Exploration

The Integrative Brain Theory

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Abstract

The element of conscious interpretation remained an unknown fact for more than a century. It can be realized from the observation that the theories explaining consciousness have changed over time. It is still difficult to explore a relationship between the brain activity and the conscious mind, the involved neuronal processes, and how do we determine an appropriate motor response. Determinately, a testable theoretical description will be more paramount and acceptable to consciousness. In this article, we will amass information on different theoretical models explaining consciousness, and later, the electromagnetic concept will be discussed in the form of an integrative brain theory (IBT). We claim that IBT gives a complete description of conscious meaning, motor response, and differences in basic sensory modalities at one moment in time. In this theory, the electromagnetic field effects (accompanying spatial patterns of neuronal activity) bind the processed information and serve as a medium of detection. A temporal relationship of these spatial field effects may engender an overall meaning of a perception. The linear polarization frequency is suggested to exist along the surface of cortical dendrites, and possibly differentiate the basic sensory modalities. A simple experiment can evaluate the presence of dendritic polarization rates and, therefore, the dipole idea of cortical activity may become less consequential for the differences in basic sensory modalities.

Key Words: integrative, brain theory, spatial pattern, consciousness, electromagnetic field, dendritic polarization.

1.0 Introduction

The true nature of conscious mind remained a baffling puzzle to the philosophers, neuroscientists, and psychologists. There hasn't been a single concurred definition for consciousness. In general words, it means self-awareness or knowing of self-existence. For me, it is a property of brain activity, which creates awareness of self, and relates meaning to our thoughts and psychic experiences. The underlying mechanism for consciousness is always speculated, because it is not an entity at a single point in space to be quantified. The neuroscientists have so far been unable to explain the neural processes involved in the vast diversity of psychic experiences like thoughts, color perception, passage of time, feelings, and the different modalities of sensation. We don't yet have an explanation for the differences in various forms of qualia at the level of the brain. The peripheral nerve impulses of different

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sensory modalities behave similarly, and there is no considerable variation in the morphology of neurons in the brain to account for the differences in perception. When we relate these diversities of mind to the underlying neuronal processes, it is called a mind-brain problem. The sensory perception, which becomes single in mind, has multiple aspects interpreted in different parts of the brain. A mechanism that brings all these aspects together, and produces a unified perception in mind is called a binding problem.

We have sensory and motor areas in the central nervous system. The neurons of all the sensory areas interlace in an intricate fashion, and process a sensory signal of any kind into a quantified meaning. The neuronal activity determines a pattern of motor coordination, which is an implicit destination of all kinds of interpretations in the brain. In fact, the brain's interpretation of any sort is destined to determine an appropriate motor response. It seems that the consciousness has evolved over time to enhance the brain effectiveness in survival against the challenging environment. A large chunk of brain tissue between the sensory and motor areas makes all this complex integration. The whole confusion resides in the sensory aspect of interpretation.
The excitatory electrodynamics of neurons is considered in multiple field theories to develop an explanation for consciousness. However, there is no successful theoretical description so far to explain, all problems of the conscious-mind. The broad significance of the mind-brain problem prompted William James [1] to declare that the attainment of a genuine glimpse into the mind-brain relation would constitute "the scientific achievement before which all past achievements would pale''.

It will also be appropriate to recall the Charles Sherrington's [2] comment, which remains as valid today as when he wrote it many years ago: "we have to regard the relation of mind to brain as still not merely unsolved, but still devoid of a basis for its very beginning".
In the earlier part of the twentieth century, Wolfgang Kohler presented a theory of electrical currents in the brain as a possible means of detection and integration. The proposed electrical currents were recorded on the surface of the scalp, and presented as an evidence of electrical activity in the brain. Many invasive experiments were performed in the cats and monkeys to disrupt the proposed electrical currents of the brain. However, the brain's function couldn't be impaired.

Therefore, it was considered that the deflections recorded on the surface of scalp were not due to the travel of electric currents to the external electrodes. The deflections were probably due to the electric field effects of the brain. It encouraged the evolution of electromagnetic field theory of the brain towards the end of the twentieth century.

Johnjoe McFadden believes that consciousness is an electromagnetic phenomenon with a low electric potential value of 0.5 to 1 millivolt /mm, capable of influencing the membranes' potentials and activity of motor neurons. The electric potential initially develops as a local field potential from depolarization of neurons. Reinforcement of the local field potentials forms an amplified electromagnetic information field. The resultant information field activates the motor neurons to show an appropriate motor response to the environment.

Susan pocket, on the other hand, has a different theoretical description for the conscious electromagnetic phenomenon. She believes in the presence of conscious and non-conscious electromagnetic field patterns. The cortical dendrites are suggested to behave as dipoles. It will be explained in the relevant section of our article.

Towards the end, we will describe that electromagnetic field theory of consciousness can have a third possible dimension of explanation. We call it an integrative brain theory. This theoretical model suggests that the large chunk of brain tissue between the sensory and motor areas possesses a delicate network of neurons with complex wiring. The complex sequence of wiring in the neuronal network influenced by everyday experience will be capable of fine integration, and finding an appropriate motor response to a given problem. If every kind of interpretation is possible for the brain, then the electromagnetic field effects of neurons may not require additional processing of information to determine an appropriate motor response. The electromagnetic field effects accompanying the spatial patterns of neuronal activity may only bind the processed information, and serve as a medium of detection and meaning.

The integrative brain theory introduces the idea of dendritic polarization rates to explain the differences in various forms of qualia. An experimental technique is also suggested to evaluate the presence of dendritic polarization rates. If the polarization frequencies are found to exist along the surface of dendrites then the neurons may be viewed as integrating entities of conscious mind for the differences in basic sensory modalities. They can interpret information in the form of different frequencies. The same frequency may also be reflected into the electromagnetic field of the brain. This matter will be discussed further in detail as we move forward in the article. Now we will discuss the neuronal electrodynamics first followed by the theories of consciousness. The third possible dimension of conscious mind in the form of integrative brain theory will be discussed at the end.

1.1.0 Neuronal Electrodynamics

Neuronal activity engenders a conscious mind and, therefore, first we will elaborate the neuronal electrodynamics. The dendrites, somatic impedance, and a long myelinated axon make the three essential parts of a neuron. An axon is a single long process, and conducts an ionic signal away from the cell body. The axonal terminal is loaded with the transmitter vesicles. The transmitter vesicles contain a particular type of neurotransmitter i.e. acetylcholine, glutamate, and serotonin etc. The transmitter is released into the gap (synapse) between the axonal terminal and the dendrites of another neuron. The neurotransmitters move across it, and bind to the receptors on the postsynaptic membrane. The ligand's gated channels open up for the sodium ions to depolarize the membrane potential. The electric potential sensitive ion channels are incorporated separately for the sodium, potassium, and calcium ions in the neuronal membrane [3]. Under the normal circumstances, there is high sodium ions' gradient to the outside compared to the inside of a neuronal membrane.

Similarly, the intracellular potassium ions' concentration is higher than the outside. The sodium-potassium pumps serve to maintain the high sodium ions' gradient to the outside and high potassium ions' gradient to the inside of a neuronal membrane [4]. This complex protein is driven by the adenosine triphosphate (ATP). It pumps three sodium ions to the outside and two potassium ions to the inside against their concentration gradients. It builds an extracellular sodium ions' concentration of 140 mmol /l, and a similar amount of potassium is maintained in the intracellular compartment. The intracellular sodium is maintained as low as 10 -12 mmol/l. Similarly, the extracellular potassium concentration is only 4 mmol/ l. The ionized calcium is required for the interneuronal signal transmission. The calcium ions enter the cell when an electric signal arrives at the axonal terminal. The diffused calcium ions mediate binding of the transmitters' vesicles to the presynaptic membrane. The neurotransmitters are released in the synapse from the transmitter vesicles. Subsequently an electric signal is induced in the second neuron.

In the resting state of the membrane's potential, the potassium ions being smaller in size move out of the membrane's pores easily than either of the sodium and calcium to the inside. The potassium ions are positively charged. The rapid diffusion of the potassium ions to the outside compared to either of the sodium and calcium ions to the inside, creates a negative electric potential of -65 to -85 millivolts on the inside of the neuronal membrane [5].At the same time, a similar amount of charge of the opposite polarity is established on the outer surface of the membrane. When a signal arrives at the axonal terminal, a neurotransmitter is released and binds to the receptors in the post-synaptic membrane. If an excitatory neurotransmitter like acetylcholine, binds to the receptor then a central ion's channel of the receptor will open for the sodium ions. The sodium ions rapidly move to the inside making the membrane's potential less negative. If the input signal is strong enough, the transmembrane potential may fall to a level of -40 millivolts, known as the threshold potential. An impulse is fired at the threshold level. The impulse produces electric potential changes and travels from the dendrites to an axonal terminal.

1.2.0 Wolfgang Kohler

Kohler was a gestalt psychologist. Kohler believed that the conducted action potentials could not explicate the complexities of visual perception. The action potentials traveling along the separate fibers cannot merge together to form a molar object, and separate it from the attributes of the environment in the cerebral cortex. He suggested that the cerebral cortex integrates information in the form of electric currents [6, 7].The description was initially formulated to explain the visual perception in the striate cortex. However, the cortical currents were believed to operate in all forms of cerebral activity. An electric field is established when impulses arrive at a circumscribed area in the cerebral cortex. An electromotive force develops due to the electric potential difference between this area and the surrounding tissue. It causes an electric current to flow that passes through the circumscribed area. The direction of flow is opposite within the area compared to the surrounding tissue.

In this regard, the cortical currents were also recorded on the surface of the scalp [8].The cerebral currents were recorded with two electrodes positioned on the surface of the scalp over the occipital area. The active electrode was placed 1 cm above the occipital protuberance to represent the foveal locality of the striate cortex. The second electrode was positioned at the vertex. An object in the form of either a projected bright circle or a strip of the bright cardboard with a dark background was moved in the visual field across a fixation point. A fairly smooth deflection was recorded multiple times. The deflection peaked when the object passed the fixation point. It corresponds to the activation of the foveal part of the visual cortex. The smooth deflections recorded on the surface of the scalp were suggested to represent electric currents of the brain. The brain activity responsible for the external deflections required exploration. The researchers performed multiple experiments to reveal the nature of the underlying cortical currents.

Kohler himself did not suggest an experimental model to show the presence of cerebral currents. There was a great deal of interest in the scientists' community to reveal the nature of electric currents in the brain. Different intracranial experiments were endeavored in the cats and monkeys to disrupt the cerebral currents. However, none of them was rewarding to show the presence of molar currents in the brain.

In 1951, Karl Spencer Lashley and his colleagues attempted to disrupt the predicted cortical currents with the strips of gold foil and pins[9].The strips of gold foil were placed in contact with the striate cortex of monkeys, while the gold pins inserted perpendicular to the macular area. The presence of gold was expected to fuse the cerebral currents and make clouding of the visual field. However, the visual function was preserved. The idea of cerebral currents became uncertain if the presence of gold couldn't impair the recognition of visual patterns.

Roger Sperry et al performed similar experiments [10],[11]. The cats one-half to three-fourths grown at the start were trained to differentiate an equilateral triangle from a series of imperfect triangles with similar dimensions. The cats were then operated and subpial cuts produced in the visual area to obstruct the flow of cerebral currents. In some cases, metal wires cut from the tantalum sutures were inserted in the visual area to disrupt the flow of currents. However, the cats performed well after the surgery, and specific equilateral triangles could still be differentiated. In another experiment with a similar approach, dielectric mica plates were inserted in the visual area to disrupt the vision. However, no effect was observed in recognition of the visual patterns to suggest the presence of cerebral currents.

1.3.0 Johnjoe McFadden (Conscious electromagnetic field theory)

McFadden explained the idea of electromagnetic (EM) information field as a possible substrate of conscious mind **[12]**. McFadden believes that consciousness is an electromagnetic phenomenon with a low electric potential value of about 0.5 to 1 millivolt /mm, capable of influencing the membranes' potentials and activity of the motor neurons.

A resting electric potential of -65 millivolts is established at the inside of a neuronal membrane due to the activity of ion pumps. These ion pumps move out the positively charged sodium and calcium ions to the extracellular space. However, the resting membrane potential is influenced by the electric field changes occurring in the surrounding neurons. The cerebral cortex has a parallel alignment of cells and densely packed with virtually 10^4 cells per square millimeter. Therefore, when a group of neurons with a parallel alignment is activated, their extracellular field effects reinforce to form an amplified local field. The amplified field is able to modulate the membranes' potentials of neurons in the vicinity. Its strength varies from a few hundred microvolts to about one millivolt. The weak local field may produce a small drift in the membranes' potentials, and activate neurons that are already close to a firing threshold. Therefore, a further amplified field is generated. In this fashion, a self-referred feedback loop of the electromagnetic field is created between the groups of neurons. McFadden expanded the vision into an integrative electromagnetic field known as conscious electromagnetic information (CEMI) field [13, 14].The digital information of neurons is pooled and integrated into the electromagnetic information field. Consciousness constitutes that part of the integrative EM field which activates the motor neurons and makes communication with the external environment.

McFadden explained in his recent papers [15] that the CEMI field is capable of producing neuronal synchrony. The neuronal synchrony is considered to be a stronger correlate of consciousness and awareness. It is believed that conscious awareness is produced when all the aspects of an object are processed at the same time, though in different parts of the brain, producing a unified perception. The CEMI field binds the digital information of these aspects into a single physical system known as a gestalt [16]**.** The structure of the gestalt is similar to that of the real object. Awareness and meaning are believed to be a part of the same gestalt information. Therefore awareness is produced when all the aspects of an object bind together into the gestalt information. However, the theory is still required to explain:

1. An experimental technique to confirm that the CEMI field operates the conscious mind.
2. A possible mechanism for the differences in basic sensory modalities on the basis of CEMI field theory.
3. How does a CEMI field determine the position of motor neurons to be stimulated without an anatomical connection?
4. It is a common observation in neurology that the patients with a middle cerebral artery infarction, [17], [18] develop a motor aphasia and or contralateral hemiplegia (power of 0/5) due to degeneration of the motor neurons. However, they are still able to develop a conscious desire for speech and movement in the paralyzed limb. If consciousness constitutes that part of the EM field which activates the motor neurons then these patients would have not been able to make a conscious desire for the lost function.

1.4.0 Susan Pockett

Pockett believes that the conscious interpretation happens in the sensory areas of the brain rather than in the motor cortex. The sensory cortex contains an electrically neutral layer 4 as compared to the motor areas [19]. She claims that the presence of a neutral layer may be a possible reason for the development of conscious patterns in the sensory areas.

The cortical pyramidal cells are suggested to behave as dipoles. When a signal arrives, a negative charge is established on the upper outer surface of a dendrite due to diffusion of the positive ions to the inside. The intracellular electrical neutrality is maintained with the diffusion of positive charge to the outside near the cell body. In this fashion, the cortical dendrite operates in the form of a dipole. The presence of a neutral layer 4 within the dipole makes it a conscious pattern of the electromagnetic field. The motor cortex lacks the neutral layer and, therefore, the dipole spatial patterns behave unconscious.

However, we feel that the cortical dendrite is a long slender filament of the pyramidal cell. The neuronal electrodynamics changes in a short span of time during an action potential. If the dendrite passes a series of impulses rapidly then the changing ionic gradients may develop polarization patterns along the surface. This is explained in the relevant section below. If experiments showed the presence of polarization patterns along the surface of dendrites then the dipole idea of cortical activity may become less important.

Susan Pockett also explained that the brain electromagnetic waves are produced as a result of convective ionic currents with a spatiotemporal coherence [20]. The behavior of the convective ionic currents in a tissue is different than that of electrons in a metal. Therefore, Maxwell's equations of the electromagnetic phenomenon based on the electrons' dynamics are required to be changed for the electromagnetic field effects of the brain based on the convective ionic currents.

We feel that Susan Pockett is absolutely right because Maxwell's equations are entirely based on the electron dynamics. The transmembrane electrodynamics of ions is different than the movement of electrons in conductors. During an action potential, the sodium ion's permeability of the membrane is increased and diffuse inside rapidly. The process brings a negative charge on the outer surface of the membrane and at the end voltage-sensitive potassium channels are opened. Subsequently the outward diffusion of the potassium ions restores the membrane's potential. The entire process is accomplished in fractions of microseconds. The electromagnetic field effects associated with the above neuronal electrodynamics may have a different spatiotemporal configuration. Therefore the theoretical and experimental values of the Maxwell's equations are required to be changed for the electromagnetic field effects of the brain.

Unless the experimental evaluation of the CEMI field as a possible substrate of consciousness remains difficult, it is better to consider a testable theory explaining consciousness as a property of brain activity, EM field as a medium of detection and distinguish sensations on the basis of dendritic polarization rates. If evidence of dendritic polarization rates becomes available then we may become certain that the brain has potential mechanisms to explain diversities of the conscious mind, and can be gathered into a structured theory. We call it an integrative brain theory. The theory also gives an explanation of certain basic facts discussed below.

2.0 Discussion

Kohler theory of cerebral currents was disproved in a series of experiments performed over the decades at that time. The failure of demonstrable electric currents in the brain gave space to the electromagnetic field theories of consciousness. The *electromagnetic field effects can be detected in association with the brain's activity* and, so far, remained the only alternate option to explain the conscious mind. The electromagnetic field forms the base of a different theoretical idea of consciousness. However, this new evolving concept is required to give an explanation to the vast diversities of conscious mind. We will explain these diversities of conscious mind in the form of certain basic facts. Susan Pockett, [21] discussed three important difficulties with the electromagnetic field theories of consciousness. Here we will discuss some more important basic facts that would require flexible explanations in the electromagnetic field theory of consciousness:

I) The EM field concept is altogether theoretical and the conscious mind has too many aspects. The theory is quite primitive, and needs to explain various dimensions of the psychic mind. The electromagnetic field theory is required to incorporate flexible explanations for differences in basic sensory modalities, i.e. touch, pain, pressure, vibration, hearing, and color vision. How do these differ and what is the possible explanation on the basis of EM field theory.

II) The peripheral nerve impulses all over the body behave similar [22]. The quality and characteristic of conduction of peripheral nerve impulses for the different sensory modalities are similar and, therefore, may not influence differentiation of sensory signals at the level of the brain. The differentiation is determined by areas of the brain into which they discharge. When a given sensory area of the cortex is stimulated in a conscious human subject, it produces a sensation in that particular area of the body [23]. If peripheral impulses of the basic sensory modalities behave similarly, then, how do we differentiate them at the level of the brain? For instance, if the peripheral impulses of touch and pain are similar, how do they become different at the level of the brain? We suggest a model of dendritic polarization rates to explain the differences in basic sensory modalities. It is discussed in the relevant section below.

III) It is likely that the EM field of consciousness will be made up of electromagnetic waves. The confusion arises when we consider how waves are produced in the EM field of the brain? When a neuron is activated, the sodium ions move to the inside of a cell followed by the exit of potassium ions to the outside to complete an action potential cycle. The two types of ions move opposite to each other during the process. The movement of sodium ions to the inside causes depolarization of the membrane and exit of the potassium ions will restore the membrane potential. The two processes are well separated in time, and the associated electromagnetic field effects will travel away from the membrane by a speed of light. Therefore, it becomes difficult to believe that the fast traveling field effects produced by a slow process of ionic currents would merge together to form an electromagnetic wave. We can overcome the difficulty by considering that the electromagnetic waves exist in the brain in the form of dendritic polarization rates or frequencies. We describe the dendritic polarization rate as a linear polarization pattern on the surface of a dendrite when a series of impulses are transmitted. The electromagnetic field effects of the polarization patterns on the surface of aligned cortical dendrites may reinforce together. Subsequently, the polarization pattern frequency of the aligned cortical dendrites is incorporated into a spatial pattern of EM field (formed as a result of synchronous neuronal activity).

IV) The brain has a complex sequence of connections. However, the brain connections are usually fixed for a period of time. The conscious experience is a property of brain activity. With the fixed connections, how does the brain activity evolve into a conscious mind that has a variety of options to think, feel, and execute?

V) The electromagnetic field effects generated within the brain represent our conscious perceptions. These field effects can also be recorded on the surface of the scalp. Therefore, the field effects are not confined to the inside of the brain. The brain's electromagnetic waves travel by a speed of light. We should have been able to feel the interaction of these EM waves in the external environment at a distance far away from our body in a matter of no time. These field effects ultimately distort as EM waves move in the brain tissue. If the spatial patterns of EM waves have conscious values, their distortion effects should have been experienced.

2.1.0 Integrative Brain Theory

Despite all the above facts, the conscious mind and different modalities of sensations can still be experienced as electromagnetic in nature. This is because the psychic feeling of our own existence cannot be attributed to the organic membranes of cells. There is no comparable diversity in the organic membranes to explain the different aspects of conscious mind. It includes the perception of different colors, calibration of distance, binding problem, the passage of time in mind, and differences in various forms of sensations. It will not be logical to think that the interaction of transmitters with their receptors will be interpreted into any sort of information. Similarly, a simple movement of ions cannot give you a perception. This is because ions are only particles. They lack awareness of their own existence and may not add up anything to consciousness with a simple movement across the membranes. If we look as a second observer to a depolarizing neuron then as a single neuron it may not produce a quantified feeling of any kind.

A particular perception may be experienced only, if activities of the neighboring neurons are unified together. The only adequate explanation that unites a synchronous neuronal activity is the interaction of field effects produced by the individual neurons. The electromagnetic field effects accompanying a synchronous neuronal activity can bind the information into a spatial pattern. The informational values of field effects may become productive of a meaning when they bind together in a spatial pattern. The spatial patterns of the electromagnetic field may then serve as a medium of detection and meaning. However, many serious problems will occur if values of the electromagnetic field are extended to a level of self-integration. The spatial patterns of electromagnetic field effects may disrupt while traveling through the brain and their informational values may not remain intact. This can make the integration quite difficult within the electromagnetic field. It may be very difficult to evaluate the integrative electromagnetic field with an appropriate experiment. Again it is quite difficult to explain that an electromagnetic field operating at a speed of light, determines the exact position and sequence of motor neurons for an appropriate motor response. The picture is further complicated when EM field has to take a decision with a speed of light in a limited distance between the sensory and motor areas. Consciousness behaves in a controlled fashion and requires processing in a well inhibited environment. A controlled well inhibited environment may not be possible in an EM field operating at a speed of light. The brain contains both excitatory and inhibitory neurons and is a suitable place for a controlled processing.

Based on these facts we present a model of integrative brain theory of electromagnetic consciousness. The theory suggests that integration and processing happen within the controlled environment of the brain while the electromagnetic field effects produce detection and meanings only.

If perception is at all related to the neuronal field effects then at which point do we feel anything as the neurons become activated via action potentials? For this reason, the neuronal status may be viewed as changed when its polarity reverses compared to the surrounding during a depolarization. It happens when a depolarization makes the intracellular potential more positive. A similar amount of negative charge is also established on the outer surface of the membrane at the same time. A cluster of neurons that depolarize together at the same time produces a reinforced localized EM field. This localized EM field is called a spatial pattern. A spatial pattern can form in a matter of a few microseconds. When a series of spatial patterns follows each other in a short span of time then a temporal relationship will be established. In the meanwhile, a signal comprising of several spatial patterns with a gap of microseconds will take a few milliseconds to reach the premotor area. At that time, the operational effect of temporally related spatial patterns of EM field may reflect a psychic meaning in mind.

We believe that the conscious awareness of meaning is a result of the brain processing forming temporally related spatial patterns of electromagnetic field. A conscious meaning may be an impact of processing of more than a few spatial patterns. The spatial pattern of neuronal activity binds its information into a spatial pattern of the electromagnetic field. It may happen with the processing of every spatial pattern of neuronal activity as the signal proceeds towards the premotor area. Ultimately the brain processing will yield temporally related spatial patterns of the electromagnetic field. Temporally related spatial patterns of the electromagnetic field may be the ultimate point of detection and meaning. The spatial patterns of neuronal activity will permeate a dense volume of cells in the brain before arrival in the premotor area. Therefore, information arriving the premotor area will be well processed, inhibited, reflect more of a conscious type, and determined to show an appropriate motor response.

Each signal processed in different sensory areas may have a tendency to move to the premotor area and determine a pattern of motor coordination to show an overt response. However, one signal with many spatial patterns of neuronal activity may get a chance to reach the premotor area at one time with a desired effect. This fact is based on the observation that the human mind can be conscious about one thing at a time. The information of different sensory areas may share a “common group of neurons” before reaching the premotor area. When a signal passes through the common group of neurons, it becomes refractory to receive and process signals from other sensory areas that are a fraction of a microsecond late to arrive. In this situation, one signal will produce a conscious meaning at one time that succeeds to permeate all the way to the premotor area.

Subsequently the later signals would fail to produce a meaning and a desired effect. They cannot permeate all the way to the premotor area and do not complete the required numbers of spatial patterns to have a conscious impact in mind. The common groups of neurons with a relative refractory state explain the fact that the brain can approach the premotor area with a variety of options even if the connections are fixed. It also explains our basic fact IV mentioned earlier. A psychic meaning that appears to emerge in milliseconds may actually contain the integrated values of spatial patterns in series. A single spatial pattern is a local EM field. We predict that a single spatial pattern add up its value to the overall meaning during the process of development and binding. When a spatial pattern of EM field is well established its integrated value for the overall meaning is released. Later if it is distorted while traveling through the brain, the meaning won't be affected. Its effect is felt with the integrated values of other spatial patterns ahead. It explains the basic fact V as well.

2.1.1Patterns of Brain Stimulation

The physical patterns of brain stimulation may not always resemble the perceptions in mind. It may depend on the sequential arrival of impulses in the sensory cortex. For instance, consider the stimulation of visual cortex for a triangle. The visual field is divided into the right and left halves. The left half of the visual field is processed in the right occipital cortex while the right half of the visual field is processed in the left occipital cortex respectively. When the vision is fixed at the center of a triangle then its left half moves to the right occipital cortex and the right half goes to the left occipital area [24]. The two occipital cortices are quite separate and apart. The single image is divided in equal halves and interpreted in separate visual areas.

However, the image is still perceived as a single quantified entity rather than two separate halves. The quantified perception of an image or any other information may not require interpretation at a single point in the brain. It is probably the time of interpretation of various aspects of an object in the brain that matters for a quantified perception in mind. The sequence and timing of arrival of photons for the various aspects of an object may be fixed and specified, and peripheral receptors in the retina will be stimulated according to the sequence of arrival of photons. Consequently, the impulses carrying information to the visual area will be traveling with a time sequence for all the aspects of an object. The same temporal relationship of all the aspects will also be preserved between the spatial patterns of neuronal activity in the visual areas. The spatial patterns of neuronal activity for the different aspects of an object will bind information into the spatial patterns of EM field and their temporal relationship may give an impression of a unified perception. The above explanation still considers the brain as a possible source of integration of information for a unified perception in mind rather than the EM field.

2.1.2Dendritic Polarization Pattern Frequency

At the end, we will discuss an important aspect of mind that requires an additional explanation. The basic sensory modalities like hearing, vision, touch, pain, pressure, cold and vibration are all processed by action potentials in the cerebral cortex but still we experience them as separate and distinct. One aspect of the action potential can explain the difference. There is experimental evidence that action potentials can develop in the distal parts of the dendrites and travel towards the soma [25]. The conduction of action potentials in a dendrite depends on its geometry i.e. morphology and the density of ion channels in the membrane [26]. If there happens to be a difference in the speed of conduction of impulses in the dendrites then polarization patterns may develop along the surface of the membranes. A group of neurons that interpret one particular sensation may all have a similar dendritic polarization pattern. The polarization patterns can integrate into the spatial patterns of EM field and represent a particular sensation. The phenomenon of dendritic polarization pattern is shown in the diagram below. It gives a two-dimensional view of the long dendritic process of a pyramidal cell.

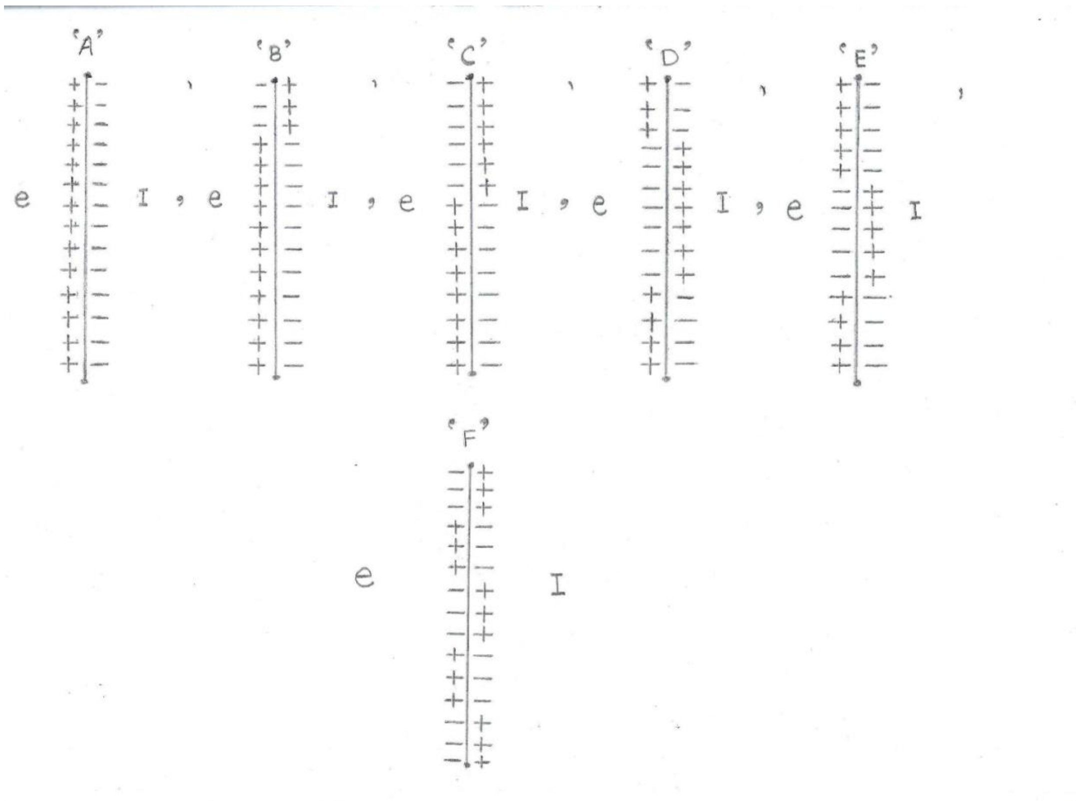

Fig.1. Formation of polarization patterns along the surface of a dendrite.

In part 'A' the dendrite has a stable resting membrane potential with extracellular surface 'e' charged positively compared to the intracellular surface 'I'. When an excitatory signal arrives, the upper part will begin to depolarize. The positive sodium ions will diffuse to the inside of the dendrite. At this instant diffusion of sodium ions bring a positive charge of approximately +5 ---- +10 millivolts to the inside at the upper segment as shown in 'B'. At the same time, positive charges permeate a small distance of the cytoplasm but still not all the way to the cell body because of resistance in the cytoplasm.

As positive charges move forward, the intracellular resting membrane potential of -65 to -80 millivolts is raised to the threshold level of -40 millivolts. When the threshold is achieved then sodium channels are opened up again for further diffusion of positive ions as shown in 'C'. In that much time, the repolarization process may be activated in the upper part of the membrane. The potassium ions move outward and restore the resting membrane potential near the upper segment as shown in 'D'. When a dendrite has to pass a series of impulses then the two processes may follow each other rapidly. Finally, polarization patterns will develop along the surface of the membrane as shown in 'F'. We predict that such polarization patterns (dendritic polarization rates/ frequency) may vary for the different groups of neurons. During a synchronous neuronal activity, the intrinsic polarization pattern frequency will bind into the special patterns of the electromagnetic field. The dendritic polarization pattern frequency in different groups of neurons explains the differences in various sensory modalities.

2.1.3Experimental Technique to Evaluate the Presence of Polarization Patterns

Our theory relates dendritic polarization patterns to the differences in various forms of qualia. The pyramidal cells in the cortex have a long slender dendritic process. These neighboring slender processes have a close parallel alignment to each other. Therefore, the changing electromagnetic field effects can readily reinforce together as signals travel these fibers. Reinforcement can establish in all the aligned fibers with a synchronous nerve impulse.

There are about ten thousand cells in one square millimeter area of the cerebral cortex. So, there will be a synchronization of a few hundred cortical neurons in a spatial pattern of neuronal activity. Keeping in mind the density of cells in the cerebral cortex, it is quite certain that the individual spatial patterns would measure in micrometers. Therefore, it is inappropriate to think that the entire sensation can be impaired by interfering with a few cells at a random point in the macro map of that sensation. The interruption mechanism will be appropriate if it disrupts the reinforcement of the maximum number of cells in a micro map in real time. Merzanik developed the concept of micro mapping in the past century with multiple successful experiments [27, 28]. These experiments were performed to test the hypothesis that neurons change their representative function after every few months. This is called the brain's plasticity. The micromaping is an invasive procedure. It determines a group of cerebral neurons working for a small portion of the body.

Like the representative area of the thumb is grossly localized in the cerebral cortex. Similarly, neurons representing a single point of the surface of the thumb may also be localized. It requires insertion of a micro electrode in the representative area of the thumb and recording in real time from the individual cells. A microelectrode is inserted in one neuron at a time and different points are stimulated on the surface of the thumb. The electrode produces a spike when a relevant point is stimulated on the surface of the thumb. Thereafter the electrode position is changed and adjacent points are stimulated again to know their cortical position. With this effort, the entire set of cortical neurons may be mapped for the surface of the thumb. A similar technique may also be used to localize the cortical cells for the different modalities of sensation. The cortical area where different modalities of sensation arrive may not be the ultimate site of conscious perception.

The conscious awareness of a sensation may develop when a signal penetrates deeper in the brain tissue. We already explained in an earlier section that the conscious awareness of any kind may be an overall operational effect of all the processed spatial patterns of EM field accompanying the spatial patterns of neuronal activity. Therefore, we believe that psychic awareness of a particular sensation may not develop at one particular point. Our hypothesis suggests that the spatial patterns of a sensation occupying a neuronal track have a linear polarization frequency. The linear polarization frequency is the total number of electric field gradients established on the surface of a neuronal membrane during conduction of an action potential as explained in fig 1. The following figure demonstrates how linear electrical gradients may reinforce together.

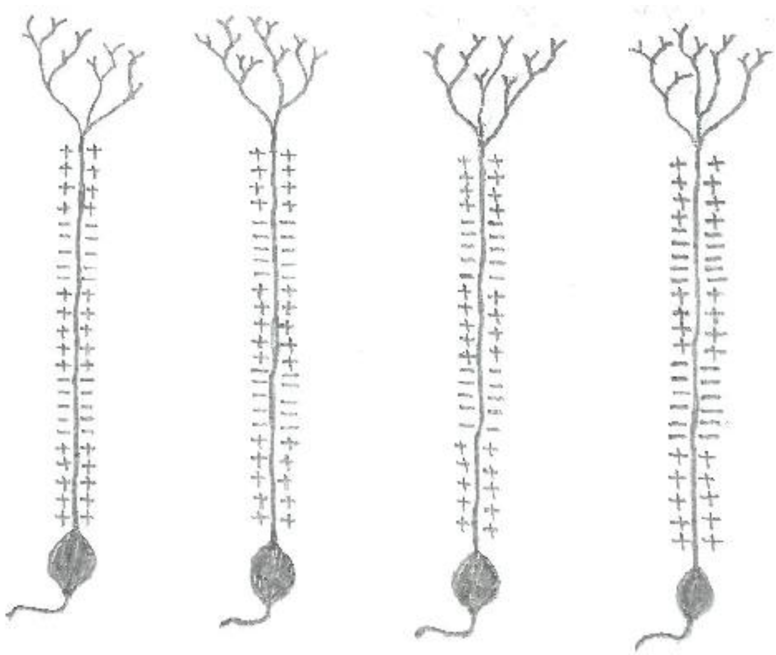

Fig.2. Synchronized polarization patterns

The linear polarization frequency in the above figure is five. The linear polarization frequency can either be single or be a range of frequencies for a particular sensation. In the later case, the idea will not be surprising if we consider that the linear polarization frequencies of a sensation exist with a small difference along the neuronal track. Stimulation of the entire frequency sequence may give feelings of a particular sensation. Suppose the sensation of touch has a hundred spatial patterns in the neuronal track divided in a group of three, 40, 30 and 30. Consider that the polarization frequencies in these groups are 06, 04 and 02 respectively. Now stimulating the entire track of 100 spatial patterns in a sequence with a slight variation in frequencies could be an energy value and determinant of touch. Similarly for the sense of smell and taste the polarization frequencies may range from 08 to 10, 12 to 15, and so on. Before discussing the technique, we will elaborate certain basic facts regarding the approach of an appropriate experiment:

1. The technique should not interfere with the release of neurotransmitters and the movement of ions across the membranes.
2. Spatial patterns are suggested to measure in micrometers. Therefore, application of gross techniques like mica plates or widely separated scars may not interfere with the conscious perceptions. These experimental techniques were however appropriate to test the Kohler's theory at that time.
3. A conscious interpretation of any sort may develop as an overall operational effect of all the processed spatial patterns of EM field. It is unlikely that a technique employed at a single point will disrupt the whole conscious phenomenon.

4. It is hard to accept an experimental technique applying the external electric fields to the brain activity. If an external electric field is stronger than the changing field effects of the membrane, it may resist the movement of ions. If the strength is equal to the changing field effects of the membrane, it may either get aligned or do not affect the reinforcement.

Therefore, we recommend demonstrating the presence of linear polarization patterns in the neuronal track. These polarization patterns may establish in fractions of microseconds along the surface of a membrane. A microelectrode that takes recording at a comparative speed without a significant time lapse will be appropriate to show such changes. In other words, if a greater time lapses at the recording end then such critical changes may not be registered. First, we will be required to localize a neuronal track. Micro map technique may then be employed to localize the first point on the surface of the sensory cortex. It may be labeled as point ‘a’. Three consecutive points ‘b’, ‘c’, and‘d’ should be localized with reference to the first point such that all may be stimulated in a series.

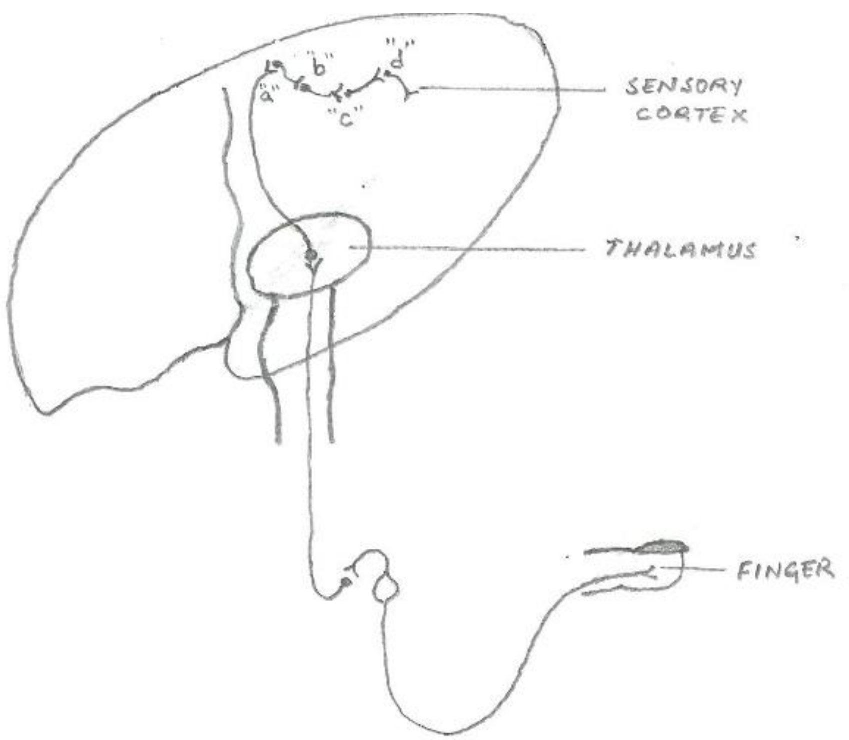

Fig.3.Transmission of signal to the sensory cortex

Three electrodes can now be placed inside the long dendrite of a pyramidal cell at point ‘b’. The first electrode positioned at the top, second in the middle and third near the body of the pyramidal cell with a gap of micrometers in all three. Point ‘a’ should now be stimulated continuously to make uniform discharges in the neuron at point ‘b’ with the positioned electrodes. When a transmitter is released for a few microseconds, it may sustain discharges of impulses in the neuron at point ‘b’ for a brief period of time. The molecules will metabolize in a few microseconds. Transmitters at the receptors’ site will keep the ligand-gated sodium channels open for the repeated transmission of action potentials. The positioned electrodes will take independent recordings. The phases of the deflection of all the three electrodes may then be compared at a specific time interval. If phases of the deflection are different at one time, the segments of the neuronal membrane will be at a different electric potential level indicating the presence of polarization patterns.

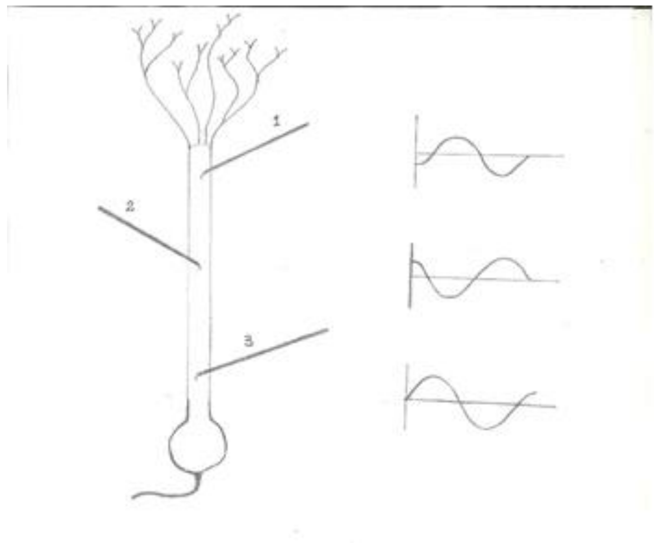

Fig.4. Recorded polarization patterns of a dendrite

The third electrode is introduced in the experiment to compensate for time lapses in recording the electrical changes. A similar procedure can also be repeated for the other two points ‘c’ and‘d’. If all the electrodes show a similar deflection at one time then it suggests that the dendrite is activated as a single unit and polarization patterns do not exist along the surface.

3.0 Conclusion

After a detailed study of the theories of consciousness and observing the fact that the organic membranes of neurons lack a comparative diversity to the conscious experiences, we believe that the conscious mind and its various aspects are electromagnetic. The brain activity generates spatial patterns of the electromagnetic field. A spatial pattern is possibly a basic integrative unit of the conscious meaning. The spatial pattern is established with synchronous neuronal activity and all the neurons working together may have similar polarization patterns. The polarization patterns can form linear polarization frequency. The dendritic polarization frequency may be a possible reason for the differences in basic sensory modalities. When a set of spatial patterns follow each other in a short span of time then a temporal relationship is established. Proceeding of temporally related spatial patterns can produce a peculiar awareness and psychic meaning in mind as an overall operational effect. The operation and integration happen in the complex neuronal network of the brain while the binding and meaning may develop in the accompanying electromagnetic field. The spatiotemporal relationship of the brain activity remains preserved in the electromagnetic field.

The brain activity is directed from the sensory areas towards the motor cortex. A signal comprising of a series of spatial patterns, permeates a large volume of cells before arrival into the premotor area. It moves through a lot of neuronal groups and becomes more decisive and a complete conscious information before arrival into the motor areas.

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