Reframing the Consciousness Discussion

Michael J. Young

Introduction

What is consciousness? Many researchers say it is very hard to define. I believe that is because the phenomenon of consciousness is not well understood. The definition I prefer comes from Nagel (1974): "an organism has conscious mental states if and only if there is something that it is like to be that organism-something it is like for the organism". A comparable definition comes from Pierce (1989, 1935): "there is a distinctive *quale* to every combination of sensations. |There is a distinctive *quale* to every work of art| a distinctive *quale* to this moment as it is to me |a peculiar *quale* to every day and ever week |a peculiar *quale* to my whole personal consciousness. I appeal to your introspection to bear me out." Consciousness is subjective experience. Both quotations seem to suggest that only living creatures, or perhaps only humans, are conscious. In this essay, we are going to extend that definition to all matter. In doing so we will explore the idea that there might be consciousness without any subject to be aware of it.

The key to this discussion is being very clear on what certain terms mean within this discussion, so we start with some definitions. Consciousness is described above; below we will further refine the definition by describing factors that determine what you can be conscious of. Consciousness is different from being conscious. When you are conscious, you are awake in our world. When you are not conscious, you might be asleep, knocked out, or in a coma. You are not participating in shared reality, although you might experience consciousness of another reality, as when you are asleep but lucid dreaming, where you are cognizant of and experiencing a dream world.

The term we need to be the clearest on is awareness. In normal usage, awareness is the state of being aware. When you possess awareness of an issue, you are aware of the key information that defines that issue. Further, the term awareness is normally associated with an actor: there is someone who is aware. For the purpose of this discussion, we are going to remove the idea that there must be someone who is aware. We are going to use the term awareness in its noun form. Awareness is stuff. More specifically, awareness is a property of matter similar to spin or charge. All matter possesses it. When we refer to the state of basic matter, we will designate it as *awareness*.

The presence of awareness does not mean that a mind is present. Basic or fundamental matter is not alive, does not have feelings or emotions, and does not have sensory or effector (e.g., motor) systems. It is just basic matter. To have emotions or the ability to see, or to move about, or to think requires additional levels of complexity in the way matter is bound or aggregated together. Further, it probably requires the system or entity in question to be alive. Correspondingly we will refer to entities that have cognitive and motor capacities as *organisms*. The defining characteristics of an organism are that it has structure, or organization, and uses metabolic processes to maintain its structure.

When we refer to the subjective experience of organisms, we will designate it as *consciousness*. The subjective state of consciousness that is experienced is a concept: It is internally represented knowledge that may form the basis for action. Plants and animals both possess varieties of consciousness. The presence of consciousness does not necessarily mean a mind (or an actor) is present. We reserve the term *mind* for the subset of organisms known as animals.

The stance we are taking fundamentally reframes the discussion of consciousness. Instead of the main focus being on what exactly is consciousness, where does it come from, and how does it manifest in the brain, the key questions become how does consciousness/awareness manifest in different things (primarily living versus non-living things) and what role did consciousness play in the evolutionary process that enabled the proliferation of organisms?

Matter, Flora, Fauna

Consider figure 1. When you look at the world there seems to be three broad categories of things: Matter, which is not alive, and is probably best characterized by the knowledge of the periodic table (at least at the level of elements). Flora, which are alive, and are probably best characterized physically by chemistry and biology. And fauna, which are also alive, and probably best characterized physically by biology and neuroscience. Are there other ways to characterize them as well?

If all three are truly consciousness as we propose, then could one look at them from the perspective of what states of consciousness can they assume? Our proposal is that every physical change of state in matter is a change of awareness (or consciousness). Starting with matter, which for the purpose of this discussion will be elements of the periodic table, and for which we will use the term awareness (to minimize anthropomorphizing), there is a fundamental state of awareness for each element. Heating or cooling the element, and interactions with other physical forces (e.g., gravity), can modify this state. Therefore, for an element there is probably a multi-dimensional continuum it can experience, based upon the physical factors in the surrounding environment.

Further, when an element combines with another and forms a compound, we believe that the awareness aspects of the elements merge. It is not clear how this happens, but we suspect it has to do with sharing material elements. For example, it

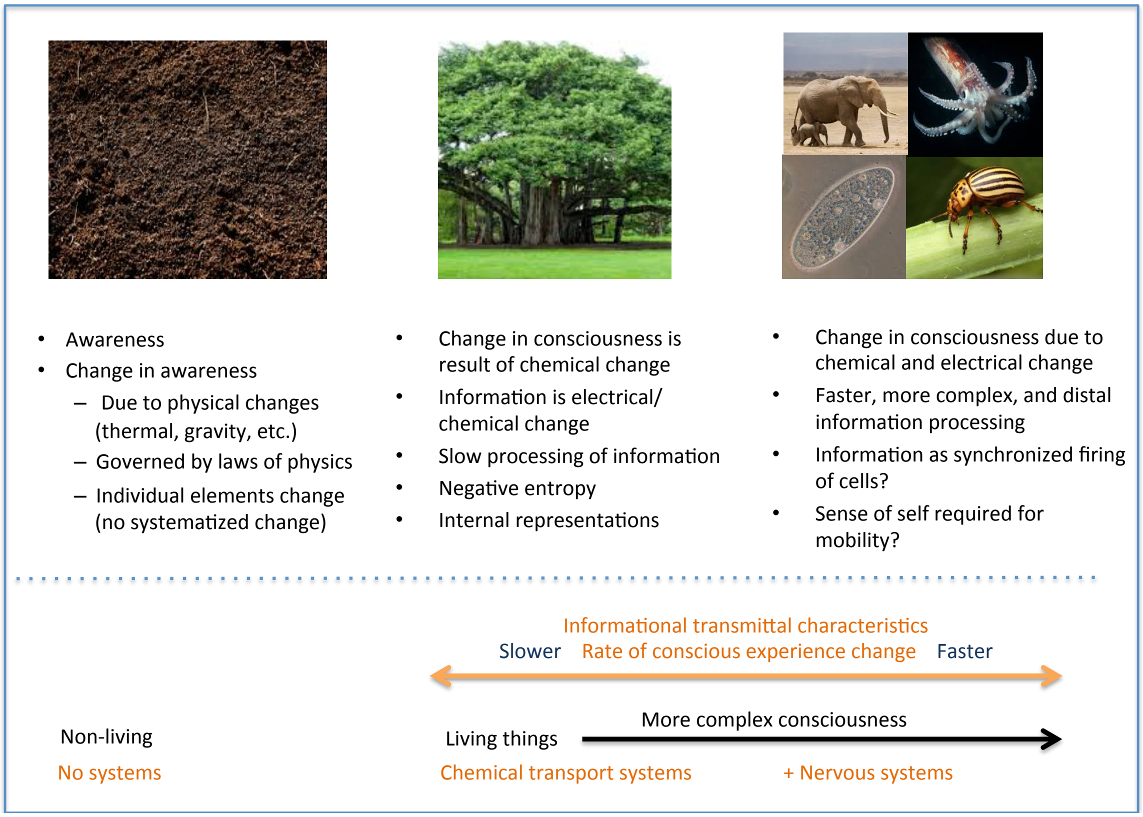

Figure 1 Matter, Flora, and Fauna

could result from the sharing of electrons when the compound is formed. Alternatively, it could also result from sharing quarks, or aligning spins of atoms, or other factors we are unaware of. Understanding this integrating process is a major research challenge for this framework.

Plants

Next is the world of flora or plants. There is a significant difference between basic matter and plants: Plants are alive. While there is no agreed upon definition of life there are a set of "generally" agreed upon principles for characterizing it (Boden, 2000; Boden, 2001). These principles include: self-organization, emergence, autonomy, growth, development, reproduction, adaptation, responsiveness, evolution, and metabolism. Of these terms, two are critical to this discussion: self-organization and metabolism. As described by Boden (2001), self-organization is a process that creates organization and structure out of a state that is less ordered by means of autonomous development. Essentially, self-organization is "negative entropy" through which an organism creates a complex structure and then maintains that complexity for a period of time (normally as long as it is alive). This "negative entropy" is carried out by metabolic processes that extract energy from the environment and use it (to include budgeting its use) for construction and maintenance of a physical body, and accomplishing behavior. (Boden, 1999)

When discussing the world of plants, there are several issues to discuss. First, the storing and use of energy by plants seems to be the start of extracting and storing (representing) information for use by the organism. This information allows the organism to sense and respond (Ferris, 2010) to its environment by taking advantage of factors such as the availability of water and sunlight. The manipulation of information is primarily accomplished through local electrical/chemical changes that produce modifications to internal structures (i.e., proteins and larger structures). The computational processes of plants are not complex. They are more of the order of a group of functions or circuits that activate when certain conditions are met. Even though the computations are not complicated, the behavior produced can be quite sophisticated as when a plant "recognizes siblings" and responds differently to them than to other plant shoots (Milius, 2007). The use of information is a major evolutionary step forward in terms of flexibility and adaptability: Plant activities can be instigated and controlled by internal changes to the plant and not solely by external changes in its environment.

Second, it is also the start of a distinct world of meaning where the most useful information we need to understand the plant's behavior is not necessarily chemical in nature, but functional. That is, you can talk about plant changes in chemical and electrical terms, but it is also possible to describe these changes in functional terms (e.g., the plant is orienting towards the light, or adjusting its leaves to maximize water intake, or absorbing extra energy to use when sunlight is unavailable). This distinction is similar the distinction ethologists make between physiological approaches to study behavior and the whole animal method (Manning & Dawkins, 1992). Physiological approaches study chemical changes, whereas the whole animal approach looks at the functional significance of behavior. As discussed by Manning and Dawkins (1992), variations at the physiological level, particularly different cells within a cluster firing from one time to the next, still normally produce the same functional behavior at the whole animal level. Therefore, if you want to study behavior, you need to combine similar behavior together regardless of which specific cells fired and produced it (as long as the cells are from the same cluster or same type). Conversely, if you want to study the role of cell clusters in triggering behavior you probably want to study which specific cells fired and when. The two approaches combined usually produce the greatest understanding of behavior.

Third, because plants store and dynamically manipulate information, we describe their states of being as states of consciousness (as opposed to awareness). The interaction between plants and the environment creates a world of meaning for the plant. The electrical/chemical changes on the physiological level of description constitute evidence of the information being extracted from the environment; and also correspond to the activation of *concepts* such as "orient towards the light" on the functional level. Concepts are aggregate cellular actions that capture information and produce a coherent behavioral response. Concepts embody a form of intentionality for plants (and animals; see below), in the sense that they define coherent behavior that tends towards an action or outcome. It is important to stress, however, that even though the plant displays or possess intentionality via the concepts it can represent, it does not have a sense of I, as in "I need to do this…". Finally, it should be noted that the "concepts" activated in the plant are probably quite different from the concepts activated by someone observing it. The plant is responding to environmental conditions, the observer is inferring intent and significance of the plant's behavior.

Fourth, plant components are considerably more complex, from a physical perspective, than elementary matter. Organisms that use metabolic processes, such as plants, normally create many complex configurations of matter to include DNA, proteins, cellular components (cell wall, amyloplast, ribosomes, etc.) and larger structures (leaves, cotyledon, roots, etc.). This complexity of matter enables them to respond in more ways and in more complex ways to the absorption of energy; more complicated reaction chains can be set off. Consequently, plants can experience significantly more states of consciousness than elementary matter. There are more possible configurations of matter in a plant, which means there are more potential states of consciousness that they can experience.

Fifth, once again, each separate configuration of matter is a separate state of consciousness. What is not yet clear with respect to plants is "what is a separate configuration of matter". As we mentioned above, we suggest that when two pieces of elementary matter combine through sharing some material substance that the awarenesses merge together. We suggest that this principle holds as the combined matter becomes more sophisticated. With respect to plants, as matter becomes organized structures such as proteins and ribosomes, and then leaves and roots (on a higher level) we postulate that each structure has awareness, which, in turn, gets merged with other higher level structures with which it is combined so that there is only one consciousness per plant.

Finally, when does a plant's consciousness change? We believe that changes percolate up from smaller structures to larger, in a manner that mimics the way an action potential occurs: Neurons are constantly receiving signals to fire from many sources. However, for an action potential to occur, it has to receive a certain number of signals within a given time period to fire (because the stored potential to fire is constantly decaying). Analogously for plants, a particular change at a lower level might or might not be sufficient to produce changes at the next level. If a change at a lower level produces some type of "behavioral change" at a higher level, then the consciousness has changed at that higher level. What counts as a behavioral change depends on the structures involved. For a protein, it might be a change in configuration (e.g., folding in some fashion). For higher structures it could be the rotation of a leaf, for example. Finally, all lower level changes may not make an impact at a higher level; they might just die out without producing a change in consciousness. We believe that plants experience an integrated consciousness that only changes slowly, but again this awaits a better understanding of how the integration of consciousness occurs in living things.

Animals

The last group in figure one is the animals. What separates the fauna from the flora? There appear to be two separate classes of things specific to animals: the need for new kinds of *information*, and new types of neuronal *hardware* to generate information.

The crucial difference between plants and animals is that animals move about. Animals can change their environments. Consequentially, mobile organisms have much greater needs for information, and opportunities to use information than organisms that do not move. Mobility created a huge opening for new classes of information-processing abilities such as the creation of advanced sensory, perceptual, cognitive, and motor systems, which provide information that can potentially be used by the organism to enhance fitness.

Possibly the most critical piece of information that came to the fore with the advent of mobile organisms was a sense of I, or I-ness. We believe that the sense of I-ness developed from the ability of the organism to move about, the need to integrate information from different motor and sensory systems, and the opportunity to learn from experience. For a mobile organism, knowing where your physical boundaries are would seem to be a critical piece of information. You would also want to know if you could fit in somewhere, before you tried to enter a place, and it would be very advantageous if you could remember previous attempts to perform some action, or recall information you acquired about an environment from an earlier visit.

Many people seem to think about evolution solely from a physical perspective. A new physical thing is created (e.g., tougher skin) through a random mutation of a gene and if it (the tougher skin) enhances fitness, then the gene will spread within the population. When dealing with animals, however, one also has to consider the role and value of information. Animals need to know if an environment has food. They would also benefit from an ability to compare environments on select dimensions, and have a definite need to be able to identify predators, etc. Obtaining this type of information requires sophisticated information processing. It requires sensors that can acquire information about the world, internal mechanisms that can store the collected information, and a computational architecture that can integrate and process this information in a manner that enhances fitness.

Evolutionary processes responded to this need for knowledge by creating new methods for receiving, storing, manipulating, and using information. At the core of this expansion of sensory, perceptual, and cognitive abilities was the development of specialized cells and networks of cells for processing information. Whereas plants primarily use chemical changes to manipulate information, animals use chemical and electrical changes, and electrical transmission over significant distances within the organism to manipulate information (Ferris, 2010). In addition, a second major difference between plants and animals is that animals have a central nervous system, to include large brains in higher animals. Comparing plants to animals, plants can be described as a collection of functions that run when a situation (usually chemical) activates them; and there is minimal, if any, central control. Conversely animals have a nervous system that is similar to a modern computer. It is fast, has several types of memory, and integrates data from across the enterprise.

The evolution of the nervous system from a whole animal perspective enabled the development of many new types of information functions such as kin recognition, social skills for living in groups, and advanced and diverse auditory, perceptual, and kinesthetic systems; all of which enhance fitness. Further, we suggest that as organisms were developing whole new information capabilities, the I-function was expanding as well, primarily driven by the need to adjudicate among competing requests for sensory, motor, and cognitive system control.

Animals live in a substantially expanded world of meaning; there are many new behaviors they perform (compared to plants). Primarily because they are mobile, they have a greatly expanded behavioral repertoire that enables them to explore new environments. One can study them from either a physiological or whole animal perspective, and combining both approaches is still usually the best choice. However, due to the complexity of animals' behavior and our assumption that they are somewhat like us, there is an increased risk of anthropomorphizing, where we project our goals and motivations onto the animal. Since we can never be in the exact same physical/conscious state as another thing, we can never know what exactly their experience is. We are forced to make educated guesses and must be careful to try to validate projected motivations and behavioral goals the best we can.

It is highly likely that an additional level of system description is needed when studying animals. Because of the complexity of the nervous system and the difficulty of trying to relate the activity of individual cells to behavior, we may need to develop a method to characterize animals in terms of *information usage*. The nervous system is always active (as long as the animal is alive) representing information about both the state of the world and internal states. Can these states be characterized both physiologically and functionally at an informational level of description? Can we identify concepts such as hunger, playfulness, and arousal as distinct internal physiological states? Can we identify specific aspects of the external world the animal is representing? Can we identify algorithms that determine what behavior will manifest in a specific situation?

An alternative way to think about this is, did specialized methods for processing information evolve in animals, and if they did can we characterize them? As an example, consider synchronized firing of cells. A cell can represent one bit of information (e.g., firing or not firing). A group of cells working together, however, can represent and transmit much more diverse information. For example, some or all of the cells can fire and the firing rate can also be modulated. From an evolutionary fitness perspective, consider simple movement. Cells firing in synchrony would activate more motor cells, simultaneously, increasing thrust and speed of movement.

Synchronized firing of cells is ubiquitous in the nervous system. Cross sensory modality synchronized firing, for instance, has been proposed as being the physical implementation of consciousness (Singer, 2001). That is, your subjective experience appears to integrate information from multiple senses through the synchronized firing of cells across modalities (Engel & Singer, 2001). Further, as you attend to different stimuli, the groups of cells that are firing in synchrony changes, thus providing a possible mechanism for shifts in attention (Niebur, et.al., 2002). Synchronized firing also seems to be the basis of working memory (Engel & Singer, 2001). Distinct groups of cells firing in synchrony, but temporarily out of synch with each other, seem to represent separate items in memory. Finally, synchronized firing of brain cells occurs at different frequencies (e.g., alpha, gamma, and theta) suggesting that different rates of firing may have different functional purposes within the nervous system.

Synchronized firing is just one example of a novel information process, somewhat like a dynamic register in a computer, that could potentially be used to enhance the representation of information and decision-making. The larger question is, are there other information processes like it, and could such elements be mapped to specific conscious states enabling the creation of an information level of description? That is, the information elements, evidenced by synchronized firing of brain cells in diverse regions of the brain, are the concepts that the organism is using to make decisions. If it were possible to map these physiological level elements (i.e., synchronized firing) to specific environmental features and internal states, it might enable the creation of a conceptual framework for characterizing minds in terms of the concepts used to control behavior.

With their complex nervous systems and their higher metabolic rates it is highly likely that animals consist of more complex, or aggregated matter than plants (i.e., more complex proteins, more sophisticated structure such as muscles, and sensory systems). Consequently, there are more states of consciousness that they can assume or be in. Further, the use of electrical signaling combined with methods like synchronized firing enables animals to change from one state of consciousness to another much more quickly than plants.

Recall our earlier proposition that when two pieces of elementary matter combine through sharing some material substance that the awarenesses (or consciousnesses) merge together. We also believe that this principle holds as the combined matter becomes more sophisticated and combines to create living structures. However, in contrast to plants, we think animals might consist of more than one center of consciousness. This is suggested by research that argues that there are two distinct types of information processing in the brain, and that one of these “systems” normally processes several streams of information in parallel (Evans & Stanovich, 2013). This means that what we think of as the ego, or just ourselves (i.e., the I-ness) might be only one of a few active streams of information processing that are occurring simultaneously.

A second reason for suspecting that there may be multiple threads of consciousness in some animals is likewise based upon the potential role of synchronized firing of cell assemblies. As described above, scientists hypothesize that synchronized firing may be associated with consciousness. It represents functional (and physical) elements that are temporally bound together as a qualia (a piece of subjective awareness). In primates’ brains, there are multiple brain waves (representing multiple synchronized firing of cell assemblies) occurring simultaneously and continuously. These waves are constantly shifting, just like our conscious experience, which makes them a candidate as a marker for consciousness. However, additional research is needed to determine their exact function and their role in subjective awareness.

What is Mind?

There is a tendency among humans to reify (i.e., make it concrete) and anthropomorphize (i.e., make it human like) the causes of things that change. For example, the weather and seasons change, so our ancient ancestors believed there must be a god, or gods, who make these changes. Similarly, the thought content of our awareness changes so we believe there must be a thinking mind. But what if thoughts are actually just changing configurations of matter in a brain? Do we really need to reify this process and call it a mind?

Within contemporary thought, mind appears to be a colloquialism. A dictionary definition identifies mind as the process that reasons, thinks, feels, and wills. That definition is true enough, but it does not really explain anything. It is a short hand way of acknowledging that our thoughts, goals, and interests are constantly changing. The main problem with the term mind, from our perspective, is that it encourages you to think that there is *someone* who is thinking. What if there isn’t? What if there are only changing states of matter?

We do believe the term mind can be rehabilitated, and become useful with further definition or clarification. We believe that animals have minds, whereas plants do not. The key difference is that animals have a sense of I-ness, whereas plants do not. The sense of I can be considered a nexus of cells that integrates information and adjudicates between competing goals. Mind, in this account, is not the whole brain, but a process supported by select brain hardware. If you give this integration process a name, it can be called mind. Once again, we believe this nexus came into existence with mobility. Plants do not move, so there was no necessity for a sense of I (or minds) to develop among plants.

Mobile animals, however, need to be able to explore and remember information for varying lengths of time. This remembering and comparing is probably one of the core functions of the I nexus (and a big contributor to fitness). Other major functions include categorization of information (i.e., identifying what is what, and whether it is friendly, hostile, or good to eat) and information integration (i.e., making sure the different sense modalities agree about what is present in the environment; and "choosing" a an understanding if they do not.).

Ideally, collectively we will develop a framework for characterizing intelligent systems (especially animals) that is somewhere between the whole animal and physiological methods currently in use. Currently, the whole animal approach is a level of analysis that is too aggregated. One is forced to guess what is going on in an animal's mind (i.e., what motivates it) when it is engaged in some behavior, and frequently this results in anthropomorphizing (projecting our motivation on to it). Further, the physiological approach is not aggregated enough. One is forced to guess how the behavior of individual cells relates to the behavior of the whole animal. Preferably, the new methods would be Janus faced (having two faces, one on each side) (Koestler, 1979) where one face describes the biology and the other the psychology and they are brought together in one coin. The coin itself would be a symbol bridging the gap between the two disciplines. If we could completely characterize an animal that way, we might want to say we have mapped its mind; or characterized its world of meaning. But at the moment, mind is just a colloquialism, a short hand way of discussing thinking.

Can a Machine be Conscious?

We have described different states of consciousness: The basic awareness of matter; the beginning of consciousness in plants due to the separation from the environment (i.e., plants are living organism) and the advent of representing and storing of information internally; and the fuller development of consciousness in animals to include a sense of self or I-ness and the development of sophisticated information-processing systems (i.e., a mind). So where do machines fit into this characterization scheme? Can a machine be conscious?

Machines are made of matter, so there is definitely consciousness or awareness associated with them. But do the separately created parts integrate together like the components of plants or animals? I would say no. Machines built to date do not integrate in the same way that plants do. They do not become one organism. They remain separate pieces bolted together.

Each separate piece of a machine consists of matter, so there is a state, or states, of awareness that it can be in. The states a component can be in do not change, however, when a component is combined with another. They remain the same because the combined components do not become part of a larger whole. For the pieces to become "one" there would need to be, at a minimum, a sharing of matter, which there is not due to the way the hardware was designed (i.e., it is designed to be stable and last a long time).

As an example, consider the case of a machine, such as a calculator or a computer, where components pieces exchange information. Would that produce integration? No, because they are not sharing matter. One component is sending energy to another, and this produces a state change in the receiving component, but the two components (sending and receiving) remain separate. They are designed to remain that way. For it to be otherwise, when the two components were "bolted together" their physical states would have to be such that they would immediately start sharing electrons, or something similar. They would have to become "one".

Further, machines do not have a sense of I-ness or self, although it is possible that one could be programmed in. This is not to say that machines are alive. They are not. Machines are automata that are created and programmed by humans, but there is nothing that prevents a human from programming in a sense of self. In organisms, a sense of self is part of the "program' (i.e., executive function) that controls behavior. Including one into mobile autonomous systems (e.g., robots or autonomous vehicles) could potentially be quite useful in the same way one is useful for (mobile) animals. The sense of I in humans appears to set goals, prioritize tasks, adjudicate between competing requests for resources, and perform many other useful activities.

Situating the Theory

In general, theories of the mind can be divided into two classes: those that claim that mind and matter are one thing (monism) and those that believe that mind and matter are separate substances (dualism). The theory we are putting forth is a monistic dual property theory (Searle, 1997). We believe that only one substance—matter—is needed to explain both the physical and mental aspects of the universe. Conceptually, one can think of matter of having both an objective (3rd person) and subjective (1st person) component. We believe that the two components are best studied using separate methods, but a goal should be to develop methods that would combine the two perspectives together. Studying the physical aspect of the universe is best achieved through the application of physical sciences (physics, physiology, biology, etc.). Studying the "mental" (i.e., subjective 1st person) aspects of the universe requires the development of new methods that describe how consciousness changes as a result of aggregate physical changes and the creation of computational models that characterize intentionality. Cognitive science, and in particular cognitive computational modeling, has made a start at developing methods like cognitive task analysis that could be used to develop such models, but a lot more work remains. Cognitive methods combined with methods from ethology and neuroethology probably provide the best foundation for future development.

Many individuals would probably associate this proposal with Panpsychism, the idea that all things have minds (Skrbina, 2007). We categorically do not think that all things have minds. The term mind should probably be reserved for describing animals, and currently the term mind is really just a colloquialism for physical information processing, as described above.

The theory closest to our proposal is Strawson's physicalism theory (2006), although as noted above we do not see our position as the same as panpsychism. Strawson proposes that everything material also has experiential states. We agree with that position and have attempted to further specify what this might entail for various forms of matter, to include living things.

A Wild Card

The one wild card, the one phenomenon not really discussed in our proposal, is life (Fry, 2000). Our working hypothesis is that life came into being through an evolutionary-like process. Perhaps, some proteins folded in such a way that they could store and use energy to replicate themselves, and evolution took over from there. This perspective is supported by research that purports there are only two methods for storing energy in living things (Boden, 1999). The first method is ATP (adenosine triphosphate) and the second is storing energy across a membrane (Moran, et al., 1997). This suggests that methods for storing energy were only invented twice (through random mutation) and spread from there to all subsequent organisms.

An alternative proposal for the creation of life is the metabolism first model which uses a thermodynamic scheme. This proposal postulates the formation of chemical reaction networks that increase in complexity when forced to adapt to changing environments (Shapiro, 2007). The process begins with the formation of a compartment which segregates material between inside and out, thus enabling the material inside to become more complex, or more structured, over time as it adapts to the environment. From a probability perspective, this model appears more plausible because it relies on the initial formation of simpler cells than the protein-folding model. Both of these proposals are biologically based and depend upon readily observable biological structures and principals.

There is, however, at least one more possibility. In the last few decades, scientific research has shown that the universe we see is only between 4% - 22% of the universe that is out there. It is possible that the process of life entails another type of energy interacting with observable matter to produce the "negative entropy" that is characteristic of living things (i.e., the ability of an organism to go against the second law of thermodynamics and create and maintain complex dynamic structures).

This type of model is suggested by the Buddhist view of the universe and life which maintains that at least animals have a physical and subtle body that is interwoven during life. In the Buddhist model (which includes the concept of reincarnation), there is an essence, which is similar to a genetic code that travels from one life to the next. This essence seems to trigger the development of the organism when combined with the two types of matter. This results in an organism that has both a physical and subtle body. The physical body is the one we know, whereas the subtle body seems to play a role in structuring consciousness. I am not aware of any evidence that supports this position, but we leave it as an open possibility until a more thorough understanding of life is developed.

The main challenge for such a proposal is the same problem with all dualistic proposals: if there are two types of things coming together, how is it that they communicate? This problem of supervenience has hindered the development of dualistic models for hundreds of years. Modern physics might be able to provide a new way to think about this problem. For example, if the second type of energy/matter was dark matter, then it could interact with "normal matter" via gravity and/or the weak force. A model would still have to be developed to explain how this actually works, but at least there are potential mechanisms to exchange information across the two realms.

Figure 2 Consciousness, Living, and Mind

We believe that our proposal from the previous sections is completely compatible with current models of how life was created, and could be compatible with a dualistic model as well. In the first case, the replicating proteins method describes the development of the organism. It would account for why flora and fauna are different from elementary matter. They arise from a process that generates the required proteins (e.g., things like RNA and DNA). The metabolism first model is similar in describing the development of the organism, although it postulates a different mechanism

In these models the creation of life and consciousness are separate events. That is, neither model actually says where consciousness comes from. There are versions of them, however, where the creation of life is also the creation, or emergence, of consciousness. In this class of theories, matter is not conscious until something close to magic happens. What exactly happens is currently underspecified in all theories and cannot be empirically tested. (In reality, these positions are not really theories, but more points of discussion that are seen in the literature [Searle, 1997])

In the dualistic model, compatibility with our model depends on the role of the second substance (i.e., other than matter). If the second substance fills the role of storing energy and producing and maintaining structure, then our approach is compatible. The second substance sustains the process of life, while our proposal characterizes consciousness, or subjective awareness. Conversely, if the second "substance" was actually consciousness that was merging with matter then our proposed model would need major revision. Again, at this time there is no evidence that we are aware of that argues for a dualistic position.

Summary

The field of consciousness studies is plagued by the lack of clear definitions for many of the terms that are used in the discussion (Skrbina, 2007). Example undefined terms include mind, mentality, awareness, consciousness, sentience, and intelligence. In this essay we have fixed the definition of select words and then tried to reason from there. In particular, we have argued that consciousness is a property of all matter (or energy), and most importantly, there can be consciousness without anyone being conscious (see figure 2). Further, we have argued that a second definition of awareness is needed. The normal definition of awareness entails an actor that is aware, we suggest there should be another usage where awareness is a property of matter; and can be used as building a block to create more complex states of awareness. From this perspective, consciousness and awareness refer to the same thing: subjective experience. We specialize these terms, however, to emphasis that some things, such as elementary matter, can have subjective experience without having a mind. We would say matter is simultaneously matter and awareness, with no sense of subject implied.

We prefer to reserve the word consciousness for organisms that experience a "world of meaning". The process of life enables organisms to extract energy from the environment and use it to create and maintain structures. The extraction of energy from one perspective is the extraction of information from another. The existence of stored energy/information enables an organism to "choose" one behavior over another. Choices lead to different outcomes and there are different meanings (i.e., subjective states) associated with each choice.

Evolution is the process that exploited awareness as a property to create ever more sophisticated information-processing schemes (i.e., more sophisticated consciousnesses). It most likely accomplished this by creating novel computational methods such as inhibition, summation, facilitation, and synchronization of cell firing. Specific methods may be linked to specific brain structures. For example, synchronized firing of neuronal cells as a computational method might have co-developed and driven the expansion of the cortex (and equivalent behavioral complexity). Research is needed to determine the viability of this possibility.

An additional area where research is needed is how is the unity of consciousness produced? One could argue that every individual piece of matter should have its' own consciousness. We believe that each piece of matter is awareness (with no sense of self), but when it physically forms together with another piece of matter the separate awarenesses merge. We believe the fundamental issue is that aggregated matter shares particles and this sharing causes the merging.

Each combination of matter is a new state of consciousness (or awareness). Elemental matter combines to create compounds; compounds combine to create amino acids and proteins, which in turn combine to make more complex structures. Plants and animals, with their diverse arrangements of matter, experience diverse states of consciousness. Further, these states of matter/consciousness can change more rapidly than elementary matter. Changes in elementary matter are the slowest and are primarily driven by physical changes such as thermal and gravitational change. Changes in plants are faster and primarily driven by chemical changes. Changes in consciousness in animals are fastest and are primarily driven by chemical and electrical changes (with electrical being the fastest).

Organisms must make intelligent choices to survive. In general, evolution weeds out those organisms that do not have sufficient intelligence to survive in a given environment. We consider both flora and fauna to be alive and intelligent. Both extract information/energy from their environments and use it to dynamically respond (and adapt) to their environments. We do, however, see a major difference between plants and animals: Animals have minds, plants do not. Once again, a "mind" is a functional center that integrates information and adjudicates between competing demands.

We believe that in conventional usage mind is a colloquial term that is used to describe information-processing and behavioral adaptation that is not well understood. That is, mind is a folk psychological term used to “explain” behavior. (A folk model is a commonly held view that is not grounded in science).

We believe that the main factor that defines a mind is a sense of I-ness, and that I-ness developed in animals as a result of their mobility. Animals move around, plants (and elements) do not. Therefore, animals need much more sophisticated information-processing capabilities, to include advanced sensory, perceptual, cognitive, and behavioral systems. Such capabilities would bestow fitness, and so they where “selected by evolution”.

To fully understand an animal, you need to characterize it both from a physical perspective and a subjective/meaning perspective. Animals selectively extract information from the environment. This information means something to the animal, especially when combined with other information (which is its current state). We need to develop methods to characterize the mapping of sensory information (both internal and external) to the meaning it has for the animal and the physiological state of the animal. This will enable us to more fully understand and predict the animal’s behavior. Ideally, these methods will draw both from ethological studies of animals and cognitive task analytic methods as well. This will both speed development of the methods and ensure that all pertinent data is collected.

Our proposal fundamentally reframes the discussion of consciousness. It focuses on how consciousness/awareness manifests in different things, primarily living versus non-living things, and the role consciousness plays in the evolutionary process that enabled the proliferation of organisms. By placing emphasis on the role that information plays in evolution, this approach begins to lay the groundwork for future advancements in information science, ethology, and neuroscience, which, in turn, will enable a more thorough understanding of the mechanisms that produce behavior.

Acknowledgements.

A special thanks to Dr. Steve Rogers of the Air Force Research Laboratory and the QuEST group for many hours of discussions over the years on the topics of consciousness, cognition, and automation. Many of the ideas discussed above were first discussed there.

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