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Neuron the Memory Unit of the Brain

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Abstract: *For long, the human brain has intrigued Researchers, Psychologist, Doctors and everyone alike. It has left many unanswered questions and the more it is studied the more questions arise. This paper presents a comparison with the Human brain with that of the Memory System of the Computer. Undoubtedly Technology has progressed to such an extent that one is able to store and retrieve, but how far have we progressed? Are the machines better in storing than our grey matter inside our hard skull? The Human Brain memory is far more complex than the whole of the computer world and fascinating to an extent we cannot even understand the complexity completely.*

I. Introduction

The human brain has amazed and baffled people throughout the ages. Some scientists and doctors have devoted their entire lives to learning how the brain works. The **human brain** is considered by most of the scientists as the most complex living structure known in the universe, it has the almost the same structure as the brain of animal, is over three times as large as the brain of a typical animal with an equivalent body size, and much more complex. The human brain is made of discrete individual cell called **neuron**. It was only during the last decade of the nineteenth century that the terminology we use today was coined by the German researcher **Heinrich Wilhelm Gottfried von Waldeyer-Hartz**. The term 'neuron' was introduced in 1891. The **Neurons** are the living cells which are the storage units in our brain. They are micro organisms that store the information. The human brain is an organ of the body, and a biological extension of the human organism. The human organism is a living entity, and every part of it, including the brain, is alive, too. Since the brain is a living system, it exhibits key characteristics of living organisms. The brain is not some passive blob of organic mass that sits inside the skull. Even a mature brain responds to environmental influences by changing its form and function. Learning and living of the brain are ongoing lifelong processes. They affect both the brain function and structure. No man-made machine has such properties. To this day, we have developed no machinery or technical mechanisms to compare the brain with. However, once the brain is understood, it will become clear that life and the function of the brain are inseparably connected. To really understand how the brain represents memory, we must understand how memory is represented by the fundamental computational units of the brain – single neurons – and their networks," said Peter N. Steinmetz, MD, PhD, program director of neuroengineering at Barrow and senior author of the study.

II. Neuron Definition

2.1.Neuron-biological definition

Neurons receive information from cells, and then transmit this information to other cells. The transmission of information between cells of the body and neurons enables us to react to changes in our internal and external environments. Neurons have a **cell body**, which contains a nucleus that directs the cell's activities. Specialized extensions called **dendrites** bring information into the cell body. Other extensions at the opposite end of the neuron are called **axons**. These carry information away from the cell body. Information leaves a neuron through **axon terminals**, the endpoints of the axon.

A neuron or nerve cell is an electrically excitable cell that processes and transmits information through electrical and chemical signals. It has the ability to respond to a stimulus and convert it into action potential. A stimulus is any change in the environment that is strong enough to initiate n action potential. An action potential (Nerve impulse) is an electrical signal that propagates (travels) along the surface of the membrane of a neuron. It begins and travels due to the movement of ions (such as sodium and potassium) between interstitial fluid and the inside of a neuron through specific ion channels in its plasma membrane. Once begun, a nerve impulse travels rapidly and at a constant strength.

2.2.Neuron-Technical Definition

Neurons are the basic information processing structures in the CNS. The function of a neuron is to receive INPUT "information" from other neurons, to process that information, then to send "information" as OUTPUT to other neurons. (Synapses are connections between neurons through which "information" flows from one neuron to another.) Hence, neurons process all of the "information" that flows within, to, or out of the CNS. All of it! All of the motor information through which we are able to move; all of the sensory information through which we are able to see, to hear, to smell, to taste, and to touch; and of course all of the cognitive information through which we are able to reason, to think, to dream, to plan, to remember, and to do everything else that we do with our minds. Processing so many kinds of information requires many types of neurons; there may be as many as 10,000 types of them.

III. Structure Of A Neuron

According to the University of Washington, the function of the typical cell of the body versus a neuron is quite different. All of the cells in the body have a specific function: heart cells generate a pulsating action for the heart to pump blood to the body; liver and kidney cells form a filtration system to rid the body of excessive or toxic materials; and skin cells form a protective barrier to the external environment. Each basic cell is a functional unit; it can perform its function alone. Neurons, on the other hand, interact with each other: one neuron stimulates the next by secreting a stimulating neurotransmitter, or chemical, that triggers action in other neurons. Neurons act in a more global sense. They control how the body functions; they stimulate body movement, help people perceive their environment and provide consciousness.

The central nervous system consists of the brain and spinal cord. It is the major information-processing center of the body. The spinal cord conducts sensory information (information from the body) from the peripheral nervous system to the brain. After processing its many sensory inputs, the brain initiates motor outputs (coordinated mechanical responses) that are appropriate to the sensory input it receives. The spinal cord then carries this motor information from the brain through the PNS to various locations in the body (such as muscles and glands).

A neuron is made up of a cell body, dendrites, and an axon. Dendrites bring information into the cell body; information travels through the axon and exits the cell through axon terminals.

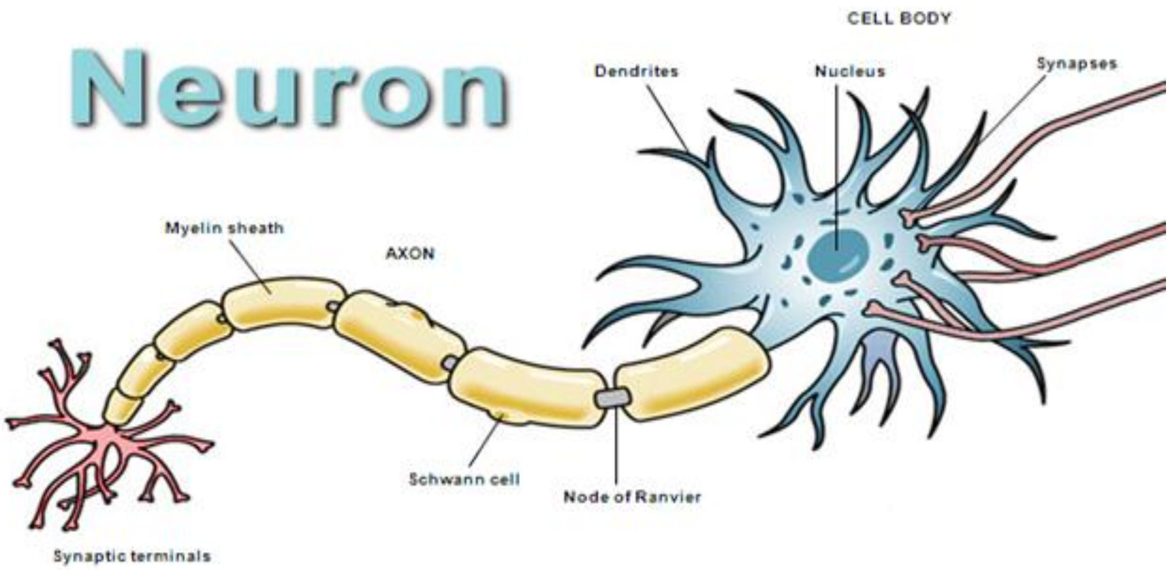

Figure 1: structure of the neuron

The nervous system includes three general types of neurons: sensory neurons, interneurons, and motor neurons. Sensory neurons are specialized to detect stimuli from the environment, such as light, sound, taste, or pressure. Detection of a stimulus triggers the sensory neuron to transmit a message to the central nervous system. There, the message is relayed to interneurons that integrate the information and generate instructions about how to respond. Instructions are sent back to the peripheral nervous system as messages along motor neurons. The motor neurons then stimulate muscles to contract or relax to make the appropriate responses. They also stimulate glands to release hormones.

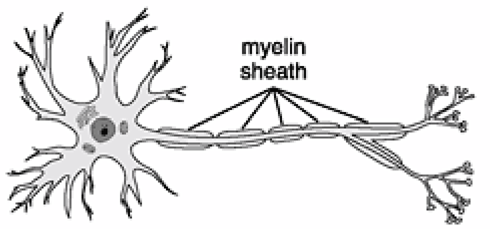

Figure 2: specialized glial cells form myelin sheaths around the axons of neurons.

Our nervous system is able to pass a message from a sensory neuron, through several interneurons, to a motor neuron within several milliseconds. Though this seems very fast, some sensory inputs (such as pain) requires an even more rapid response. If we touch a hot stove, for instance, it is beneficial for us to pull back as quickly as possible. How does the nervous system handle this reflex response? When responding to input that requires a very fast response, our nervous system allows sensory neurons to relay information through only one interneuron, or to connect directly to motor neurons. By reducing the number of inter-neurons required for signal processing, reflex responses are able to occur more quickly than other responses. Reflex responses are discussed further in Section 6, The Spinal Cord.

3.1 Glia

al cells, collectively called glia, greatly outnumber neurons. Why do we need so many glia? The functions of glia, though not as well-known as for neurons, are generally to serve as the support structure for our immense neural network.14 for instance, some glia form myelinand the insulating sheath that surrounds certain axons (Figure 3). Myelin keeps electrical signals contained within axons and enhances the conduction of electrical signals. Other glias are scavengers that remove debris after injury or neuronal death. Some glia guide the migration of neurons and direct the outgrowth of axons during development, while others facilitate communication between neurons.2 Some glia may even serve to “feed” neurons, providing them with essential nutrients.

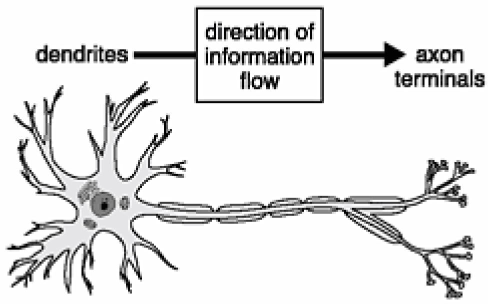

Figure 3: A nerve impulse is information (in the form of an electrical impulse) flowing through the dendrites, cell body, and axon of a neuron.

Based on the structural organization of a neuron, they can be classified as: unipolar, bipolar and multipolar.Unipolar neurons: have dendrites and one axon and they are fused together to form a continuous process that emerges from the cell body. The dendrites of most unipolar neurons function as sensory receptors that detect a sensory stimulus.Bipolar neurons have one main dendrite and one axon. They are found the retina of the eye, in the inner ear and the olfactory area of the brain.Multipolar neurons: Usually have several dendrites and one axon. Most neurons in the brain and spinal cord are of this type.

IV. Brain Memory

4.1.Memory

Memory forms a key component of our intelligence. Everything we learn in our lifetime is organized and stored in some way. Our memory is selective and interpretive, and the mechanisms driving it are spread throughout the brain. The memory is the ability of a human being to encode,retain,recall information and the past experience in the human brain, the memory is the sum total of what human can remember and gives the capability to human to learn to adapt to the previous experience. The memory in human brain takes many forms.

One neuron may make as many as tens of thousands of synaptic contacts with other neurons, said Stephen Smith, PhD, professor of molecular and cellular physiology and senior author of a paper describing the study, to be published Nov. 18 in *Neuron*.[1]

Memory is our ability to encode, store, retain and subsequently recall information and past experiences in the human brain.

It is the sum total of what we remember, and gives us the capability to learn and adapt from previous experiences as well as to build relationships. It is the ability to remember past experiences, and the power or process of recalling to mind previously learned facts, experiences, impressions, skills and habits. It is the store of things learned and retained from our activity or experience, as evidenced by modification of structure or behavior, or by recall and recognition.

The Neurons are the living cells which are the storage units in our brain. They are micro organisms that store the information. There are about 200 Billion Neurons in the Brain .The Neuron is comprised of Synapse. There are more than 125 Trillion Synapse in our Brain. .Even to the minimum, if 1 byte of Information is stored in each 200 Billion Neurons*1= 200 Billion bit of information(10,000 Million MB).But how much of Memory can be Stored in a Neuron? A typical healthy human brain contains about 200 Billion nerve cells, or neurons, linked to one another via hundreds of trillions of tiny contacts called synapses each Neuron is linked with 1,000 to 100,000 other Neurons through 125 trillion (10 14) to 10 quadrillion (10 16) synaptic junctions. In a human, there are more than 125 trillion synapses just in the cerebral cortex alone.(René Marois from the Center for Integrative and Cognitive Neurosciences at Vanderbilt Vision Research Center stated) Each synapse stores information in it. Each Synapse possesses a variable firing threshold which is reduced as the neuron is repeatedly activated. Now to the Minimum , If we assume each Synapse to store 1 bit of Information, then 125 Trillion*1=125 Trillion Bytes of Memory.

Another method is to estimate the total number of synapses, and then presume that each synapse can hold a few bits. Estimates of the number of synapses have been made in the range from 1013 to 1015 .According to Paul Reber, professor of psychology at Northwestern University the Brain's memory storage capacity to something closer to around 2.5 petabytes (or a million gigabytes). For comparison, if your brain worked like a digital video recorder in a television, you would have to leave the TV running continuously for more than 300 years to use up all that storage.The brain has an infinite amount of storage. It was discovered that if the things the average human learns in one year was broke down into 4 minute songs, that it would take 2 billion years to listen to all of them. Considering the song size in megabytes for 4 minutes is 4-6 mb Approximately 1.5 billion terabytes of memory is needed to store 1 years' worth of learned things. "According to Joe Boney Taking 5 mb as an average to store 4 minutes data as a song, 1503753662.10938 Terabytes of Memory is needed". To figure out how much you have learned in your life you would simply multiply this number time your age in years. If somebody lives for 40 years, then till that point the Brain storage capacity would be 60150146484.3752 TB

In cubic Miles of Bytes-The memories of computers are measured in terms of their smallest addressable element, called a byte. A byte usually contains eight binary digits. Nerve cells also have an "all or nothing" binary response. If combinatorial codes are remembered by nerve cells, each combination of firing inputs received by a neuron with 100 dendrites could contain 100 binary digits. The possible number of unique combinations of inputs for a single neuron with just 100 incoming dendrites could be computed as 100 x 99 x 98 x 97 x.... x 2 x 1 possibilities. That represents more than 1, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000 unique possible combinations! Multiply that number by 100 and divide by 8 to measure the number of bytes of possible memory. A single nerve cell with 100 dendrites can potentially remember that many bytes of singular combinations. Some nerve cells have upto 2,50,000 dendrites! (2004 Noble Prize Winning Discovery). Now how much memory is it? Can the computer be compared to the Human Brain? With the current Research in Nano Technology, the computers, the computer will extend its memory to a very great extent. But still, the Human Brain is Million times in higher capacity and standard. Right from the time a baby is born till its death, everything it come across, it reads, sees, smells, hears, feels, experience, Observes, all of that is stored in the subconscious mind. Whenever we see something through our eyes, its like a Video camera which is recording and storing into the memory. The actual capacity of our brain is still not known. Our brain never gets filled. There is no Limit for the brain's Memory capacity

The many kinds of studies of human and animal memory have led scientists to conclude that no single brain center stores memory. Instead, memory is most likely stored in distributed collections of cortical processing systems that are also involved in the perception, processing, and analysis of the material being learned. In short, each part of the brain most likely contributes differently to permanent memory storage.

V. Types Of Memory

Memory actually takes many different forms. We know that when we store a memory, we are storing information. But, what that information is and how long we retain it determines what type of memory it is. We are storing memory means we are storing information but what king of information is and the how long the information is retained define the type of information.

Atkinson and Shiffrin (1968) suggested that the Human Brain memory is made of series of stores. In the year 1968 they proposed a model of the Human memory. They classified the memory into Sensory, Short term and Long term memory.

5.1.Sensory memory

This is the ability to retain Sensory signals in the sensory areas of the brain .You receive information from the senses, such as sight and hearing, and hold it for one or two seconds while you process it and decide what to do with it. What you ignore quickly fades and cannot be retrieved, much as sound dissolves. Remember how you can sometimes catch an echo of a sentence, or a glimpse of someone you sort of recognize when you're not really paying attention, but then, in an instant, it's gone... The sensory signals are retained only for a short period after the actual sensory experience. But the signals can be replaced by new sensory signals in less than one second. The sensory memory is composed of multiple register also called buffer one for each sense, the sensory memory does not process the information produced by the stimuli but detect and hold the information for use in short-term memory those information held in the sensory memory is transferred to the short-term memory when attention is given to it

Duration: ¼ to ½ second

Capacity: All sensory experience (very large capacity)

Encoding: Sense specific (e.g. different stores for each sense)

5.2. Short Term Memory or Primary Memory

The short term memory was first discussed by Attkinson and Shiffrin .it is viewed as the link between the sensory memory and the long term memory as the name suggested the information is maintained in the short term memory for a shorten period of time. The short term memory is used to accomplish some task that we are planning to do Example when a chess master who tries to explore many possibilities mentally before choosing the one It also used to temporary store information in order to perform task ,when whether we perform some addiction we temporary store the two term or number to compute the some as described by Atkinson and Shiffrin the short term memory consists of several registers also called buffer each register is associated to a particular sense

If you pay attention to something, the details are then transferred to the short-term memory, which can only store up to seven pieces of data at any one time. For instance, using this memory you can remember the digits of an internet bank account or a pin code for only as long as it takes for you to key it in. As soon as the short-term memory is "full," it only takes a new piece of information to dislodge an old one because the neural mechanisms, (the meanings and associations) have not been created to allow you to recall the information later on. Some scientists believe that evolution has shaped this memory to have a limited capacity. Can you imagine if you were able to retain all the visual information you picked up in a day? What would happen if you kept a memory of every stranger you walked past and every sign you read? Well, your brain would eventually suffer from data overload. The advantage of a limited working memory is that it allows you to prioritize and focus on the task at hand.

Duration: 15-30 seconds

Capacity: The capacity of the sort term memory can be evaluated by the amount of information that can be held during a time period between 10 to 30 second. According to George Miller (1956)the short term memory is able to maintain 5 to 9 piece of information [5]

The term piece of information is called chunk (a single digits or letters, whole words or even sentences) **(chunking:** the process of binding information) .In the year 1956 the researcher miller put his research forward and found out that most of the adult can hold between 5 to 9 item in their Short term memory ,and called **the magic number 7** (plus 2 or minus 2), In the same idea many researcher like Atkinson and Shriffrin (1971) mention that items last much in the short term memory by repeating those item already presented in it verbally (Rehearsal).Brown and Peterson also mention that the rapid loss of information from the short term memory when rehearsal is avoided indicate that the short term memory having a limited capacity(a volume that can holds 7 items at a time)[6]

5.3.Long-term memory or Secondary Memory

Information stored in the brain and retrievable over a long period oftenover the entire life span of the in dividual is called as the long term memory.The phase of the memory process considered the permanent storehouse ofretained information.

Any information can be committed to this memory through the process of rehearsal and meaningful association. Once processed, the information can be recalled weeks, months, or even years later. To make this effective, you must make as many links as possible to increase the number of starting points for retrieving the memory. Links are established when you cogitate, review, and analyze information. One thing we do know about memory is that if it is linked to a personal experience or emotion it's more likely to be recalled. The more the information is repeated or used, the more likely it is to be retained in long-term memory. Long-term memories are not stored in just one part of the brain, but are widely distributed throughout the cortex. After consolidation, long-term memories are stored throughout the brain as groups of neurons that are primed to fire together in the same pattern that created the original experience, and each component of a memory is stored in the brain area that initiated it. Indeed, it seems that they may even be encoded redundantly, several times, in various parts of the cortex, so that, if one engram (or memory trace) is wiped out, there are duplicates, or alternative pathways, elsewhere, through which the memory may still be retrieved.

Memories must be actively reconstructed from elements scattered throughout various areas of the brain by the encoding process. Memory storage is therefore an ongoing process of reclassification resulting from continuous changes in our neural pathways, and parallel processing of information in our brains.

Forgetting, therefore, is more likely to be result from incorrectly or incompletely encoded memories, and/or problems with the recall/retrieval process. It is a common experience that we may try to remember something one time and fail, but then remember that same item later. The information is therefore clearly still there in storage, but there may have been some kind of a mismatch between retrieval cues and the original encoding of the information. "Lost" memories recalled with the aid of psychotherapy or hypnosis are other examples supporting this idea, although it is difficult to be sure that such memories are real and not implanted by the treatment.

All memories are stored somewhere in the brain, and that it is only in the retrieval process that irrelevant details are "fast-forwarded" over or expurgated. It seems more likely that the memories which are stored are in some way edited and sorted, and that some of the more peripheral details are never stored. Forgetting, then, is perhaps better thought of as the temporary or permanent inability to retrieve a piece of information or a memory that had previously been recorded in the brain Some hold that long-term memories do actually decay and disappear completely over time; others hold that the memory trace remains intact as long as we live, but the bonds or cues that allow us to retrieve the trace become broken, due to changes in the organization of the neural network, new experiences, etc.

VI. Differences Between The Brain Neuron Memory And The Computer's Memory

Lot of research has been done in understanding the similarities between the Human Brain and the computers .Scientists have spent their whole life in order to understand the complexity of the Brain and yet we all know very little about the differences and the way the Brain defeats the entire computer world in terms of memory and storage. Appreciating these differences may be crucial to understanding the mechanisms of neural information processing, and ultimately for the creation of artificial intelligence. Brain researchers face several big obstacles. The brain is capable of functioning the way it does exactly because of its physical neural structures and connections. These biological building elements cannot be simulated in software. They must exist in the real world. Neural chemicals alone are not enough. Any brain-like machine must consist of units that are capable of sensing, reacting to, and interacting with the world. Only neurons, which are some of the simplest known living elements, have these abilities. The neurobiological behaviors of neurons cannot be modeled by computers. For the same reason, functions of the mind cannot be separated from the biological body and the brain. Interactions between the physical brain, body, and external world make life and intelligence possible. There is no way to compute or mathematically model neurobiological interactions to produce pain, emotion, need, desire, curiosity, anticipation, boredom, determination, or consciousness. Neither computer software nor computer hardware has the necessary properties to mimic the biological processes and responses of living neurons. Incidentally, brain functions cannot be simulated in software.

6.1.Conceptual Knowledge

A computer has nothing that would be equivalent to the biographical memory. Not even the conceptual knowledge exists in computers. They only simulate concepts by processing data by the computer program. In fact, not the computer, but the human programmers determine how the computer responds. The possible responses are limited by the functional repertoire of the computer hardware and by the skills of the software programmers.

These differences imply that computer memory and human memory are very different entities. Human memory includes facts, relationships, knowledge, and overall experiences of the past by perception, consciousness, self-awareness, and volition. Through their intelligence, humans possess the cognitive abilities to learn, form concepts, understand, apply logic, and reason, including the capacities to recognize patterns, comprehend ideas, plan, problem solve, make decisions, retaining, and use language to communicate. Intelligence enables humans to experience and think. Robert Sternberg defines human intelligence as "your skill in achieving whatever it is you want to attain in your life within your sociocultural context by capitalizing on your strengths and compensating for, or correcting, your weaknesses". Computer memory only includes facts that have no connection with a broader context. For example, computers that are specifically designed for artificial intelligence often have language decoders that activate one of several preprogrammed answers. The best linguistic match is selected, and the answer is displayed or converted to sound. The computer response may appear intelligent, but the machine reacts mindlessly. There is no reasoning, just a stimulus and a programmed electronic response. The physical computer has no experience of the stimulus, of the reply, or of the broader context. Unlike the piecewise transfer of information in computers (one word at a time), brains usually deal with whole ideas and schemes. In addition, brains operate within a given context. Context focuses conscious attention in space and time. Only information from the activated context enters your awareness. Thanks to contextual focus, words that have multiple meanings are understood properly. A computer is incapable of entering this operating mode because a computer cannot sense contextual associations and operate within their limits.

6.2.Information Visibility

Another major functional difference between a computer and the brain is the level of information visibility. A computer either has information or can declare it, or the computer lacks information and cannot produce it. By contrast, the human brain can have awareness that is not declarative and is not fully conscious. For example, you can catch yourself walking toward the restroom without having conscious knowledge that you need to go. At other times, you unknowingly feed yourself without realizing that you are hungry. Also sleep and wakefulness function this way. You may wake up when you want to, even though you had been asleep and unconscious. Or, you may become emotional when you catch the smell of some forgotten biographical experience. You do not know what the smell reminds you of, but you associate the stimulus with positive or negative emotion. A similar effect is produced by the tip-of-the-tongue feeling. You can almost say a word you are thinking of, but you just cannot get over the last hurdle and recall the word explicitly. Similarly, you know that you can ride a bicycle, but you would be unable to describe what you actually do when you ride. The information is in your brain, but is not accessible to your consciousness. These forces manifest the effects of the unconscious mind. It does activities without your conscious control. The conscious mind only makes a wish, and the unconscious carries it out. No computer has such ability.

6.3.The Analog World of Storage

It's easy to think that neurons are essentially binary, given that they fire an action potential if they reach a certain threshold, and otherwise do not fire. This superficial similarity to digital "1's and 0's" belies a wide variety of continuous and non-linear processes that directly influence neuronal processing. For example, one of the primary mechanisms of information transmission appears to be the rate at which neurons fire – an essentially continuous variable. Similarly, networks of neurons can fire in relative synchrony or in relative disarray; this coherence affects the strength of the signals received by downstream neurons. Finally, inside each and every neuron is a leaky integrator circuit, composed of a variety of ion channels and continuously fluctuating membrane potentials. Failure to recognize these important subtleties may have contributed to Minksy&Papert's infamous mischaracterization of perceptrons, a neural network without an intermediate layer between input and output. In linear networks, any function computed by a 3-layer network can also be computed by a suitably rearranged 2-layer network. In other words, combinations of multiple linear functions can be modeled precisely by just a single linear function. Since their simple 2-layer networks could not solve many important problems, Minksy&Papert reasoned that that larger networks also could not. In contrast, the computations performed by more realistic (i.e., nonlinear) networks are highly dependent on the number of layers – thus, "perceptrons" grossly underestimate the computational power of neural networks.Neurons operate analogically in another sense as well. Every neuron is constantly receiving numerous nerve impulses (action potentials) from other neurons across their synapses with its dendrites. Depending on the receptors at which these potentials are received on the complex surface of the dendrite membrane, they will have either an excitatory or an inhibitory effect. The neuron constantly sums these two types of potentials, so that the overall state of polarization of its membrane varies continuously, in analog fashion, under the effect of its numerous synapses. And it is only at the neuron's axon cone that this analog signal is converted into a digital action potential.

6.4. Content-Addressable Memory

In computers, information in memory is accessed by polling its precise memory address. This is known as byte-addressable memory. In contrast, the brain uses content-addressable memory, such that information can be accessed in memory through "spreading activation" from closely related concepts. For example, thinking of the word "fox" may automatically spread activation to memories related to other clever animals, fox-hunting horseback riders, or attractive members of the opposite sex. The end result is that your brain has a kind of "built-in Google," in which just a few cues (key words) are enough to cause a full memory to be retrieved. Of course, similar things can be done in computers, mostly by building massive indices of stored data, which then also need to be stored and searched through for the relevant information (incidentally, this is pretty much what Google does, with a few twists). Although this may seem like a rather minor difference between computers and brains, it has profound effects on neural computation. For example, a lasting debate in cognitive psychology concerned whether information is lost from memory because of simply decay or because of interference from other information. In retrospect, this debate is partially based on the false assumption that these two possibilities are dissociable, as they can be in computers. Many are now realizing that this debate represents a false dichotomy.

VII. Where Is The Memory Stored In The Neuron?

Brain researchers have many hurdles. The human brain is very complex, with seemingly countless microscopic neurons and connections. Another obstacle is our lack of knowledge of the most basic brain mechanisms. We do not know how to approach the brain. Senses apparently deliver input to the brain, but beyond this assumption, we have poor understanding of how senses are processed. So far, no research team has been able to pinpoint where in the brain memory is and how it functions. It is known that memory depends on the hippocampus to some degree. Another aspect of the human brain is the Emotion. There is no clear explanation of what emotion is. Most scientists believe that emotion is an "information process" of the limbic system. Similar confusion exists about other mental functions, such as hypnosis, lucidity, or sleep. These functions exist, but their place and purpose in the neuropsychological processes of the mind are unknown to science.In a new MIT study, researchers used optogenetics to show that memories really do reside in very specific brain cells, and that simply activating a tiny fraction of brain cells can recall an entire memory says Susumu Tonegawa, the Picower Professor of Biology and Neuroscience at MIT and lead author of the study reported online today in the journal Nature. They studied mice with this genetic couplet in the cells of the dentate gyrus of the hippocampus, using tiny optical fibers to deliver pulses of light to the neurons. The light-activated protein would only be expressed in the neurons involved in experiential learning — an ingenious way to allow for labeling of the physical network of neurons associated with a specific memory engram for a specific experience.Experience has shown that the brain and the mind cannot be understood by studying just one function. By researching just one aspect of human brain, the scientist can propose an arbitrary mechanism of the unique brain function while ignoring everything else. Similarly, the brain cannot be understood by taking a global view and analyzing the brain from the technical perspective alone. Both the Biological and the technical viewsneed to be explored. According to the research done by MIT, we have proof that the memory storage is not conceptual but physical.

7.1.Neurotransmittors

The of messenger chemicals, called neurotransmitters, are released into the space between the neurons, called the synapse. The neurotransmitters cross the synapse and attach to receptors on the neighboring cell. The receptors "catch" the neurotransmitter molecule, triggering a new electrical signal that will travel to the next neuron. The neurons make chemicals called neurotransmitters. These neurotransmitters help carry information from one neuron to another. Everything we do relies on neurons communicating with one another. Electrical impulses and chemical signals carrying messages across different parts of the brain and between the brain and the rest of the nervous system. Several neurotransmitters are important for the function of the memory systems. In dementias (decline of mental function) neurotransmitters may be lost. Different parts of the brain store different types of information and control different functions. When neurons and the neurotransmitters made by these neurons do not work properly or are lost, the brain cannot store new information and loses information already stored.

The two most common neurotransmitters in the brain are the amino acids glutamate and GABA; other important neurotransmitters include acetylcholine, dopamine, adrenaline, histamine, serotonin and melatonin. When stimulated by an electrical pulse, neurotransmitters of various types are released, and they cross the cell membrane into the synaptic gap between neurons. These chemicals then bind to chemical receptors in the dendrites of the receiving (post-synaptic) neuron. In the process, they cause changes in the permeability of the cell membrane to specific ions, opening up special gates or channels which let in a flood of charged particles (ions of calcium, sodium, potassium and chloride). This affects the potential charge of the receiving neuron, which then starts up a new electrical signal in the receiving neuron. The whole process takes less than one five-hundredth of a second. In this way, a message within the brain is converted, as it moves from one neuron to another, from an electrical signal to a chemical signal and back again, in an ongoing chain of events which is the basis of all brain activity. The electro-chemical signal released by a particular neurotransmitter may be such as to encourage to the receiving cell to also fire, or to inhibit or prevent it from firing. Different neurotransmitters tend to act as excitatory (e.g. acetylcholine, glutamate, aspartate, noradrenaline, histamine) or inhibitory (e.g. GABA, glycine, serotonin), while some (e.g. dopamine) may be either. Subtle variations in the mechanisms of neurotransmission allow the brain to respond to the various demands made on it, including the encoding, consolidation, storage and retrieval of memories.

7.2.Gene and Gene Expressions

Genes do more than just determine the color of our eyes or whether we are tall or short. Genes are at the center of everything that makes us human. Genes are responsible for producing the proteins that run everything in our bodies. Some proteins are visible, such as the ones that compose our hair and skin. Others work out of sight, coordinating our basic biological functions. For the most part, every cell in our body contains exactly the same genes, but inside individual cells some genes are active while others are not. When genes are active, they are capable of producing proteins. This process is called gene expression. When genes are inactive, they are silent or inaccessible for protein production. At least a third of the approximately 20,000 different genes that make up the human genome are active (expressed) primarily in the brain. This is the highest proportion of genes expressed in any part of the body. These genes influence the development and function of the brain, and ultimately control how we move, think, feel, and behave.

Neuroscientists at MIT have discovered what appears to be the master gene that controls the forming of new memories in your brain. Called Npas4, the gene triggers a complex reaction that results in memories (events) being encoded into your brain's neurons — and by knocking out Npas4 from test subjects, the neuroscientists were able to stop new memories from forming. In specific, the neuroscientists discovered Npas4′s effect by testing for contextual fear conditioning. Basically, in the control test, a healthy mouse receives a mild electric shock whenever it enters a specific chamber — and within a few minutes, it freezes in fear when it next comes across the same chamber. By knocking out Npas4 — manipulating the DNA so that the Npas4 gene is no longer present — the neuroscientists created mice that couldn't form memories and kept running through the chamber, irrespective of the continued electric shocks. Npas4 is also present in humans, and it almost certainly has the same effect as mice. We're obviously a long way from breeding memory less, fearless human beings — well, legally at least; the American military is probably already working on it — but it does make you think. It's also possible to suppress a gene through drugs, rather than having to genetically engineer a human cell line and wait 18 years for your fearless baby to reach adulthood though whether Npas4 in specific can be suppressed, who knows.

The next step, according to the MIT neuroscientists, is to find out whether Npas4 is also present when memories are being recalled, and ultimately find out where exactly memories are stored in the brain. It might even be possible to locate the exact neurons that store specific memories — and from there, just like Eternal Sunshine of the Spotless Mind or myriad sci-fi books, we'd be very close to erasing specific memories. Perhaps more excitingly, we might even be able to change the content of our memories we know which protein a gene will make by looking at its code, also called its DNA sequence. What we cannot predict is the amount of protein that will be made, when it will be made, or what cell will make it. Each cell turns on only a fraction of its genes, while it silences the rest. For example, genes that are expressed in brain cells may be silenced in liver cells or heart cells. Some genes are only turned on during the early months of human development and then are silenced later.

7.3 RNA and DNA

In order to understand how genes work in the brain, we have to understand how genes make proteins. This begins with DNA (deoxyribonucleic acid).The functional architecture of the brain just mirrors the DNA structure. This relationship can be fully appreciated only when the functional architecture and physiology of the whole brain are understood.

7..3.1DNA

DNA is a long molecule packaged into structures called chromosomes. Humans have 23 pairs of chromosomes, including a single pair of sex chromosomes (XX in females and XY in males). Within each pair, one chromosome comes from an individual's mother and the other comes from the father. In other words, we inherit half of our DNA from each of our parents. DNA consists of two strands wound together to form a double helix. Within each strand, chemicals called nucleotides are used as a code for making proteins. DNA contains only four nucleotides – adenine (A), thymine (T), cytosine (C), and guanine (G) – but this simple genetic alphabet is the starting point for making all of the proteins in the human body, estimated to be as many as one million.

7.3.2 RNA

A gene is a stretch of DNA that contains the instructions for making or regulating a specific protein. Genes that make proteins are called protein-coding genes. In order to make a protein, a molecule closely related to DNA called ribonucleic acid (RNA) first copies the code within DNA. Then, protein-manufacturing machinery within the cell scans the RNA, reading the nucleotides in groups of three. These triplets encode 20 distinct amino acids, which are the building blocks for proteins. The largest known human protein is a muscle protein called titin, which consists of about 27,000 amino acids. Some genes encode small bits of RNA that are not used to make proteins, but are instead used to tell proteins what to do and where to go. These are called non-coding or RNA genes. There are many more RNA genes than protein-coding genes.

Stimulation of neurons causes chemical reactions that lead to changes in the composition of ribonucleic acid (RNA). Repeated activity of the same stimulus will cause the same changes. The ability of RNA molecules to change is almost unlimited and makes it possible to store a wide variety of traces. As opposed to RNA molecules, the molecules of deoxyribonucleic acid (DNA) are the carriers of genetic memory and preserve genotype. However, some types of DNA are involved in the processes of the Lifetime memory.

7.4 Proteins

Proteins form the internal machinery within brain cells and the connective tissue between brain cells. They also control the chemical reactions that allow brain cells to communicate with each other.

Some genes make proteins that are important for the early development and growth of the infant brain. For example, the ASPM gene makes a protein that is needed for producing new nerve cells (or neurons) in the developing brain. Alterations in this gene can cause microcephaly, a condition in which the brain fails to grow to its normal size. Certain genes make proteins that in turn make neurotransmitters, which are chemicals that transmit information from one neuron to the next. Other proteins are important for establishing physical connections that link various neurons together in networks. Still other genes make proteins that act as housekeepers in the brain, keeping neurons and their networks in good working order. For example, the SOD1 gene makes a protein that fights DNA damage in neurons. Alterations in this gene are one cause of the disease amyotrophic lateral sclerosis (ALS), in which a progressive loss of muscle-controlling neurons leads to eventual paralysis and death. The SOD1 gene is believed to hold important clues about why neurons die in the common “sporadic” form of ALS, which has no known cause.

7.5 The Role of Genes, Chromosomes, DNA, RNA and Proteins in the Neuron

Many different types of cells are present in the body. We say that cells differentiate as the embryo develops, becoming more specialized for specific functions. Skin cells protect, muscle cells contract, and neurons, the most highly specialized cells of all, conduct messages.

Every cell in our bodies contains a complete set of DNA. DNA, the "recipe of life," contains all the information inherited from our parents that helps to define who we are, such as our looks and certain abilities, such as a good singing voice. A gene is a segment of DNA that contains codes to make proteins and other important body chemicals. DNA also includes information to control which genes are expressed and when, in all the cells of the body. As we grow, we create new cells, each with a copy of our original set of DNA. The brain begins as a small group of cells in the outer layer of a developing embryo. As the cells grow and differentiate, neurons travel from a central "birthplace" to their final destination. Chemical signals from other cells guide neurons in forming various brain structures. Neighboring neurons make connections with each other and with distant nerve cells (via axons) to form brain circuits. Neurotransmitters are important chemical formulations can be accurately described as the brain messengers as they play such a crucial role in facilitating the movement of impulses between different nerve cells.

The vital importance of protein can be summed up in two words:” Building Blocks”. Neurotransmitters do not enter our bodies; they have to be manufactured by the body. This is done by using basic chemical building blocks of which amino acids are the most important. Where do we get these amino acids? From proteins. The body needs twenty two different amino acids which it then combines and reconfigures into the things that are necessary to sustain human life and thought. Eight of the twenty two amino acids (phenylalanine, valine, threonine, tryptophan, isoleucine, methionine, leucine, and lysine) are considered essential. In particular, neurons can sense nutrients to control their own metabolism or to generate signals that are transmitted to other cells. Genes produce proteins and hence influence the development and function of the brain, and ultimately control how we move, think, feel, and behave.

Memory works by making something memorable, organizing and then storing that piece of memorable information and retrieving it accurately at any given time. There are two main types of memory. Short-term memory holds every experience encountered, while long-term memory retains only what's important. Short-term memory happens as a result of chemical and electrical impulses in the brain, as compared to more structural changes that are associated with long-term memory. The retrieval of decoded information occurs the same way it was encoded. Memory is affected through optimistic and pessimistic emotions, some remembered others suppressed. Memory not only helps us dwell in the past it formulates our present and future.

Hence, neurons process all of the information that flows within, to, or out of the CNS. All of the motor information through which we are able to move; all of the sensory information through which we are able to see, to hear, to smell, to taste, and to touch; and of course all of the cognitive information through which we are able to reason, to think, to dream, to plan, to remember, and to do everything else that we do with our minds. Processing so many kinds of information requires many types of neurons which are located in different parts of the brain. The cerebrum and cerebellum play a key role in memory storage. Many of the complicated things that the brain does - memory, language, vision - need several parts to work together. Signals move along pathways of nerves that connect different lobes. Different parts of the brain store different types of information and control different functions.

The connections between neurons are not static, though, they change over time. The more signals sent between two neurons, the stronger the connection grows and so, with each new experience and each remembered event or fact, the brain slightly re-wires its physical structure. Your brain works around the clock. It generates more electrical impulses each day than all the mobile phones in the world. There are more than 100,000 chemical reactions happening in your brain every second. The interactions of neurons is not merely electrical, though, but purely electrochemical!

VIII. Memory Storage In Water

To what extent is water capable of storing information? The Aerospace institute of Stuartguard has discovered a simple way to make the structure of a drop of water visible. In 1995, DrMasoro was the first one to record musical impression on water in his laboratory. They allowed water to listen to music after which they flash froze the water and then under microscope, they could clearly see the crystals that the water had formed. Music of Barque, Mozart, Beethovan and Metallica all created different structures. The researches have their efforts rewarded by their insights into a beautiful world of water. An experiment was done to find out whether the structure changes when an object is inserted into the water. A real flower was placed in the water. A while later when individual drops of water was observed, the imprint of the flower was recognized. Water has memory practically changes the way we look the brain and the neuron because 70 percent of the brain is water and 70 percent of a cell is water. Everyone of waters property is unique. Experiments done in many countries of the world show that water receives and, makes an imprint of any outside influence, remembering everything that occurs. Professor of the State University of Pennsylvania and amember of the International Academy of Science, USA stated that the structure of water is much more important than the chemical composition of water. The Structure of water names how its molecules are organized. Water molecules join together in groups called clusters. The Clusters work as memory cells of certain sort in which water records the whole history of its relationship with the world as of on Magnetic tapes. Professor Martin Chaplin, Laboratory chief of London University Great Britain stated that a cluster can last efficiently for a very long time where molecules can leave and other molecules can come. The Stability of the cluster structures confirms that water stores information. Prof… stated that Water may be the single most malleable computer.It’s like the alphabets where different sentences and words can be formed.In order to understand the Brain memory,It’s so very important to understand and research on the Memory storage of Water. It can never be ignored because 70 percent of a living cell is water. The Outer structure of the cell is Cytoplasm which is water in plasma state. The Neuro transmission activity takes place through the wall of the Cytoplasm.

IX. Summary

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X. Conclusion

The Brain and Neuron, is so much to be understood. The Neuron is a cell which has got all the properties of any other cell in the body. Each Cell has got a DNA. If we stretch all the information which is stored in one DNA, we can reach from Earth to Moon at least 3 times. Every cell has got DNA, chromosomes, Proteins, Ribosomes and 23 pair of chromosomes. If all the information which is in a single cell is stretched, it can reach from Earth to Moon at least 1500 times. Its all stored by a neuron which we cannot even see in our eyes. It's much more than what we can understand and imagine. A neuron is a cell which stores information in it beyond all of these. And beyond all of this, the audio, video, smell, emotions are all stored in the Analog form. How much can a single Neuron store? What is the maximum Limit, Where in the Neuron is it exactly stored? How is so much information stored on such a tiny space? All of this still remains a mystery. Lot of research needs to be done in order to know all of this.This will be the key to unlock the role of every single neuron in brain storage. The brain cannot be understood without our understanding of mental functions and their manifestations. They will be unable to understand the functions of the brain until they learn what the brain does. Any effort in this field should start with the study of the mind and behavior. First scientists need to identify all essential Biological and Technical functions and learn about the interactions between them. Then researchers need to create a model of the functional architecture of the mind. And only then will neuroscientists be able to associate the model of the mind with brain anatomy and neural responses. In the end, there must be agreement between psychology, neurology, and neurobiology. The fact is that there are many mental phenomena that have not been explained by research teams, not even recognized to exist! Nevertheless, despite these obvious deficits, it is interesting to review some of the better known "functional models" of the human brain. As the discussion hints, the unique properties of the brain cannot be duplicated by any other means but by life itself. A living cell with the ability to sense the environment and react to it is the basic building block of all higher organisms. Some cells build the body; some process information in real time; some store memories, and some facilitate metabolism. Although all cells are living individuals, they specialize and, similarly as social insects, fulfill unique functions within hybrid biological systems. Interactions of many neurons result in higher thought. There is no self-awareness at the level of a single neuron; the responses are "instinctive." Higher cognitive functions (emotion, self-awareness, and consciousness) only emerge as a product of interactions between huge numbers of neurons. These principles apply not only to life, but also to the existence of intelligence. An intelligent machine would have to be functionally structured the same way as the brain is. In reality, machines only mimic the overall behavioral manifestations of life, but lack the essential internal relationships that define life, feeling, emotion, intelligence, and consciousness. The Human Brain and the Neuron storageare far beyond understanding. What we know is very little.

We as Humans have designed and invented so many devices for Memory Storage right from the Magnetic Drums to Nano Technology. But nothing is of match with the aweinspiring Brain and the Neuron. The Human brain is the epitome of complexity. Our brain constructs a representation of the world and how we function within it. Time and change could never make such an astonishingly complex system. It is a marvel of engineering. One that the best of our scientists and researches struggle to comprehend. Nature is full of intricate design and beauty. God has hitched his indelible signature upon every galaxy and living cell. We are fearfully and wonderfully made. God's creation is worthy of praise. What a marvelous creation the human brain is and what a marvelous creator it reflects. The works of vast intricacy is truly a remarkable testament. It's the boundless intelligence and powerful witness of the eternal glory of our awesome creator. The Maxine profusion of all this speaks of the extravagant creativity and prodigal love of thegreatest designer, Engineer and Master Mind, our creator, GOD.

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