Commentary
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Observations and the Intensification of Reality by Neurons

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ABSTRACT

Classic experiments involving photons passing through adjacent slits show that the fate of the photons beyond the slit is determined by whether or not they have been observed while passing through the slits. This is the "Observer Effect," and is fundamental to the differences between Newtonian Mechanics and Quantum Mechanics.

This effect has been studied extensively, and the concepts of Observer and Observation are important throughout quantum mechanics. Among the questions are what qualifies as an "Observer" and what qualifies as an "Observation?" These questions are addressed here, and the concept of "Intensification of Reality' is explored. Accordingly, the intensification of reality imposed by heavenly bodies and grains of sand is low, whereas the intensification of reality by cells, especially neurons, is much higher. It is suggested that intensification of reality may be a force of nature that has influenced the evolution of highly organized cells and systems and helps to explain how living systems have become highly organized despite having to swim against the inexorable increase of entropy throughout the universe.

INTRODUCTION

The double-slit experiment reveals the dichotomy between Newtonian mechanics and Quantum Mechanics. The fate of photons going through adjacent slits depends on whether they are observed. If they are not observed, the outcome is different than if they are observed. This non-intuitive outcome falls within the scope of quantum mechanics, thus separating these outcomes from what is predicted by Newtonian mechanics. Many experimental approaches confirm the results of the double-slit experiment [1-5] and is a fundamental principle of quantum mechanics.

A quandary from these results is, what is it that constitutes an 'observation?' Can a camera make an observation, or does it require a sentient observer to observe the camera output? The invoking of a sentient observer suggests that there is something about observations made by a sentient observer that is fundamentally different from an observation made by an inanimate electronic device.

This question was explored during a philosophical journey by this author in *Treefall* [6]. The concepts are philosophically derived and not inspired by experimental results. It addresses the ideas that distinguish between observations made by inanimate objects and devices and those made by a sentient entity. The idea is presented that observations made by a biological entity with neurons are quantitatively and qualitatively different from observations made by nonbiological entities.

THE MAKING OF OBSERVATIONS BY HEAVENLY BODIES, GRAINS OF SAND, AND NEURONS

As human beings, we associate observations with detecting things with one or more of our five senses, especially when we use our eyes to look at something. A contemporary concept is that the universe requires observers to exist, and for the observers to succeed, they need to be sentient and able to interpret and understand what is being observed. This concept unleashes many related arguments, but the focus here will be on how and why observations made by sentient beings are quantitatively and qualitatively different from those made by say, heavenly bodies and grains of sand.

For now, an observation will be defined as when one physical entity impinges on another physical entity in such a way that the first entity affects the second entity in some way. This interaction is reciprocal in that the observation is made in both directions, so that because of gravity and the exchange of electromagnetic radiation among the heavenly bodies they are observing each other all the time. Without the earth, the moon would behave differently than it does. Without the moon, the earth would behave differently than it does. These mutual interactions, which cause the earth to behave differently because of the moon and cause the moon to behave differently because of the earth, constitute observations between the earth and the moon. An attribute of these observations is that they are indistinct and of poor resolution, because the earth and moon consist of just two bodies, and they are separated by a considerable distance. Observations that are more distinct and more highly resolved require the participation of objects that are greater in number and closer together.

A more complex observation is the entire solar system observing itself, because it consists of many objects, although they are still far apart. If we include all the planets, moons, comets, and asteroids in the solar system, there are millions of objects that are observing each other.

Consider that these mutual observations among the objects in the solar system constitute a kind of "knowing" or "awareness" in the sense that the moon is "aware" of the earth and where it is, by the direction of its gravitational pull and electro-magnetic radiation that it receives from the earth. However, although this information tells the moon the direction or the earth, it cannot determine how far away it is. Two objects orbiting each other have limited "knowing" in that each can accurately judge the direction of the other, but not its distance. However, if you add a third object to the system, you can now employ the principle of triangulation. If there are two moons orbiting the earth, each of the (now three) objects can more accurately determine the direction to the other two, and they can share information among themselves to determine the distances among them. This is because the three interacting objects cause mutual perturbations in their orbits that provide this distance information.

The idea here is that as you increase the number of mutually interacting objects in a system, the amount of information that is available about the location of any one of them is increased. Our earth is therefore "feeling" the presence of all the other objects in the solar system, and each one exerts an effect on the orbit of the earth. This provides an enormous amount of triangulation information that informs the earth about both the direction and distance of each of the other objects. If astronomers had telescopes that could observe the orbits of all these millions of objects, they would be able to calculate their relative positions precisely. The more objects there are, the more precise the calculation would become. The information is there whether you do the calculations or not. thesolar system is doing all these calculations all of the time in that every object in the solar system constantly follows an orbital path that is affected by every other object in the solar system. The solar system is accordingly highly triangulated, and the more objects a system possesses, the greater the degree of triangulation becomes.

One could say that a solar system with many objects in it is a "better-defined" solar system than a solar system with fewer objects. Or one could say that that a solar system with many objects is doing a better job of "observing itself" than is a solar system with few objects. One could say that the totality of these observations imposes a "reality' on the objects. If observations enhance the reality of objects, then a solar system with many objects has a has a more enhanced reality than a solar system with fewer objects.

The idea applies to any group of objects. Consider grains of sand on a beach. Each of the millions and millions of grains is exerting its effect on every other grain. If you moved one grain of sand from one position to another, the effects it would exert on the other grains would change. All the sand grains are "observing" each other in much the way that the planets observe each other in orbit.

BIOLOGICAL NEURONS FUNCTION IN A WAY THAT INTENSIFIES THE REALITY OF THEMSELVES AND THEIR SURROUNDINGS

This suggests that the *observation of an object confirms its existence, and the more observations you make, the more confirmed this existence becomes. This establishes the principle that increasing the number of objects in a system causes an "intensification of the Reality" of the system.* When you have just two interacting objects, the intensity of Reality is low. When you have a solar system with millions of objects, the intensity of Reality is much higher. One could say that the objects in the solar system are more real because of their being gathered together.

Let us now consider how Reality could be intensified as much as possible. To do this, we need to think not only about the number of interacting objects, but their size, their distance apart, and whether or not they are in motion. This is because of the bizarre nature of Quantum Mechanics, which dictates that the rules that operate on objects that are very small and close together, such as atoms and subatomic particles, are different from large objects such as pencils, people, and planets. It is also because of the Uncertainty Principle, which tells us that the precise location and momentum of an object, especially very small objects, cannot be determined simultaneously.

The argument is that if an object is subjected to few observations, its intensity of Reality is low. If you increase the number of observations you make of it, its intensity of Reality increases. The more observations you make, the more intense the Reality becomes. One can imagine that there is some critical threshold of Reality that you must cross for waveforms to collapse into real, definable objects whose physical properties (velocity, mass, location) are sufficiently well-defined that they can exist. The universe as we know it has clearly passed this threshold. But could this threshold have been passed solely as a consequence of the intensity of Reality that is imposed by the heavenly bodies? Or the grains of sand on the beaches of the planets? Perhaps this is not enough to pass this threshold. Perhaps there needs to be a system that possesses vastly more objects than the solar system in order to pass this threshold, and this system needs to have objects that are much closer together and much smaller in order to provide the triangulated information necessary to pass this threshold. It also helps that these objects are in motion.

LIVING CELLS HAVE MANY MOLECULES THAT INTERACT IN AN ORGANIZED MANNER

It is not among the heavenly bodies, but in the biological world that we need to look to find highly triangulated systems of objects. Living organisms are composed of myriad tiny objects (atoms and molecules) that are in a highly organized state. A single human cell, with a volume of a picoliter, contains ten trillion molecules, most of which are water molecules. There are also hundreds of millions of protein molecules, as well as fat molecules, carbohydrate molecules, and nucleic acid molecules, and billions of molecules of metabolites that are the products of the tens of thousands of distinct enzymatic reactions in the cell. There are also hundreds of millions of atoms of many kinds of metals, such as sodium, potassium, and magnesium all within this single cell. An attribute of many of these molecules is that they have ionic charges, such as the proteins and the metal ions. Or they are polar, such as the water molecules. These charges interact, like heavenly bodies, to form a highly triangulated system that informs each of the charged species about the direction and distance of each of the other charged species. A cell, with all these objects in an interactive state, provides a much higher level of “knowing” or “Reality” than does the solar system. It is particularly important to realize that any one of these tiny objects, if placed in an isolated spot, would be in a highly undefined state as dictated by the Uncertainty Principle. But surround this tiny object with many other tiny objects that are very close together and allow them to interact through electromagnetic forces; the principle of triangulation reduces the uncertainty of the position of any of the objects at any moment to a low level. Because the cell is composed of very small particles that are very close together, and because they are in a highly interactive state, and thus are highly triangulated; the cell should possess a highly intense Reality.

NEURONS SPECIALIZE IN THE INTENSIFICATION OF REALITY

Whereas this is true of all cells, it applies to some kinds of cells more than it does to other kinds of cells. Biological evolution makes it possible for cells to change, so the ability of a cell to intensify Reality can improve through mutation and natural selection. A primitive cell would accordingly contain relatively few objects, and these might not interact very well. As the cell evolves, it could acquire more components, and they could organize themselves in a way that would provide better information about their mutual locations. To see what course evolution might take, imagine a darkened stage filled with dancers. If the dancers were to just stand in one position, arms at their sides, they would be unable to tell anything about the locations of the other dancers. But suppose you attached the dancers together with strings, with a string extending from each dancer to every other dancer. As long as these strings remain slack, there is no information provided to the dancers about their mutual positions.

Now tell the dancers to move around. As each dancer moves, she tugs on the strings that are attached to all the other dancers. Suddenly, although the stage is dark, each of the dancers knows something about the location of each of the other dancers. During the period that they are in motion, the uncertainty of the positions of all the dancers, as they appear in the minds of the individual dancers, is reduced to a low value. But you wouldn’t want the dancers to move around too much, because everything would become tangled and confused. The ideal thing would be for the dancers to remain at one location and just move around enough to tug on all the strings that interconnect them. Imagine an individual dancer as she sways back and forth. The strings that are attached to all the other dancers will tighten and pull in response to the sways. If you had a big computer that could keep track of all the tugs, it could use triangulation-type computations to determine the location of each of the dancers with precision. Even if you do not do the computations, the information about the locations is there. This information does not become available until the strings are tugged by the moving dancers. Quiescent dancers will not provide this information.

It is reasonable that the course of natural selection could evolve cells toward an increasingly intense Reality. Whereas this is a selective force that would apply generally to all kinds of cells, evolution toward a more intense Reality may have proceeded to a greater degree in some cells than others, so that certain subsets of cells in multicellular organisms may be able to intensify Reality better than can other subsets of cells. This is a common evolutionary strategy. Accordingly, the general ability of cells to use contractile proteins to change shape is brought to a very high level in the muscle cell, and the ability of cells to secrete fluids is brought to a very high level in the kidney cell, and the ability of cells to be sensitive to light is brought to a very high level in the retinal neuron.

A candidate for a cell that has evolved the ability to intensify Reality to a high level is the neuron. Our bodies are permeated by neurons, which interface our senses with the outside world. Our brains are mainly neurons. Since we appear to use neurons to think with, we tend to assume that neurons are the product of an evolutionary process that reached its pinnacle within the human brain, and that our neurons are superior to the neurons found in lesser organisms. But that is not the case. Our neurons are fundamentally similar to the neurons in primitive creatures, such as nematodes and flatworms. Our brain neurons differ from nematode and flatworm neurons mainly in that our neurons have more projections (dendrites) that provide more inter-neuron connections. But the architecture of the neuron itself, especially its internal organization and the way it operates, is basically the same in a nematode or flatworm as it is in our brain. This means that whatever force of evolution that culminated in the evolution of neurons occurred a billion years ago, and neurons have remained little changed ever since. It also means that the abilities of humans to think, reason, and create are derived from a neuronal cellular architecture that is the same in humans as it is in flatworms.

THE ARCHITECTURE OF THE NEURON AND ITS ROLE IN THE INTENSIFICATION OF REALITY

Let us now look at the architecture of the neuron and see how it is designed in a way that is suited for the intensification of Reality. Like all cells a neuron possesses a membrane that surrounds it. Unlike most cells, the membrane of a neuron is coated with highly organized arrays of ions. On one side of the neuronal membrane is an array of sodium ions, and each one possesses a positive charge. On the other side of the neuronal membrane is a layer of potassium ions, and each one is also positively charged. Both sides of the membrane are bathed in a salt solution, which contains negative ions, largely chloride ions, that are attracted to the positive sodium and potassium ions. All these charges pull and push against each other, with negative ions being pulled toward positive ions, positive ions pushing against positive ions, and negative ions pushing against negative ions. It is as if they are all dancers that have not only strings with which to tug each other but also sticks with which to push each other. Both tugs and pushes provide triangulation information. Neurons are quite large as cells go, so the membranes have considerable surface area; so there are a billion or more objects that are tugging and pushing amongst themselves near the surface of a single neuron.

The neuron spends much of its time in a quiescent state, with its membrane resting quietly, covered with its arrays of sodium, potassium and chloride ions lined up like a billion dancers arrayed on a great, darkened stage; or even more, like armies arrayed for battle other ionic soldiers.

Then suddenly there is a cannon shot, and the ranks of enemy soldiers plunge into each other, bayonets slashing. This is what happens when a neuron fires, and the ions charge across the membrane toward each other. For a brief moment, the ranks of sodium ions plunge forward into the ranks of the potassium ions that are themselves plunging toward the sodium ions. Their positive charges are like bayonets that slash at each other as they pass. It is during the brief instant that this is occurring, in which the billions of ions in the neuron are moving among themselves in a highly organized manner, with billions of positive ions pushing other positive ions, billions of negative ions pushing negative ions, and billions of negative ions tugging positive ions, that each of these ions "knows" about the locations of all the other ions because they are all informing each other through septillions and septillions of triangulations. This all occurs within the confines the molecule-thin membrane of a cell that is a few microns across, so that all of these interactions are occurring over quantum distances, and after the neuron has fired and the ions have exhausted the chemical gradient that gave them the energy to move, it returns to its original state by means of tiny molecular pumps embedded in the membrane which pump the ions back across to regain their original positions. It is only during the brief instant after the neuron fires, when the ions are charging across the membrane, slashing at each other as they pass, that this highly intense "knowing" occurs. It is at this time that Reality reaches its most intense level. A neuron thus becomes "more real" at the moment it fires than at any other time. This is because of the myriad triangulation interactions that occur among its moving parts, that have the effect of reducing the level of uncertainty of all its parts to an extremely low level. This has resulted in the Intensification of Reality in the immediate vicinity of the neuron.

Thus, despite the uncertainty that is imposed by the Uncertainty Principle, the neuron achieves a state of high certainty, or Reality, whenever it fires. The observations made by a neuron are similar to the observations that are made among any group of objects, except that the neuron is unique in having an extraordinarily large number of highly organized interacting components that are extremely close together. This combination of number and closeness of the interacting objects thus sets neurons apart from other groups of objects, such as heavenly bodies or grains of sand that are comparatively few in number and much farther apart, resulting in lower intensification of Reality within solar systems and galaxies than in neurons. Now that we see what the neuron achieves, it is hard to imagine a system to do better. To do better would require even more interactive objects than are found in neurons, and they would have to interact over even smaller distances. That the neuron has remained unchanged for over a billion years suggests that Nature, with all her powers of natural selection, cannot "think" of a better way either. It follows that when a neuron fires, its Reality becomes more intense than that of any other entity we know of, unless one considers the possibility of grouping neurons together and letting them cooperate. We see that Nature has done this. Our entire bodies are interlaced with an interconnected network of neurons that integrate the senses of sight, hearing, smell, taste, and touch. Therefore, the firing of a retinal neuron resonates throughout the neuronal network, with each instant of Reality being like a raindrop falling on the ground, which gathers with other raindrops into puddles, which flow into streams, which merge into a river of Reality in our minds.

THE INTENSIFICATION OF REALITY AS A FORCE OF NATURE AND A DRIVER OF EVOLUTION

Let us accept this idea of intensification of Reality for the moment and see how it could constitute a Force of Nature. Darwinian evolution, or "survival of the fittest," tells us that if you have two organisms that are very similar except that they differ in some small way, such as one is taller than the other, or stronger than the other, or smarter than the other, then the one that is taller, or stronger, or smarter may be better suited to survive if it finds itself in a practical circumstance in which being taller or stronger or smarter is an advantage. It is these more fit individuals that have more progeny and thus are more evolutionarily successful.

THE LESSON OF THE AUTOMOBILE CONSTRUCTED FROM NON-PRECISION PARTS

To see how intensified Reality could contribute to the competitive fitness of an organism, let us consider how it could contribute to the fitness of a single cell. To do so, consider an analogy of an automobile that has been constructed from prefabricated parts. If the parts are fabricated using a high-precision process, the automobile will operate better than one constructed from parts fabricated using a low-precision process. For example, if the pistons and the cylinders they fit into are not perfectly round, the automobile will have poor performance. The design of the two automobiles, one comprised of high-precision parts and the other comprised of low-precision parts, may be exactly the same; and if you did not know about the difference in the precision of its parts, it would be very hard to tell just by taking the cars apart and looking at the parts why one works so much better than the other, especially if the possibility of a difference in precision did not occur to you.

Using this reasoning, one would expect that cells with a more intense Reality would work better than cells with less intense Reality, because their components would be better defined and thus more precise. Just as you would have difficulty in discerning the cause of the automobile with high-precision parts working better than an automobile with low-precision parts, a scientist with no awareness of the importance of the intensification of Reality would not think to attribute cell survival to it. This is particularly likely if the effect on survival caused by a minor improvement in the intensification of Reality is small and might go unnoticed unless you were looking for it. This is illustrated by looking at what happens if you culture two strains of bacteria that differ only in that one of them grows one percent faster than the other. If you were to study each one of them individually, it would be very difficult to detect this difference in growth rate, because it is so small. If you were to mix these two strains together in the same culture flask and grow them for several generations, the one with the faster growth rate would completely take over. This could explain why intensification of Reality is not recognized as a significant force of evolution, since the only way to observe it would by means of experiments that were carefully designed to detect it. Although the evolutionary effects of the intensification of Reality may be small over the short term, they could be very large over the long term and constitute a powerful force that moves living systems toward the evolution of complex cells that have a multitude of interacting components.

THE EVOLUTION OF LIFE REQUIRES A REVERSAL OF ENTROPY

This idea provides insight into why the biological world is the way it is, and how life appeared in the first place. There is a scientific discipline called the Study of Chemical Evolution, in which a basic premise is that life is not a wildly improbable accident, but the inevitable result of the fact that the rules governing the universe favor life springing very quickly into existence wherever appropriate conditions occur. For example, Chemical Evolutionists argue non-living chemicals such as amino acids and nucleosides that arose though the action of lightning and other natural processes resulted in a dilute "primordial soup" that somehow came together, and by an inexorable step-by-step process through non-living intermediates, finally assembled themselves into a living cell.

One of the arguments against chemical evolution is that it goes against entropy, which is the tendency of the universe to move toward disorder; whereas living things are the epitome of order. While it is easy to see how living things maintain this tendency toward order now that they are here, it is harder to discern how chemical evolution was able to swim upstream against entropy in the first place. The tendency toward the intensification of Reality could be a guiding force to account for this. It provides a force that favors the coming together of individual objects to form interactive associations and for these objects to communicate with each other. Even the simplest cell is a monument to the process by which molecules have come together to form highly organized associations that are in a state of intense communication. All the parts of a cell constantly communicate with all the other parts, the result being that they cooperate to maintain the integrity of the cell and to perform the functions required for it to live. One can see how the force to intensify Reality would cause simple cells to evolve into more complex cells, with even more intermolecular associations, higher organization, and more effective and comprehensive intercommunication among its parts. A scientist, observing these highly evolved cells, could conclude that the only force involved in the process was that survival of the fittest selected highly organized cells over less organized cells because they were more efficient or more effective at deriving food from their environment. It is easy to see how a cell with mitochondria (to provide energy) is fitter than a cell without mitochondria. The intensification toward Reality has not been considered among the forces of natural selection. It is argued here that it should be.

CONCLUSIONS

Our human bodies are suffused with billions of neurons, each with a dedicated role. Some serve the visual system, some the auditory system, some the olfactory system, some the prefrontal cortex, and so on. At an average firing rate of 1 *per sec*, billions of neurons intensify reality billions of times every second. As these firings transpire, reality is intensified with respect to what we see, what we hear, what we smell, what thoughts we think. We are immersed in the reality that our neurons create for us. This reality seems to surround us and extend forever beyond us. As our neurons engage with our surroundings, we may have more influence on outcomes than we currently imagine. If our neurons can intensify reality within themselves, how far outside those neurons can this intensification extend? This question is for future contemplation.

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