of an apprehending mind which is somehow something other than the body. The notion of a causal ghost in the machine, a non- physical entity that somehow knows how the biological system works and is capable of interacting with it, is even more suspect. If the brain is not involved in the qualitative aspects of experience, if qualia are peripheral processes incorporating physical stimuli, then it is hard to see what the ghost is suppose to be doing at the experiential level, or where it is suppose to be doing it. Moreover, if the brain is really able to function as an information system capable of sensory processing and generating behavior –if it really works- then the interactive immaterial mind is not needed on the operational level either.

Perhaps some of the supposed problems of mind arise because we essentially assume that we can reasonably claim that sensation as we experience it is nothing like what we might imagine it should be given our understanding of the physical processes that generate it. But this judgment is based on an erroneous comparison, one that conflates being something with knowing something. Being these processes and knowing them or understanding them intellectually are two different things. It is the difference between being in pain and understanding the physiology of pain. Our knowledge of the processes of sensory experience is not the same sort of thing as the sensory experiences themselves. Personal knowledge is a mostly mnemonic cortical or CNS phenomenon; qualitative experiences are peripheral processes and CNS activity. Consider a different sort of question here: If it seems as though being the sensory processes we are is not like sensory consciousness, then what is it like? What should experience be like given what we are? Perhaps someday human beings will acquire solid state brains and electronic eyes and be able to make a before and after comparison or note the changes. But until then we have no way to answer the question of why experience is as it is or how it could be different given only the hardware and processes we currently have. But more likely, questions like these will always prove to be unanswerable.

Suppose we had a subject with one normal retina and one electronic retina. Imagine further that through some miracles of nano-technology and biomedical engineering the artificial retina produced the same signal for the brain as the biological one with any given visual stimulus. Under the theory presented here the subject would have no way of directly telling the two eyes apart because they both provide the same information for the brain, even though the qualia associated with each retina would have to be different because the transduction processes would be different. One would utilize solid state electronics like a charge coupled device while the other would use the normal biological equipment. Now it might be argued that this is the definitive disproof of our conjecture concerning qualia; that qualia must be produced internally because gross changes at the periphery make no discernable differences in them. But not being able to notice a difference does not mean that there is no difference. The assumption underlying this critique, that the qualia generated by each eye are in fact identical because the subject cannot detect any differences between them, is not confirmable if the information produced by the two different eyes is the same. Neural level information, action potentials, generate the CNS activity that determines thought and behavior not qualia. In fact there is no way to determine if the subject's qualia are the same with the new retina. We would have to conclude that they are not, based on the theory presented, but the issue lacks even the possibility of empirical resolution. It is essentially a metaphysical judgment of a new kind; one that concerns proprietary states in an information system. We have encountered here a fundamental epistemic limitation generated by the nature of interactive information systems.

Let us consider this thought experiment a little longer. The real lesson here is that any information system's self knowledge or ability to understand or explain itself is limited by the nature of the system's operations. Moreover it is limited by the mere fact of the existence of these operations, these sequential

processes, if there is no way around them. The lesson is that cognitive behavior is system output which is internally generated and information based (as near as we can imagine now) and that any alteration in the system which does not change information is undetectable or unrecognizable to the system. Transduction by itself produces qualitative experience, not knowledge, and can be known only through the information processes it initiates. Attempts to answer some questions that systems like human beings might ponder including why their transduction processes are experienced as they are or why sensory processes produce integrated experiences are ultimately limited by this fact. We must now view sensation as a process with two components: qualia and information. Since qualia are not part of the information stream that determines CNS operations, they can not be fully explained by cognitive information based processes. We might allow – as many will probably insist- that they can be described (through the information associated with them) but basically they can only be experienced.

We have outlined a theory of a sensory consciousness by variation here, a consciousness of qualia. The variability of experience seems to be the essential element, the *sine qua non* of sensory consciousness. It is difficult to imagine what any consciousness would be like without variable content. But still a question suggests itself here: Is there any such thing as pure consciousness, devoid of qualia, associated, somehow, with brain activity that doesn't ultimately involve transduction events and their variability? Is there an experience of pure consciousness and does it have anything like a qualitative element? Does consciousness always involve qualia, or perhaps more exactly, does it necessarily involve variable qualia? Searle, for example, thinks that the problem of qualia "… is the problem of consciousness…" (Searle 1997, pgs. 28-29) but this view just begs the question. An important issue here is whether or not we would have to be able to exhibit evidence of any qualia free consciousness in volitional behavior. Can we have an element or "kind" of consciousness that does not produce the activity required for specific motor behavior, i.e., a consciousness that does not produce the internal information required to determine behavior? If so, then how can we know we have it?

Do we have a general sort of non- specific consciousness analogous perhaps to the on/off state of an electronic system? Our thoughts, recollections, hallucinations, all the elements of consciousness that are decoupled from immediate experience may in fact involve the sense organs via retrograde activity in the CNS as was previously suggested. These experiences then may not be very different from those produced by sensory activity originating from external sources except for the lack of the external stimuli. But this tells us nothing about the possibility of a pure consciousness without variable qualia or any specific content at all.

Finally, let us admit here that the theory outlined above would seem to result in many paradoxes, especially under certain abnormal conditions. First of all, we have concluded that qualia are epistemically irrelevant; they do not produce knowledge which is dependant on the information component of sensory experience alone. Thus many sorts of information systems could conceivably have the same knowledge that biological systems possess even if they lacked a transducing interface. These would only need the information basis for the

knowledge; they would not require qualitative experience. We also seem to be attributing sensory consciousness to inanimate objects like cell phone cameras for example. An electronic camera involves both transduction events and information production. The reasons we resist saying that the camera is conscious are undoubtedly complicated and cannot be explored here, but essentially it is probably because the camera cannot exhibit the kinds of complex behavioral patterns we associate with consciousness. But even biological systems with complicated behavior produce conceptual difficulties. If the sense organs are functionally separated from the CNS, if all the nerves serving the eyes are severed for example, then we have qualia without the awareness of qualia. The retina will function, probably poorly, but the subject will have no awareness or knowledge of this function. So if we think we can't have the qualitative aspects of experience without even the possibility of being aware of them, we are simply wrong. Defining qualia in terms of awareness is erroneous, the result of the impressions of those with normal physiology who have ignored the process accounts of sensation. Having qualia is one thing, being aware of them, i.e., being able to respond to the information associated with them is another. Our thoughts or actions based on the information normally accompanying qualia are dependent on CNS activity which cannot happen unless that information is there. If this still seems problematic it is because we fail to recognize that sensory experiences are complicated processes and not simple events as a matter of fact if not intuition.

Robert Eichler

ts@e-z.net

REFERENCES/ BIBLIOGRAPHY:

1. "Blindsight": http://everything2/blindsight

2. Brook, Andrew ; Mandik,Pete (2004) "The Philosophy and Neuroscience Movement" *Analyse & Kritik* ***26*** pp. 382–397

3. Deutsch, Sid (1967), *Models of the Nervous System*, (New York: John Wiley and Sons)

4, Geschwind, Norman (1965) "Disconnexion (sic) Syndromes in Animals and Man" *Brain*, **88.**

5, Geschwind, Norman (April.1972) "Language and the Brain" *Scientific American.*

6. Geschwind, Norman (1979) "Specialization in the Human Brain" *Scientific American*, **241**, number 3,

7. Libet, B., Gleason, C. A., Wright, E. W., and Pearl, D. K. (1983). “Time of conscious intention to act in relation to onset of cerebral activity (readiness-potential). The unconscious initiation of a freely voluntary act.” *Brain*, **106**:623-642.

8. Penfield, Wilder; Roberts, Lamar (1966), *Speech and Brain-Mechanisms*, (New York: Atheneum)

9. Searle, John (1997), *The Mystery of Consciousness*, (New York: A New York Review Book).

10. Shepherd, Gordon (1994), *Neurobiology* (New York: Oxford University Press).