A Theory of Consciousness

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April, 1988

Abstract

A set of hypotheses in terms of the biology of the brain is presented, and the functioning of the nervous system is explained in terms of these hypotheses. Also, the experience of consciousness is presented in a light such that a certain mapping between elements of consciousness and biology manifests itself. The hypotheses are then further elaborated in terms of common concepts of human consciousness and behavior.

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1 Introduction

Research in neurosciences has found the brain to consist of a very large number of special purpose cells called *neurons*. Neurons are connected to other neurons through nerve fibers which grow out of their cell bodies. Some of these fibers provide input to a neuron. One or more of the fibers carries an output from the neuron. The nature of the input and output is electrochemical. In general, the inputs and outputs may be treated as having a sign and a magnitude. The neuron sums up all its inputs and compares the result against its *threshold*, which is a particular value and varies for different neurons. If the sum exceeds the threshold, the neuron *fires*, i.e. it sends output along its output fibers. The frequency of firing increases, to a limit, with the excess of the sum of inputs over the required threshold.

The sign and magnitude of the output also varies for different neurons. These outputs, again, go to other neurons and the process continues. In general, the senses (vision, balance, touch etc.) are the starting point and motor action (movement, speech etc.) the ending point of the total action.

The nerve fibers joining two neurons are not continuous. There is a gap where the fibers coming from the two neurons meet. Until reaching this gap, the output signal from one neuron is electrical in nature. To cross the gap, the signal causes release of chemicals called *neurotransmitters* which diffuse across the synaptic gap and start the electrical input signal at the other side of the gap. The junction of the two fibers is known as a *synapse* and the gap is known as the *synaptic gap* or the *synaptic cleft.*

The fiber carrying output from a neuron is known as an *axon*. There is typically only one axon per neuron, but this axon may branch into a very large number of smaller fibers, each carrying output signals to their destinations. The input fibers, typically shorter projections from the body of the cell, are known as *dendrites*.

There are many variations on this theme. E.g. the axon may not make a synapse with a dendrite, but with the body of the cell, or with another axon, or two dendrites may form a synapse, or the synapse may be completely electrical in nature with no neurotransmitters involved. But the general mode of operation stays the same.

Various texts are available for further details, e.g. [2,5,8].

In this paper, a set of neurobiologically testable hypotheses is presented as a theory of consciousness based upon the operations of the neural processes.

2 Hypotheses

We know that much of the neural network is genetically determined. In certain species, all of it is genetically determined.

It has been assumed here to be self-evident that neurons having chemical inputs do not discriminate between the relevant neurotransmitter coming from the proper synapses or just being globally abundant. Therefore, the physical excess of neurotransmitters or hormones causes changes of state in the whole network.

It has been also assumed that in the more flexible forms, much of the neural network is very plastic, both in terms of synaptic strengths as well as synaptic connections themselves. Changes in synaptic strengths as well as formations and eliminations of synapses do not cease after development of an organism is complete.

Furthermore, synapses only form between the proper types of neurons, e.g. between neurons using the appropriate neurotransmitters etc.

Given the infinite complexity, flexibility and variability of the behavioral repertoire, a theory of mind should consist of simplifying generalizations and not of complex organizing principles.

With these in mind, the following hypotheses are presented:

1. Firing frequently is important for neurons. Neurons which fire relatively more often are able to maintain and increase their synaptic strengths more readily as well as are able to form new synapses more readily. Infrequent firing leads to loss of synapses or cell death.

2. In some parts of the neural network, the physical orientation is important in forming new synapses. This leads to most of the input coming from one direction and most of the output going in another direction in these parts. The closer a neuron is to sensory or motor functions, the more important orientation is.

3. In changing strengths of existing synapses, forming new synapses or eliminating existing synapses, a typical neuron is designed to attempt to increase or at least maintain its own synaptic inputs as much as possible. (Thereby increasing or maintaining its own frequency of firing.) Such neurons will be called excitatory.

4. Exceptionally, in cases of neurons which will be termed inhibitory, the neuron is designed to attempt to decrease its own frequency of firing,

through changes in synaptic strengths and formation and elimination of synapses.

5. Genetically, pathways exist for recognizing various sensory combinations. Such recognition typically causes release of various neurotransmitters or hormones. Presence of excess neurotransmitters or hormones in the neural network leads to a global change of state in the network. Two of such states experienced by the network are particularly significant: those corresponding to pleasure and to pain.

6. The experience of pleasure significantly increases the ability of the excitatory neurons to form synapses and to increase their strengths. It also makes it more likely for excitatory neurons without synapses to acquire them.

7. The experience of pain significantly increases the ability of the inhibitory neurons to form synapses and to increase their strengths. It also makes it more likely for inhibitory neurons without synapses to acquire them.

Implications and elaborations:

- The terms excitatory and inhibitory, when used in describing a neuron, do not limit the neuron to forming any one type of synapses. It is possible for an excitatory neuron to directly inhibit another neuron (it is known that release of the same neurotransmitter may have different effects depending upon the type of the receiving neuron), and for an inhibitory neuron to directly excite another neuron.

- All neurons are in competition for synapse formation. This is distinct from the more explicit competition in terms of inhibitory synapses, described below.

- Circular, immediate feedback loops to increase a neuron's firings are quite permissible. The only trouble is that a neuron may not necessarily be able to locate its input neurons. Moreover, the orientation restrictions would reduce immediate feedback loops in various parts of the network.

- It is likely that neurons are constantly forming tentative synapses, and an increase (decrease for inhibitory neurons) in the synaptic inputs makes any recently formed synapses more permanent, or increases their strengths. Tentative synapses not followed by an increase/decrease in inputs are discarded after some time.

- As a matter of strategy, generally, a neuron should attempt to get input from neurons which fire often. Some of the more complicated strategies a neuron may use to maximize or minimize its frequency of firing:
  - If a neuron N often fires at the same time, and in particular immediately preceding, the firing of an excitatory neuron E, there is the probability that the two firings are causally connected. Thus it may be of benefit for E to have N fire, and E should attempt to form an excitatory synapse providing input to N. If such a synapse already exists, its strength should be increased. This strategy has been recognized earlier in a hypothesis by Hebb [4].
  - Similarly, if a neuron N often fires at the same time or immediately preceding the firing of an inhibitory neuron I, I should attempt to form a synapse inhibiting N, directly or indirectly. If such a synapse already exists, its strength should be increased.
  - An increase or decrease in the synaptic inputs of excitatory or inhibitory (respectively) neuron N should cause N to attempt strengthening all its excitatory synapses whose targets are firing, since these synapses are probably doing something right. Similarly, N should attempt to strengthen all its inhibitory synapses whose targets are not firing.
  - Conversely, if the target neuron T of an excitatory synapse is often found not to fire despite the excitatory source neuron E having fired, the synapse is being useless. E should attempt to decrease the strength of the synapse, or to eliminate it. A similar strategy applies to inhibitory synapses. The reverse strategies are useful in the case of inhibitory neurons.
  - If the firing of a neuron A leads to a decrease or increase, respectively, in the synaptic input to excitatory or inhibitory neuron B, an attempt to inhibit A directly or indirectly should be made by B.
  - In case of input synapses, the ones active more frequently should be strengthened by excitatory neurons. However, the correspond-

ing strategy is undoubtedly *not* used by inhibitory neurons, since it would make them useless. It is postulated that while inhibitory neurons tend to make themselves fire less, their metabolism does require accepting inputs.

  - The first level strategies mentioned above lead to a second level of strategy. Assume two neurons A and B are both receiving input from neuron X. Now, if A were to not fire whenever X fired, the synapse from X to A would lose its strength and would finally be eliminated. This would lead X to concentrate its synaptic strength in the synaptic connection to B. Thus it is beneficial for B to inhibit A, and vice versa. Any asymmetry in such a competition would tend to increase. Note that this strategy would often be in competition with, and tend to defer to, the other (first level) strategies mentioned above.

- Initial synapses are simply determined by the neurons being of appropriate types and by physical locations (proximity).

- A neuron not having any synapses would initially fire by the action of excess neurotransmitters and hormones alone. As a result of doing so, it would then tend to acquire synapses.

- Firing characteristics of a neuron are determined by the levels of pleasure/pain present in the neural network at the time the initial synapses to that neuron were formed.

- The sole interest of a neuron is its own rate and strength of firing. Thus connections to other axons, dendrites, cell body etc. are all permissible, as long as they tend to maintain or increase the firing of the source neuron. Undoubtedly, various novel means of affecting the network are tried by various neurons.

- It is postulated that growth processes in a neuron sense the firing of other neurons through electrical or chemical means.

- It is postulated that having its input synapses fire, and firing itself, is important for the metabolic processes of a neuron, and particularly to mechanisms of growth.

- The genetic development of the nervous system is permissive rather than instructive.

- As development proceeds, those neurons which develop early achieve relative stability in terms of their input and output synapses.

3 Functioning of the Nervous System in Terms of the Hypotheses Presented

In the following discussion, the nervous system is viewed as consisting of three logical subsystems, viz. the sensory, motor and central subsystems. The general direction of synaptic connections in the sensory subsystem is from the external input inwards, and in the motor subsystem is outwards to the motor activations. The orientation restrictions relax as the central subsystem is approached. Neurons in the central subsystem have none or little orientation restrictions. Synaptic connections from the sensory to the motor subsystems are permissible.

Considering the sensory subsystem at first, we notice that the net effect is to funnel the total sensory input at any one time into relatively few neurons. This will be because once a firing sensory neuron at a lower level has established a connection with a target neuron and caused it to fire, other firing neurons at the same lower level and in physical proximity will also be more likely to make connections to the same target neuron. With this process being repeated, and because of the directional orientation, sets of sensory input will tend to converge into sets of relatively few neurons. This phenomenon will lead to recognition of previously experienced sensory combinations in terms of their associations with particular sets of neurons. Furthermore, because a second level strategy dictates that neurons sharing inputs should compete in the absence of other reasons, there will be competition between the recognizing neurons at various levels, leading to fine-tuning of such recognition.

As far as the motor subsystem is concerned, a firing of a motor neuron is likely to directly lead to firing of some sensory neurons (through changes in the external world). Thus sensory neurons and their targets at various levels, in their attempt to keep themselves firing as frequently and strongly as possible, will make synaptic connections to motor neurons and their sources.

In the central subsystem of the neural network, the network is dominated by various sets of active neurons and synapses. Any set of firing neurons tends to keep its inputs firing, which in turn tend to keep their inputs firing, and so on. This process, however, cannot go on indefinitely, since the orientation becomes important as one gets closer to the sensory neurons.

As we get closer to the sensory levels, the neurons no longer excite their inputs through direct means, but through connections to the motor part of the network. Therefore, the synapses (from excitatory neurons) formed at a time of pleasure tend to cause motor neuron firings aimed at recreating the original sensory situation. Conversely, the synapses (from inhibitory neurons) formed at a time of pain tend to cause motor neuron firings aimed at avoiding the original sensory situation.

Various motor actions are, however, inherently contradictory. For instance, a hand cannot be moved in two different directions simultaneously. Thus neurons leading to these actions learn to inhibit each other directly or indirectly, and are in competition with each other. This competition is in turn learned by the neurons feeding into these neurons, and so on, leading to general competition in the network. [Note: "Learning" here includes the broader genetic learning as well as neural learning].

Thus many of the dominant neuron and synapse sets are in competition with each other. The competition is resolved by how strongly and how numerously these neurons are firing at present (i.e. by how much of the original sensation is present), as well as by how strong the original pleasure/pain experience was. The motor actions taken by the network are the result of this competition. This is in essence, the normal functioning of the network, apart from the ongoing neural modifications which denote learning. In other words, the actions taken by an organism are the sum total of the various pleasurable/painful situations it is being reminded of by the present external stimuli, and attempts by the representations of these pleasurable/painful situations to recreate/avoid themselves.

This basic competitive-cooperative nature of the neural network has also been recognized in previous work by Edelman [3].

The above describes the normal functioning of the nervous system. This normal functioning is altered by certain sensory combinations being recognized by genetically determined parts of the network and causing the release of various hormones or neurotransmitters, thereby changing the state of the whole network, and making some genetic responses more likely. For instance, muscular contractions become more likely upon recognition of threat to the total organism.

It is postulated that normally, the neurons of the motor subsystem have a high tendency to fire (intrinsically or due to the presence of some common neurotransmitter). This leads to a tendency to explore when no dominant pleasure/pain sets are active, or are active but not competing for motor actions.

4 The Hypotheses in Terms of Human Consciousness, Awareness and Actions

4.1 The Basic Correspondence

The philosophical axioms assumed may be summarized as

- A sensation or perception exists on its own, without anything behind it to carry out the sensing or percepting. There is no agent within the brain with a smaller set of eyes to *really* observe what the eyes have found, presumably with another agent inside with even smaller set of eyes to observe what the first agent's eyes have found ...

- The activation of the memory of a perception exists on its own, without a further agent for observing the activation.

- Attention may be drawn to a perception or a sensation. It may be preceded by other thoughts. However, the event itself (of attention being drawn to a perception or sensation) exists on its own, without necessitating a further agent for the *actual* selection and carying out of attention drawing.

- In general, thoughts exist as abstractions of sensations, perceptions, memories or other thoughts. The activation of thoughts exists on its own, without a further agent for carrying out or observing the activation.

- Formation of new thoughts or ideas, in terms of previously existing sensations, perceptions, memories, thoughts or ideas, exists on its own, without a further agent for selecting or causing the formation.

- The occurrence of a motor action, though preceded by thoughts, perceptions etc., exists on its own, without a further actor behind it.

- At this level of detail, there is no longer anything corresponding to a "self", though there may be thoughts or ideas of there being one. If so, these thoughts or ideas are not distinct from the various other thoughts or ideas in their nature.

This particular approach has been explored in historical philosophical thinking, particularly in the teachings of Gautam Buddha. Several texts on the subject are available, e.g. [7].

Let us consider the issues in more detail. Part of the functioning of our minds involves the actual sensory activity present at the moment. But, of course, there is more than that. Consider the question "What is the color of the sky?". In particular, consider the act of "thinking about the question regarding the color of the sky". Many people, upon thinking of this question, actually visualize the sky, where "visualizing" is some internal process which is in some way similar to vision. Similarly, thinking of the color blue may invoke a visualization of a patch of the color, or the letters of the spelling or a sensation similar to hearing. Much of human thought involves such activities, which are derived from the physical sensations actually experienced. Humans also "think in words", i.e. in terms of pseudo-auditory stimuli, or perhaps in terms of visualized spellings. The visualizations or other pseudo sensations brought forth in this manner may be considered part of a human mind's knowledge base.

The *bringing forth*, or *activation*, of the pseudo sensation is a rather special event for the mind. There is a very large number of such possible pseudo sensations present in the mind, for the most part resulting from actually experienced sensations. Some such pseudo sensations for you may be your name, the color of your car, the sound of rain, the taste of various foods. These are things you know. However, the "knowing" does not necessarily mean holding currently in conscious or subconscious awareness. There is a sharp transition when these pseudo sensations become active. But they are not all active at the same time. Rather, a few are active at a time, and they tend to become inactive soon. The question about the color of the sky leads to the activation of the stored "sky" pseudo sensation, or the "blue" pseudo sensation. While the "sky" pseudo sensation is active, various other pseudo sensations are on the verge of activation. If the individual is asked "What does the sky bring to mind?", the "sky" pseudo sensation becomes active, and then, with some additional processing, some other pseudo sensations may become active, such as clouds, rain, rainbows, snow, airoplanes, birds, kites ...

The activations of other related pseudo sensations need not follow questions. In the normal mode of activity, a combination of sensations and pseudo sensations becoming active automatically leads to other pseudo sensations' activations, which in turn lead to other pseudo sensations' activations and so on. After a while in this chain, the pseudo sensations may be fairly far removed from the basic sensation. For instance, a *bird* might have a specific pseudo sensation associated with it which is derived from a specific perception. But *living beings* is much less directly connected to a sensation or perception. At this stage, it has become more of an abstraction, abstracting several lower level pseudo sensations.

In particular, "abstract" thought, bears the same relation to a basic pseudo sensation as a pseudo sensation does to a real life sensation. Clearly, there can be multiple levels of these "abstract" thoughts. However, there is no sharp boundary where they become entirely detached from real life sensations.

These perceptions, sensations, pseudo sensations and abstract thoughts operate in chains, with one or more automatically leading to others (without necessitating an extra agent for selecting, carrying out or observing such chaining). Such chains, particularly when trying to comprehend a text on a difficult subject, are all too familiar!

At some point, all this activity of perceptions, sensations, pseudo sensations and abstractions leads to the human mind causing the motor muscles (movement, speech) to act, or not to act.

We also need to consider moods and emotions. The chain of sensations and pseudo sensations we discussed above is not invariant. Experience with human beings would indicate that responses to similar situations can be widely different, depending upon the mood or "state" of human being under consideration. For instance, in the state normally considered "anger", the responses may be totally different from those in the state considered "happiness".

Often enough, the mind is engaged in forming various permutations and combinations of the basic perceptions, sensations, pseudo sensations and abstractions. Either the mind is being driven by a dominant abstraction, such as "Make money", "Get promotion", "Get grade" and so on to try out various possible scenarios, or it is acquiring new sensory observations and trying out various permutations and combinations and obtaining generalizations.

Finally, various abstractions are contradictory. Commonly, if a person is "good", the person is not "bad". If the person is "bad", the person is not "good".

Henceforth, perceptions, sensations, pseudo sensations, abstract thoughts and all various levels will be referred to as *mental units*.

To recapitulate,

i) The human consciousness includes a very large number of mental units at various levels of abstraction.

ii) Mostly these mental units are in a state which may be referred to as inactive. Their state may change to active.

iii) A mental unit has other mental units associated with it in such a way that its own activation leads to these other mental units *tending towards activations.*

iv) If the *tendency towards activation* of a mental unit becomes sufficiently great, that mental unit itself becomes activated.

v) The activation of mental units is guided by emotional states.

vi) New permutations and combinations of mental units are constantly forming in a consciousness at rest.

vii) Some mental units are contradictory. If one is active, the other must not be.

Comparing this with the neurons and synapses:

i) The human brain consists of a very large number of neurons.

ii) Mostly these neurons are not firing. They may change their state to be firing.

iii) A neuron has other neurons associated with it as its outputs. When firing, it causes these other neurons to tend to fire.

iv) If its tendency to fire increases a threshold, a neuron fires.

v) The firing characteristics of neurons change depending upon the neurotransmitter levels.

vi) New synapses are constantly forming in a brain.

vii) Various neurons inhibit each other.

The mapping between neurons and elements of consciousness being presented here is not entirely new. An essentially similar mapping has been proposed earlier by Barlow [1].

In summary, the experience of consciousness is an aggregate. Components of this aggregate behave in a manner strikingly analogous to the observed behavior of the biological components of the brain. Therefore, it is reasonable to assume that

firing of a neuron is *the element of consciousness.*

No matter how complicated connections some of these elements of consciousness may have, they are essentially the same. Ultimately, we may conclude, consciousness is an innate property of matter and energy.

4.2 One Neuron, One Concept?

Yes and no. Primarily, of course, the answer depends upon the questioner's concept of "concept". An attempt will be made here to correlate the term with neurons and neuron assemblies, unavoidably favoring a certain interpretation of the term itself.

In general, two neurons which have synapses from different sources or of different strengths, denote different combinations of neuronal firings and therefore correspond to cocepts comprised of different subconcepts. Thus two such neurons, generally, correspond to distinct concepts. However, there is no reason why two neurons should not happen to make synapses with the same inputs. As a matter of fact, this situation should arise often enough.

When this happens, for some time the two neurons denote the same concept. Not only that, they make the concept more important in terms of the effect it will have. At least initially, the two neurons benefit from cooperating, and they will probably develop cooperative synapses.

However, they may still differ in the output synapses. In this case, as soon as an incompatibility in output becomes important, the two neurons are likely to compete. This represents the effort by the neural organization to find the best possible response.

Even if the outputs are the same, it is ultimately of benefit for neurons to compete if they are sharing inputs.

As a result of these cooperative and competitive tendencies, the neurons, particularly if they fire often, are very likely to develop assymmetrically and will soon denote different concepts. Depending upon the resultant cooperation or competition, the different concepts may be subtly different without conscious awareness of the difference, or they may be explicitly contradictory.

4.3 Refinement of Concepts

In the central parts of the nervous system, any two sets of neurons are in competition if they would tend to excite contradictory motor neurons as a result of their firing. The basic unit of this competition is the individual neuron. In terms of consciousness, this is the tendency towards finer and finer refinements of concepts. This refinement does not tend to occur without need. That is to say, we ignore a very large number of possible subtleties in our concepts. For instance, consider the perception of the color blue. Now consider the perception of the color green. Now consider the hypothesis that the world is divided into two types of people. For type A, the perceptions are exactly like yours. For type B, the perceptions are exactly the reverse of yours. On seeing the color green a type B person experiences what you experience when seeing the color blue and vice versa. Consider whether you would ever notice the difference. For that matter, the number of types may be four billions instead of two. Also note that typically, we simply do not have the subconcepts "blue as perceived", "blue as perceived by person X", "blue as perceived by person Y" and so on. These two facts are connected: the sole reason for not having this refinement is that this refinement is not dictated by anything in the environment requiring distinct responses.

As a less extreme example, consider the letter 'A'. A typical individual does not particularly distinguish between, or is even aware of the differences between, the various fonts the letter appears in. However, an individual working in the typesetting industry quickly develops competing mental units for the visual representations of the letter 'A' in various fonts, since need, in terms of responses, for developing such competing units arises in that industry.

4.4 Awareness

The experience of awareness is a graded phenomenon, ranging from sharp awareness to marginal awareness. Some general properties of awareness are:

- When learning a new task, one is very aware of all the detailed steps. Once having learned it, the detailed steps happen without "much" awareness. Somebody learning chess is very much aware of rules of possible moves which can be made by a piece. Advanced players are no longer aware of the rules, but rather engage their awareness in counting supports or playing out exchanges. More advanced players are no longer even aware of counting supports or playing out exchanges. Similarly, somebody learning to drive a car is very aware of pressing an accelerator or pressing a brake, but loses this awareness after some time.

- Awareness typically encompasses no more than seven or eight concepts in any one category [6].

- Awarenesses associated with experiences of pleasure or pain become easily recalled memories.

These would seem to indicate that primarily awareness is related to formation of new (probably tentative) synapses. One rather astonishing conclusion of this assumption would be that, of the astronomical number of neurons in the brain, at any one time only seven or eight or so may be involved in formations of new synapses (possibly with a single "freshly allocated" neuron).

To a lesser degree, we are aware of all the neurons firing. But we are not "much" aware all the time of even all that we see or hear.

4.5 Associativity and Language

Associativity is essentially a side effect. It results from the strategy of a neuron to tend to excite other neurons firing at the same time as itself. A particular side effect of associativity is language. We use language as a means of duplicating a particular neural firing structure.

A very important effect of language is in creating a vast number of refinements. As noted above, a refinement does not occur without need. With language, the words distinguishing between similar (but not same) concepts create the need for a refinement and hence the refinement itself.

The basic intent of language, of course, is to create and communicate refinements corresponding to sensory realities. The growth of language, however, does in no way restrict itself to this basic intent.

It has been postulated that pheromones in insects are a long distance manner of communication between neurons [8]. Similarly, language is a long distance manner of very accurate communication between neurons. Not only can it cover long distances, it can also cover long time spans. Arbitrary marks made on a slab of stone, resulting from a particular neural firing pattern, can evoke similar firing patterns after thousands of years.

4.6 Creativity

There is no creativity from void. The wheel is invented because someone watches a stone rolling down the hill. Effectively, creativity is simply the result of the collecting together of various abstractions in different ways, which in turn is a direct effect of the fact that new synapses are continually being tried out and forming between neurons.

4.7 Representation of Causality and Expectation

While the neurons and synapses with the maximal pleasure and pain associations dominate the initial directions taken by the neural net, the neurons and synapses with relatively neutral pleasure/pain associations provide representations of causality and expectation. An initially dominant neuron D may find it useful to excite a neuron representing situation S1, if S1 always excites S2, S2 excites S3 and S3 excites D. The connections between S1 and S2 and between S2 and S3 represents causality or expectation. Note that all such connections are likely to be stronger and more numerous in one direction than the other, since direct feedback loops cannot always be successfully formed. (A neuron has as much chance of connecting to some other simultaneous neuron as it has of connecting to its source neuron.) This directionality represents the direction of time. Occasional confusion between cause and effect is not at all uncommon, particularly as neural distance from sensory levels increases, and the role of orientation is diminished.

4.8 How Can Somebody "want" to "own a car" Without Having Experienced the State?

At first glance, the theory seems to suggest that individuals may only "want" or "want to avoid", states previously experienced. Therefore, one cannot want an unknown state, and a person who has never owned a car cannot want to do so.

However, one cannot want to own a car without having experienced the concept of a car in any way. Once exposed to the concept of a car, the desire to create the state of "owning a car" can arise in various ways:

- The experiences associated with the exposure to the "car" concept were pleasant. This may result from physical comfort, sensation of speed etc. Thus a set of neurons and synapses results which attempts to recreate this pleasant experience. These new neurons find that they can get themselves to fire if other neurons (with newly formed synapses) are also firing, where these other neurons represent the concept of "owning a car", which has simply resulted from a creative combination of the concepts of "ownership" and "car".

- There are various pleasure/pain neurons already competing in the network. Some of these neurons may be the ones representing the pleasurable sensation of "approval". These neurons find that they can get themselves to fire if they feed into the creatively formed set of neurons representing "owning a car". Thus, "owning a car" neurons acquire the intensity of "approval" neurons. Note that the "approval" neurons may themselves have acquired their firing intensity from pleasant associations of approval.

- Alternatively, there may be associations of muscular pain with walking between different places, or with waiting for a bus to arrive. These (inhibitory) neurons would seize upon creatively formed "owning a car" neurons as a means of reducing their own firing.

5 A Few Unresolved Questions

What is the exact mechanism of recognition of impossibility at the sensory and motor levels? Does it directly inhibit or weaken the initially dominant competitors?

What underlying realities, if any, are reflected in natural language grammars?

What are the mechanics of sleep? Hypnosis? Meditation? Of states of consciousness beyond, and allowing freedom from, pleasure and pain and the various related neural dominances?

What are the significances of the gross anatomical details of the brain?

Why are certain neural organizations more suited to solving certain types of problems? To grasping concepts? In terms of time taken? In terms of accuracy and effectiveness of the solutions or of the grasp of the concept?

Why and how does music affect minds?

What is the significance of different types of neurons? Of the varied physical characteristics?

6 Conclusions

The theory presented and expounded above makes specific predictions about the behavior of individual neurons. It also makes predictions about the overall behavior of organisms with nervous systems. Thus the theory is experimentally verifiable to a significant degree. Subject to experimental verification or falsification as the case may be, it not only provides a broad framework for advancing our understanding of human consciousness but also presents much of use to arts and sciences such as psychotherapy, sociology, computer science and psychology. It also promises elucidation of various concepts and allegories found in traditional philosophical and religious thought.

Many questions, however, remain unanswered. Experimental work and different viewpoints should help find and refine the answers.

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