On the Significance of Amplified Macroscopic Probability in the Optimization of Learning

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Abstract:

This paper discusses the possibility that consciousness is the result of a large-scale, integrated physical process within the brain. This is a claim that will be substantiated by showing how, through modulating the fluctuations in the probability of a specific population of neurons firing or not, constrained variance within this activity is intimately related to a person's ability to learn and become conscious of themselves. The biological manipulation of neuronal firing operates through a form of processing that can be putatively referred to as non-systematic connectionism: a form of connectionism that is able to learn creatively. The variation in probability of neuronal firing, as it is related to consciousness, is associated with the motion of a specific set of neuronal processes inside the cortex. The agent that is being proposed as the cause of this movement - acting as a factor promoting nerve growth - is a magnetic field residing in the sixth layer of the cerebral cortex. Furthermore, it will be shown that the predicted physiological profile of the area responsible for the field could link it to the gamma frequency observed in human brain studies.

There are many different aspects of the human mind that we do not understand. Some, such as consciousness and thought, cannot presently be explained by our sciences. Because clear and meaningful definitions cannot be produced for these terms due to their ambiguous natures, each phenomenon is still too abstract to capture. Without a definite purpose being given to either phenomenon, no precise definition can be generated for them. Without a reason affixed to either phenomenon it becomes easy to dismiss them as having no purpose at all, and therefore as not existing. However, we can use other faculties we know something about, for example the ability to learn as a starting point in the investigation. By focusing on learning and its optimisation in humans, it may be possible to find a purpose for consciousness and thought.

Creatures that learn the quickest usually have the highest frequency of survival. And because humans are defined – amongst other characteristics - by both their staggering ability to survive as well as having a form of self-awareness that is unique in the animal kingdom, perhaps these two ideas are interrelated. Perhaps both are the reflection of an underlying capacity and representative biological structure that work simultaneously. Consequently, if it was possible to fashion a pertinent theory that links learning to consciousness, i.e. outlining how consciousness is an end result of a human's continual struggle to survive with the latter eventually leading to the development of the former, then some progress can be made in the investigation of consciousness and thought. And, to this purpose this paper outlines the hypothesis that constrained variability in the firing pattern of a group of discrete neurites in the cerebral hemispheres results in the optimisation of learning. Furthermore, when this basic structure is modified through evolutionary pressures, consciousness was a primary result.

Due to the magnitude of this task, the body of this article has been divided into four sections. In part one, the problems inherent in learning and also what is necessary to learn will be highlighted. This will allow us to acknowledge the fundamental problems inherent in the question of how to optimize learning. With this background, the second section is discussed: How do we Learn Effectively? To begin, Top-Down and Bottom-Up algorithms, will be defined and examined, providing a starting point to the dialogue. This further develops the information from the introduction by highlighting the two basic types of learning. After this, due to the limitations of both types of learning paradigm, a hybrid solution is offered. Once this is solution is elucidated, the discussion moves toward describing the two parts of a signal: message and noise. This is done to show how a hybrid solution might be best developed in a successful learning system given the dichotomous nature of information (signal). This concludes the second component of the paper.

After the fundamental aspects of the theories underlining learning have been addressed, the next part of the paper focuses on the physical parameters of the human brain. This takes place under the heading: How Does the Brain Permit us to Learn? This is done to determine if the attributes brought up in the first part - the aspects of a successful and adaptive creature that is able to optimally learn - can occur within the human brain. Due to this section's hypothesis that learning is maximized by a central nervous system which is in flux there exists a brief discussion on nerve growth factors that can induce such flux. This leads to further speculation in the rest of the section that a small amount of variance in pairing could be produced by having a magnetic field in some part of cerebral cortex causing a neighboring portion of the brain to vary the intensity of its firing through varying the amount of interference that occurs.

Then, the idea of 'Additive Variance' is emphasized to show that this model, when operating normally, does not generate sufficient amounts of variance to render the model ineffective.

The last part of the paper endeavors to tie together learning and consciousness. It is entitled: Can a Person Who Effectively Learns be Conscious? This discussion begins with a tentative definition for what consciousness could be, as it is related to learning. From here, the original problem is revisited: can an organism that is evolving to maximally adapt its learning capabilities, become conscious? At this point, due to previous arguments, it is concluded that learning and consciousness should be considered as different aspects of the same process; developing through an ongoing continuum.

1.0 Learning

1.1 Reacting versus Learning.

The act of learning can change the way we view both the world and ourselves, because it permits us to be affected by the environment and as a result, understand the rules that may govern it. By this, we become better able to obtain our needs from our surroundings. Sometimes learning and responding to stimuli are treated as similar, but in this section a distinction between them will be strictly held. Learning will be defined as the production of a new status quo. While those who merely respond, are following hard-wired reaction patterns hence, maintaining the status, even in those cases where a regulated response changes, it is not a new response if it occurs within its range of outputs. As long as the behavioural changes that are due to an interaction are a result of a new kind of association between stimulus and response, the response can be qualified as learning.

The most straightforward version of responding to input is through regulation, where a sub-system (or other system) of the creature endeavours to maintain a steady average output. The ability to regulate both heart rate and breathing is controlled by neurological subsystems that fire at a regular rate. The Sino Atrial (SA) and the Atrio Ventricular (AV) nodes control heart rate and the Dorsal Respiratory Group (DRG) controls breathing. This is not referred to as learning because a new association between input and output is not generated, all that happens is a predefined reaction is given for a predefined input. If the SA and AV nodes, as well as the DRG's intrinsic firing rates are not altered by external stimulation or inhibition, there will be little variability in their response. Heart and breathing rates change when other neuronal tissues modify the pulse, but when left alone the intrinsic rates of these areas continues. In general there is little variance, except in cases of increased demand, such as exercise.

1.2 Body and Neuronal Acclimation

Zoologists use the terms Acclimation, Developmental and Genetic Adaptation to describe what strategy an organism's physiology may employ to deal with changes in its environment. All three terms refer to various levels of change in the body to adapt to changes in the environment. Usually, acclimation is used to describe changes at the level of the body, but unlike developmental and genetic adaptation, their affects are not as permanent, nor take as long. Examples of acclimation include the type of proteins being produced in an organ that occurs in response to an alteration in the environment.

This paper would like to introduce another category of acclimation: Neuronal Acclimation. This is physiological change occurring in the human brain. It is a reversible alteration in the physiology, just like the standard acclimation, or body acclimation, but is located, as the name suggests, in brain.

The key aspect to either type of acclimation is that they both are reversible and quick. Developmental changes cause an irreversible change in an individual's physical makeup (phenotype), but not in the genome. Then there is genetic adaptation: the genome itself changes due to the effects of natural selection with inherited traits being passed on through changes in the allelic frequency. Therefore, acclimation would occur the quickest, and could take place many times within an organism's lifetime. Developmental and genetic alterations involve very complex changes, and take place over many generations. And because of this, developmental and genetic changes cannot lead to learning within a generation. Consequently, acclimation, specifically Neuronal Acclimation, will be the process we will concentrate on. It is a type of learning that is reversible because the processes that are responsible for it can be altered within the organism's lifetime as well.

Neuronal Acclimation is also necessary because the human form, in general, does not easily lend itself to manipulation. Gross physical changes, for example, the ability to grow wings in situations where flight would increase man's chances of survival, have to give way to alterations in the body that are easier to perform. In other words, large-scale phenotypic plasticity has to give way to small-scale plasticity. The ability to change, the ability to learn as it pertains to neuronal development is quick and does not require great expenditures of energy because gross-structural changes for a complex life form are energetically too expensive

Because individual optimums from different parts of the body are being taken together due to integration of information, humans have become generalists. Through blind necessity the human body has produced a generalized sort of reaction to input so that unique, special changes that can and do occur in simpler life forms are no longer the only means available for human survival and adaptation. Consequently, in such organisms that are more complex there is a change towards employing a centralized allocation of the inputs and learning from them, so that new and adaptive behaviors are formulated. If this did not happen, complex, multi-cellular organisms would not have a way of overcoming the limitations of having a phenotype that is not as plastic as simpler creatures. Complex acclimation through neuronal processors is the successor to primitive acclimation, which didn't have such integrated optimums.

Dynamic systems like the central nervous system are able to learn based on what are called Comprehension Algorithms. This is the accruement of knowledge through the installation of information through various means. Learning, as it occurs within the scope of Neuronal Acclimation, involves producing new integrated optimums that are more adaptive than old integrated optimums. Although the word comprehension could imply understanding, in this case the term is only used to denote the ability to grasp the bare associations evident in a situation and how one piece of information might lead to another, but not an appreciation of the connecting reasons. Reasoning is possible, but would only occur if there was an ability to study the information that lead to the outcome.

2.0 How Do We Effectively Learn?

2.1 Top-Down and Bottom-Up Algorithms

There are two different categories of Comprehension Algorithms: Top-Down and Bottom-Up. Although these terms are used primarily to describe systems regulated by

Artificial Intelligence, the concepts involved are also firmly rooted in organic life. According to Levy (1992) and others, the Top-Down learning schema brings about learning by relying on established protocols. Instructions or rules pertaining to the management of the system are placed in the system before information is fed into it, i.e. the rules precede the data that it will affect. This model is known as an expert driven system, it is similar to a computer acting on the commands written down in its software.

In a manner of speaking, the internal drives that meet the basic needs of life appear to be based on a Top-Down algorithm. Drives, or commands, or rules, are put within the mind to acquire the necessities of life. Nevertheless, although the tendency a newborn animal has toward water, food, and warmth are similar to Top-Down directed goals, the goals themselves are not specified. An animal driven by an endogenous impulse to eat after birth is acting on an internal drive, but the type of food consumed is left unspecified and the way to get it still has to be learned. The drive is blind, and consequently it is closer to Bottom-Up or emergent behaviour.

Due to the fact that infantile endogenous drives are not pre-specified, they cannot be considered within the scope of Top-Down learning paradigms. Indeed, when considered in this way, a newborn baby has no behaviours that can be truly defined as directed towards any certain goal. More specifically, it is better to state that they are attempting to reduce the need for a desire than it is to say they are trying to obtain it. The former is a more primitive state than the latter.

John Locke (1939) came to this realisation when he noted that children are not born with a wealth of knowledge. The ability to know and recite facts does not come until somebody else has taught the child the very same information. According to this observation, Locke concluded that we are just blank pieces of paper on which facts are written. We do not actively partake in this transfer of information, which is what Locke referred to as *tabula rasa*.

Whereas Top-Down models stress foreknowledge, Bottom-Up models involve an emergent process: learning without foreknowledge. This idea resembles Locke's blank sheet of paper. In biological terms, the sheet would be the surface of the brain and the pathways inside of the brain can be considered to be the places where information is stored, similar to the printed words placed on the lines of a sheet of paper. However, the basic associations between deposits of information within the brain are lacking. Such associations need to be developed, leading to new relationships being formed between pre-existing ideas resulting in the production of new patterns in the Central Nervous System. So called knowledge-empty systems appear to be more reminiscent of how an animal learns and how its actions change through its many stages of growth. Therefore, many people favour this mechanism as being the appropriate model for how the human brain learns.

Yet, there appears to be a problem with this theory. True Bottom-Up models do not seem to be goal-directed or to even have the necessary algorithms to direct the development of the organism. Due to a lack of organization, they are inefficient. In accordance with one of biology's principles, efficiency is a primary characteristic of a successful organism. Waste and wasteful strategies that will not maximize a creature's efficiency will be discarded. Consequently, an organism that only has Bottom-Up, emergent processes in place always searches for meaning in an aimless fashion and would behave in a very inexact and haphazard manner.

This impediment in Bottom-Up adaptations can be overcome if these inexact 'drives' can be transformed within the brain into more meaningful goals. If the organism has the mechanism with the basic needs already within itself, in the form of ‘blind drives’ (as is the case for the human brain that has such features intrinsically set inside the hypothalamus), it can be posited that precise goals are not entirely necessary. As mentioned, the baby does not look for nourishment because they understand nourishment is important, they just wish to decrease the drive to obtain it. Because the satisfaction of basic needs is primary and therefore considered first, a specified set of goals is only an approximation of the original needs. The secondary goals only become important when they are associated with the original ones. Consequently, implied meaning (meaning on a deeper level) could be derived from a simple set of Bottom-Up drives and not the other way around. An aimless wish to acquire a general form of nourishment becomes the impetus for more organized behavior.

But, Bottom-Up learning does not permit true creativity. Even in this circumstance, structured associations between patterns are set by antecedent conditions. As the creature's knowledge base emerges, patterns will be formed and tendencies will be produced. The organism has learned to act in a specific way from what it has experienced previously. Therefore, variability within the behaviors produced will be seriously reduced in time.

Although learning maintained by a Bottom-Up paradigm has some variability in the beginning, Top-Down algorithms are even more structured. This is because all schedules in the Top-Down algorithm are entirely linear: fixed input would produce fixed output. Consequently, after a set amount of variation has been produced - either beforehand or as the system adapts to its environment - further change is highly unlikely. Because behavior would be dependent on the specific nature of the input, there could be no deviation from the standard.

Bottom-Up learning forces the organism to follow associations it has learned from the environment, and Top-Down learning forces the creature to follow associations that are already placed inside of it. Therefore, emergent paradigms (as well as, expert driven associations) are firmly linked to the dispositions of the environment to varying degrees. Volatile situations could not be dealt with, and consequently the fluctuations that are often experienced in a given habitat could destroy a creature following fixed relationships. Bottom-up learning appears more beneficial in this respect, however, if the environment changed in a way that the creature had not seen before, the organism would still be too entrenched in previous ideas to help itself. Furthermore, since this does not happen and since humans can contend with capricious milieus due to their ability to overcome diversity, it is reasonable to state that the human brain's ability to manufacture behaviors cannot be completely linear or fixed.

2.2 Hybrid Solution

How, then, can the apparent failings of both comprehension algorithms be overcome? As mentioned in 2.1, either paradigm taken by itself and treated as an absolute answer to how a person learns produces contradictions. Can the two algorithms be merged? Consider Ocam's Razor which suggests that the simplest solution is usually the most efficient. In respect to this recommendation, the following series of premises could be proposed: Since learning is a function of time and survival is a function of the organism learning how to meet its basic needs as quickly as it can, then by taking the most promising aspects of the two former paradigms and increasing the efficiency of learning we can follow Ocam's theory to the letter and maximize the brains ability to acclimate to new situations in its environment.

With this qualifier in place, we could tentatively assume that the brain begins processing trains of neuronal frequencies in a Bottom-Up fashion. By doing so the information would not be hindered by constraints and would have sufficient latitude to form optimal associations. Nevertheless, as stated previously the malleable nature of the Bottom -Up system only exists while it is developing its associations. It is only with time that the variability is reduced, a shortcoming that could be alleviated if the associations were allowed to not be completely fixed, as it might be with a non-specific Top-Down protocol. If it were also possible to amend the Bottom-Up condition with the favourable attribute of time reduction that exists in Top-Down protocols, as it occurs in such systems because the knowledge is already there (or the ability to get the knowledge), we would come up with the perfect mixture of the two paradigms.

Therefore, a nervous system guided by both protocols would have the capability of finding patterns and associations between pieces of information without the lengthy periods of learning inherent in undirected systems. Perhaps, as hinted at, this could be achieved if the system's Top-Down knowledge was not completely specified. Exact procedures and protocols would then become generalised traits that the individual would follow from their birth.

2.3 Top-Down, Bottom-Up Non-specific Algorithms.

Another way at viewing a Top-Down event is that it is a guiding principle. The guiding principle can come in the form of a set of commands or even a force. A process with no specific agenda similar to the relationship between gravity and physical objects would continually mould Bottom-Up knowledge. In this metaphor, gravity would always have the same effect, but the amount of acceleration that is produced depends on how far the object was from the ground. Consequently, either gravity or the non-specific Top-Down event can have different outcomes, even though the underlying effect does not change. By having a force instead of a set of guiding terms as Top-Down terminology often implies, it is possible for the brain and all its pathways to be under the same guiding process without requiring foreknowledge. In terms of the non-specific Top-Down event, which I will refer to as a non-specific algorithm, it creates a consistent set of possibilities but with results that may differ, given the parameters that are involved. This point implies that Locke's sweeping metaphor should be modified. The human mind is not just a blank piece of paper - it can process and modify the messages that are written on it.

Penrose alludes to the use of a non-specific algorithm as a way by which understanding and knowledge are obtained. In his 1994 book, Shadows of the Mind, Penrose states that the ability to solve abstract mathematics could not have come about due to any specific algorithm, because it would not be naturally selected for. Therefore, Penrose maintains that in order for this ability to have arisen it must be the result of something that cannot be readily defined. He states the following:

> The situation is quite different once we allow 'understanding' to be a non-algorithmic quality. Then, it need not be something so complicated that is (sic) is unknowable or incomprehensible . . . Understanding has the appearance of being a simple and common sense quality. It is something difficult to define in any clear-cut way, but nevertheless it is so similar to us that is seems hard for use to accept that it might be a quality that cannot be properly simulated even in principle, by a computational procedure. Yet, this is indeed what I am contending. On the computational view, one needs an algorithmic action that allows for any eventuality, so that the answer to all mathematical questions that it is ever likely to be confronted with are, in a sense, pre-programmed into the algorithm. (P. 150-151)

This quotation clearly implies that Penrose believes that understanding or learning has to rely on a set of variable rules, produced by an algorithm that cannot be defined. And, possibly, the only way by which this can happen is for the algorithm to be the result of a processor that is itself in flux.

Descartes' Dualism has a component in it that is similar to the non-specific algorithm. In Discourse on Method, his introductory work on Dualism, Descarte (1637) maintains that the brain simultaneously consists of both physical and non-physical elements. He endeavoured to show that a non-physical (Cartesian light) aspect of the brain is prominently involved in the elementary qualities of the individual. In part, Descarte believed that we are just copies of a divine element that cannot be defined. His reasoning was that in order to understand a being as perfect as God we have to have something close to that perfection within us. Taken a *prima facia*, Descartes' thesis seems groundless. However, by not viewing the non-physical aspect of his work as a purely transcendental construct, but instead an indefinite algorithm that can move between any number of possible solutions, we may gain a fresh perspective of Descarte's work. The human mind, or the non-specific algorithms produced by it, appears transcendental because there are going to be aspects to of its output that cannot be readily defined.

When this solution is considered in terms of one's ability to learn, the non-specific algorithm could be a means of experimenting with different responses to a given input, taking responses produced by the traditional, linear behaviour of a first generation hard-wired connectionistic network (see section 3.6 for a definition of this term – especially for the difference between a hard-wired and a soft-wired system) and changing them. This thereby adds a small amount of flux to the computational ability of the network as a whole. Or, in keeping with neuronal plasticity, the flux permits neuronal acclimation to occur because different outputs could be produced for the same input.

In one circumstance an animal's brain could have chosen to respond to stimulus 'A' with response 'A'. The basic viewpoint would imply that if object 'A' was a goal that was to be obtained by the system, then the connections and weights of the various sub-components of the system have been properly adjusted to get this response. However, if 'A' did not work with this stimulus, or was not indeed the best response for input 'A', there is the possibility that behaviors 'C', 'D' or even 'Z', as encoded by other neuronal tracts, could be more successful if chosen.

To me, one of the major faults of connectionism theory is that there is a prejudice in the goal-directed behavior. Because connectionism is implemented in machines, it is up to the researcher to decide the goal. And consequently, the goal that is suggested is supposedly the best one. However, for a person, and given the complexity of our selves, it is almost impossible to readily define distinct goals. Except, that is, that we do whatever is necessary to survive. For machines, defining goals is a lot easier and hence, it makes more sense to have defined goals. For a person, it is better to create as many sub-goals (with survival being the ultimate goal) as possible.

A good example of this is when a person cannot figure out a difficult problem but through some capability is able to solve it. They are being creative. Later in this essay a more detailed description of this phenomenon will be provided in the ‘Additive Variance’ section (3.6), but at present let the example be an introduction to the idea. In this circumstance the person cannot solve a problem. Every time they think of it they come up against the same answer. Such would be the case for a computer, or else a neural net that only does things one certain way. But a person, given time, will be able to solve difficult problems by using logic that exists outside the question that they could not originally solve.

As stated in this article, the aforementioned person would be able to solve a difficult problem by overcoming the limitations of logic that are predefined for him or her by the situation. What is being suggested is not that the non-specific algorithm goes through all the permutations between the various stimuli and responses in a logical manner e.g. going from ‘B’ to ‘Z’ in sequential order (systematic connectionism), but instead, the algorithm or processes that are responsible for it, randomly selects pairings between the various stimuli and responses. This implies that input ‘A’ to output ‘A’ could be followed by input ‘A’ to output ‘D’; a sequence that is not systematic.

This proposal offers us the feasible hypothesis that the process of learning - the ability to acquire information - is built upon a non-specific, possibly nonlinear algorithm that is continual and therefore spontaneous. This involves pairing inputs to outputs that do not follow the traditional systematic format that rule-based networks operate by. It is an innate, underlying system that, when fully employed, tries any number of different patterns to provide a high degree of fit between the different stimuli-response pairings being produced. The more extensive this ability, the better is the chance that the fit between the stimuli and response will be optimized. It is a process, a force that is as relentless, and as objective as gravity. It exists and guides the development of the mind, but does so without words or actually instructions.

Yet, one has to ask, how can this kind of mandate be maintained? Can a system that is nonlinear with the rest of the brain, and subsequently partially divorced from the other elements in the brain, produce the kind of variable probability that would merge the best parts of Top-Down and Bottom-Up ideologies? How can the two simultaneously exist?

3.0 How Does the Brain Permit us to Learn?

3.1 Information Systems.

Before attempting to answer this question directly, it is necessary to realise that in any information management system such as the brain or the like there is always going to be variability, and therefore change in the primary signal. As described by Shannon (1948), information is made up of two parts. The first is the Signal and the second is the Noise. Signal is the data that the sender wishes to transmit, and the noise is the other part of information that is sent, but not desired. Noise occurs because of interference from other processes that occur within the environment in which the signal is being developed, sent and or received. Because both of these components exist simultaneously in the data stream, and since both are fundamentally different, noise can and does interfere with the strength of the signal. Subsequently, with more noise in the signal, the structure and the meaning of the information being sent will be corrupted. It will become weaker and harder to define.

The likelihood noise will affect the primary signal is based on the Laws of Probability. The greater the noise or the greater the variability in the signal due to the noise the more likely, the greater the probability that the primary signal will be changed and or corrupted by the noise.

The ideas evident in information theory, probability and neurology intersect because, when taken together, they help us to predict how best to optimize learning. In section 2.0 of this article, it was asked if it was possible for a non-linear phenomenon (non-linear with the input coming into the system) to be integrated with the rest of the system so as to enhance learning. Because as mentioned, input, other than the intended input is considered noise, as such, it can, if taken without further qualifications, diminish the fidelity of the signal. Therefore, adding noise (in the form of the non-linear input) to the system to optimize learning appears to produce a Catch 22. With each of various senses carrying information into the brain already having a certain degree of noise in them, adding more noise to these signals and those that already exist within the brain would seem to be counter-productive.

Before emphatically stating that this cannot be done, and the use of variance to promote learning is an entirely ill-advised biological stratagem, it is important to discuss the phenomenon of variance and how it may be manipulated. Previous arguments have stated that that by changing the strength of the signal to noise signal, the fidelity of the output is modified. Consequently, since the Law of Probability is involved in estimating the type of output that will be produced based on original conditions, it is possible to state that the nature of the noise (being one of the original conditions) may be very important in how the signal is changed. Even further, perhaps there are different Laws of Probability (Microscopic versus Macroscopic) involved for the different types of noises (internal versus external noise) that may be produced. And that perhaps, that one of these Laws of Probability, or probability itself, is not a detrimental phenomenon when applied to an information system that can use it to its advantage.

3.2 Microscopic and Macroscopic Probability

The study of information management systems and how noise may be generated can be further obscured because, in theory, there are also two different categories of probability: microscopic and macroscopic. John Eccles and Karl Popper studied this idea in their 1977 book entitled <u>The Self and its Brain</u>, which was further explored by Eccles (1994) in <u>How the self controls its brain</u>. In this first work, it was concluded that it is possible for emerging events and their probabilities to be described by two different scales. Eccles and Popper write:

> The answer too can be found, I think, if we replace the classical ideas of possibility or potentiality or capacity or force by their new version - by probability or propensity. As we have seen, the first emergence of a novelty such as life may change the possibilities or propensities in the universe. We might say that the newly emergent entities, both micro and macro, change the propensities, micro or macro, in their neighbourhood. They introduce new possibilities or probabilities or propensities into their

> neighbourhood: they created new fields of propensities, as a new star creates a new field of gravitation (P. 30)

By this, the authors are indicating that the change in the probability of an outcome can be brought about by elements that may be small as well as large. It could be suggested that the predictability of the systems described by the two forms of probability may have different qualities due to their scale. While causation for the most part is still practiced, the size of the event occurring may obscure the ability of the observer to determine the probability of an outcome because the events that lead to an outcome (the amount of signal and noise) may be difficult to measure.

For the sake of this paper, Microscopic Probability will be defined as changes in the probability of an outcome that is brought about by the internal variability of the individual members of the system. An example of this sort of probably exists in quantum physics. As is apparent in Schrödinger’s equations, used to map out this kind of probability, the nature of the object and not its interactions with other distinct objects is the reason for uncertainty. If everything was stable in the atom, or any other system that displays this kind of probability, then it would be possible to define it accurately. However, because it is only possible to talk about favourable cases given mathematical equations and mathematical abstractions in sub-atomic physics, the system does not lend itself to certainty.

Due to the large amount of noise produced by an interlinked and multi-bodied systems generating Microscopic Probability, it is highly unlikely that the brain would operate in this fashion. With each member of the system having its own variability, a high amount of instability would create chaos. High levels of variability would ensure that management of information and learning would not be possible if the CNS functioned in this manner. Also, it would also be impossible to co-ordinate so many different nerve cells and their corresponding patterns if they each functioned within the current scope of Microscopic Probability. Such a situation would result in an unacceptable time lag existing between the separate members of the system and therefore, with the information that is being held and processed in each part of the system.

With the locus of control for this kind of probability existing within each cell, overall management within a suitable range of cohesion is unlikely. Therefore, the locus of control, in respect to an event generating the necessary amount of probability or noise to produce a non-linear signal to increase learning must be outside of the individual neuronal cells that are being modified by it.

Whereas Microscopic Probability and the noise it generates is within the realm of the atom, Macroscopic Probability is the product of classical physics brought into flux by a physical interaction of one stable entity with another. An example of this is when pool balls hit each other. With each ball not moving before it is hit, except the ball that begins the process, it is possible to set the original conditions and determine the output. The outcome for Macroscopic Probability can be rendered more specifically for this example because the uncertainty in the makeup of the system can be defined.

Another example of Macroscopic Probability is in the movement of gas particles. Mapping the position of gas particles is very difficult because each particle can influence another and increase the complexity of the system thereby making the charting of the entire system more a science of what is probably happening than what is actually happening. However, in this situation, unlike Microscopic Probability, individual members of the system are still relatively stable. Instability in the macroscopic system is a by-product of one relatively stable member changing the outcome of another relatively stable member. The individual members are still stable, but if the observer was not aware of what had caused the object they were following to change course, they would conclude that it was unstable and hence inherently unpredictable.

Supplied with this information, the introduction of noise in the macroscopic form can be viewed as an essential quality which adds flexibility and not brittleness to an information system. In an ideal case where there is no noise in the signal entering the system, this would maximize the amount of information in the signal. With no noise, the channel carrying the information would be optimized. However, it most be remembered, in an ideal case, the environment in which the system is working and taking in information, it is itself stable. But few if any environments are stable. There are inconsistencies that are intertwined within and define the environment. If the information system did not have a form of instability within itself, such as would occur between Macroscopic Probability and the Human Brain, that fits the size and complexity of the data it is collecting and processing, it is unlikely the system could overcome the variances that are inherent in non-optimal environments.

Based on the preceding arguments, the following is being offered: the Top-Down non-linear guiding force within the brain is neuronal noise. The attributes of this event is that it is global, such as would be suggested by it being macroscopic in nature, and although it is non-linear with the rest of the information within the brain, the flux or disturbance or noise it creates in neighbouring neuronal pathways is minor. The minor disturbances that it creates are small enough in nature so as not to disturb the creation of basic Bottom-Up pairings so that the animal can comprehend the basic aspects of the environment and interact with it. Nevertheless, since the disturbances are present on a global scale and are considered in this article to be continuous they will allow for true non-linear pairings in neuronal pathways that are far removed from the basic ones developed beforehand.

3.3 Duality of Output

The addition of Macroscopic Probability to the brain may not only be a means to allow for Top-Down and Bottoms-Up learning paradigms to co-exist in an optimized manner, but it may also be an explanation for the duality for its output. As stated by Chalmers (1995), understanding what makes a person unique (and what makes a person conscious) is indelibly linked to how information is uniquely handled by the brain:

> The double-aspect principle stems from the observation that there is a direct isomorphism between certain physically embodied information spaces and certain phenomenal (or experiential) information spaces. From the same sort of observations that went into the principle of structural coherence, we can note that the differences between phenomenal states have a structure that corresponds directly to the differences embedded in physical processes; in particular, to those differences that make a difference down certain causal pathways implicated in global availability and control [...] This leads to a natural hypothesis: that information (or at least some information) has two basic aspects, a physical aspect and a phenomenal aspect. This has the status of a basic principle that might

> underlie and explain the emergence of experience from the physical. Experience arises by virtue of its status as of one aspect of information, when the other aspect is found in physical processing (pg. 216)

Like Shannon, Chalmers divides information into two parts: the main signal and a secondary signal mixed in with the first. However, instead of labelling the parts as Signal and Noise, Chalmers uses the terms Physical and Phenomenal. When taken together, these divergent labels refer to Chalmers' double-aspect theory of information. And, thus, by implication it appears possible to draw some parallels between the ideas presented by both Chalmers and Shannon.

By closely inspecting Shannon's work on the nature of information, one notices that causality is very important. This idea is none too surprising, considering noise can so easily change the quality and therefore the outcome of a signal and its subsequent accompanying information system. This notion deals with how definite or determinate a signal is; signals that produce a response that is predictable and repeatable are said to be determinate and to have a high degree of causality. That is to say, the precise nature of a signal is dependent on how much noise is in the signal: the more noise, the less causality. Moreover, as cited by Chalmers in the above quotation, he stresses the importance of causality as being a possible difference in the physical and phenomenal components of a signal.

Hence, it can be postulated that Shannon and Chalmers are both endeavouring to dissect information into its fundamental elements based on how much causality is involved in the basic components. High causality: the physical part of the signal refers to an element of the signal that has low noise. Low causality: the phenomenal part of the signal refers to a part of the signal that has more noise. Consequently, the phenomenal part of the signal could emerge from the main stream of the information because causality has been reduced by the inclusion of noise.

3.4 Probability Through Movement

The preliminary discussions involving Macroscopic Probability seem to infer that it is produced by movement, and hence implies that if it is to be produced in the brain there should be some movement in the neuronal matrix. Although this kind of rationale has not been explored before, Alwyn Scott (1995) demonstrates indirectly that motion is important in the production of uncertainty in neuronal tissue.

In his book, Stairway to the Mind, Scott attempts to demonstrate mathematically that the passage of an impulse down the length of a giant squid neuron cannot be a quantum event and therefore has a high amount of certainty. By employing his equations, he is able to stabilize all the parameters involved, and transforms Macroscopic Probability to Macroscopic Certainty, as would be predicted for a macroscopic event if all aspects of it could be described with certainty. Amongst the parameters he condenses, is the movement of the ion channels that appear along the length of the axon. However, if those very same equations were altered so as to show what can and can not be readily capturer, due to the neuronal event being much smaller than a Giant Squid Neuron or there were other phenomenon involved that he was not aware of, then Scott's line of reasoning could be used to imply, by the same line of reasoning, but with different premises, that movement could possible produce a non-linear event.

In the writings of the ancient philosophers, it is suggested that motion is somehow linked with knowledge, and its acquirement. For one, Aristotle, in his work, Metaphysics, comes to a similar realisation about motion and its importance in learning. He states:

> Now thought does think itself, because it shares in the intelligibility of its object. It becomes intelligible by contact with the intelligible; so, that thought and object are one. For that which is capable of receiving the object of thought, i.e., the essence is thought: and it is active when it possesses this object. Therefore activity rather than potentiality is the divine element in thought - actual contemplation, the most pleasant and best of all things" (p. 345).

In this quotation, Aristotle attempts to stress the active nature of thought. Thought, and therefore the person who is thinking, learns by interacting with the environment. Learning is not a matter of passively interacting with information, but is only achieved through managing the information received. In his own words, 'it is active when it possesses this object, therefore activity . . . is the divine element in thought.' There are many ways to be active. My interpretation of this passage is in favour of a person in the process of thinking not being controlled by the information coming into them, and can only occur if there was a process in this person that was beyond the control of this environment. And unless the person is instilled with innate knowledge to begin with, an idea already argued against, then the prospect of this control being a by-product of motion within the mind is a possibility that needs to be considered.

A concept similar to this was described by Windelband (1919) in his discussion of Heraclitus' work. Windelband describes it in the following quotation:

> When a man is awake, the World-reason streams into his body through the opened sense and, therefore, he knows. This comes about to be sure, only if there is besides, in the man himself, so much reason or soul that the motion coming from without is met by an inner motion, but upon this interaction, effect through the senses between the outer and inner reason knowledge rest (p. 64).

Again, it appears that another scholar believes that an 'inner motion', an inner source of activity, is necessary in order for a person to have the qualities that make them uniquely human.

This type of metaphysical evidence might appear to be simple conjecture, dismissed because it appears that a false comparison is being made between thought and motion. It is an idea that implies that the verbs thought and motion, are being falsely joined based on irrelevant facts. Thus, any features shared by either one through this apparent reasoning by analogy are considered mere suppositions. Nevertheless, there are examples of motion that occur within the human body that produce variability. For example, meiosis involves increasing variance in the gene pool by randomly rejoining different pieces of genetic information to produce an unknown result. This provides new combinations in the genome, and therefore, the phenotype. Therefore, in this context, the ability of a system inside the brain to change the probability of a pairing being made between a previously unmatched stimulus and response is perhaps similar to 'intra-generational meiosis' This is a change that occurs during the course of an organism's lifetime.

This parallel is drawn because it is possible to see how natural selection might play a role in both types of combinations. From generation to generation those individuals who display abilities that are more adaptive, will increase their survivorship, increase the chance of passing their optimums, or at least the ability to produce them, on to their progeny. Within a generation, due to new combinations of stimuli and responses being formed, this will increase the survivorship of the generation itself. Consequently, 'inter-generational meiosis' determines the genetic disposition of an organism when it is born, and 'intra-generational meiosis' outlines how well this genetic disposition may be used toward achieving survivorship within the lifetime in question.

Therefore, physical motion (a non-specific force) inside of an organ can be the impetus for variation in what output it produces. There were two examples given before to illustrate Macroscopic Probability. The first included pool balls. To begin, each of the balls were stable and based on how they were hit either by the initial ball or set into motion by another ball, an outcome was generated. Then there were the gas particles. Their outcome was not as certain because there was more noise as a result of each particle being in motion itself. Consequently, with the inclusion of motion, it caused Macroscopic Probability to almost have the variability of a microscopic event. It is a form of probability, or uncertainty, or noise that takes place on the classical scale, but whose variability is amplified by movement that is unknown to the observer. To emphasis this, modified Macroscopic Probability will, from this point onward, be referred to as 'Amplified Macroscopic Probability'.

Like the gas particle whose actions appear erratic, the noise created within the brain is based on motion, on rules and reasons that are unknown to the observer (or to the individual themselves). To this affect, the following interim hypothesis will be given: motion is created within a section of the human brain, motion that creates noise. This noise causes interference with the electrical pathways of specific areas of the brain depending on the original conditions that existed at the time before the noise and the signal were produced. Moreover, like the chemical and thermodynamic laws that govern the movement of the gas particle, the noise is independent of the signal and therefore not changed by it. As such, in keeping with the analogy of viewing this force (noise) as being similar to gravity (or an other fixed constant), the variance created by the noise is not due to changes in the force, but in its relationship to what it is affecting.

3.4.1 Nerve Growth Factors[1]

How neuronal movement be induced in the Human Brain? Moreover, how can such movement bring about noise so as to create interference? Let us discuss nerve growth factors. These substances are in the nervous system and can produce a signal or trophic agent. These substances can cause nearby neurons or their outgrowths to move toward them. The first chemical that is usually mentioned is Nerve Growth Factor (NGF): a trophic agent that is an endogenous chemical in the CNS.

1When I use this term it is implied as a generic term. It is not used to specifically talk about Nerve Growth Factor - a large glyco-protein that causes neuronal processes to grow toward its. When using this term, I am referring to any substance, chemical or otherwise, that can bring about growth. Only when capitalized, will I be referring to this specific agent.

There are two features of a chemical signal like NGF (or other chemical agents) that makes it an unacceptable candidate for creating the kind of movement we are looking for. First, it is hard to control where the substance would go inside the brain. A chemical like NGF is a fluid, and therefore is hard to manipulate. Such a physical state would lead to any number of processes, even those that cannot be considered in the input-output pairing, being brought into the equation. Second, because the movement has to be continuous, in order to maximise the chances of learning creatively a chemically-induced mechanism would rapidly become depleted.

It is possible to use the matrix itself as a rigid scaffolding to induce and direct neuronal movement, but such a solution also has its problems. The problem arises because the structure of the other brain cells, or neurons, is virtually motionless. Without motion, without something manipulating the probability of firing, stagnant neurons and their processes will not be sufficient. What is needed is a factor that is able to cause growth, but is not readily depleted and still produces a consistent affect.

A magnetic field generated within the brain could be offered as a candidate for the needed nerve growth factor. The field of neurophysiology has demonstrated in the laboratory that certain parts of a neuron do in fact grow toward magnetic fields. The phenomenon, called Galvontropism, is supported by: Bedlack Jr. and Loew (1992), Davenport and Katter (1992), and McCaig and Dover (1993). According to physics, a magnetic field is produced at right angles to a moving dipole. In the case of the human brain, the moving dipole is the electrical current, which moves down the axon or similar part of the neuron. Considering that certain neuronal processes, such as a dendrite, are not insulated, and therefore are in theory able to produce an electrical field, the prospect for the generation of a magnetic field is not far-fetched.

In addition, unlike a chemical field, a magnetic field can be continuously maintained without depleting the resources of the cells involved. It is more efficient to rely on a factor that promotes nerve growth that is relatively inexhaustible, such as an electric current. And because the network being championed is physically linked, dendrite-to-dendrite (discussed in detail in the following sections), and does not rely on a chemical transmitter to maintain the current between dendrites, it is efficient. Moreover, such a field can easily be contained within certain areas of the brain because the dendrites have a very small calibre, and cannot produce a strong field that will affect the other areas. This then means that the affects of the field can be limited to a specific area.

3.5 Mobile and Immobile Processes

The details for a full explanation are beyond the scope of this present article and are, in fact, due to the theoretical nature of this paper, mere speculation. It is sufficient to state that there are two main groups of processes involved: one mobile, one immobile. The mobile population moves and the immobile do not. The immobile group - the dendrites producing the magnetic field - can manipulate the mobile component. The mobile group – the dendrites being moved and affected by the magnetic field – cannot manipulate the immobile component.

The dendrites' size, location and their malleability (and therefore its high degree of phenotypic plasticity, as needed for Neuronal Acclimation, section 1.1) naturally allow for the two most important stipulations brought up in the previous sections. Those being, the force producing the noise is required to be constant and two, the affect caused by the force is required to be variable. The set the immobile dendrites are theorized to be interlinked and through the process of spontaneous activity (such activity has been found in brain research, see Section 3.7) generate the necessary electrical current, and the necessary magnetic field. The set of mobile dendrites are not linked to one immobile group, and due to this, do not change the energy produced by them. They are moved and their electrical activity is changed as a result.

Due to this movement and subsequent changes in electrical activity of the neuronal cells involved, there would be the generation of different amounts of excitation and inhibition in the axons associated with these fields. This is the linkage between movement and noise.

One way to picture the proposed structure of the neuronal architecture is two imagine two evergreens joined at the base. The top tree is in the upright position, while the one on the bottom is positioned in the opposite direction. The shape produced is similar to two cones held together at their widest parts. This shape represents what the theoretical neuron looks like. Now imagine the very top of the upright tree being the first part of neuron. This is where input comes in and it leaves through the tip of the cone that is pointing downward. The widest part of this shape is the immobile part of the system. The branches or dendrites of the two bases are interlinked and are generating an electrical current, and therefore, a magnetic field. The other branches or dendrites, those that are not at the base, move toward the base from either side.

Because the dendrites are growing toward the base from either side of it, the two sets of mobile dendrites will eventually touch and form a new pathway for the electricity coming in through the top of the neuron as it passes to the bottom. As stated by Slatter (1969), electromagnetic theory implies that the individual neuritis would not come in contact with the immobile grouping, and therefore, not interfere with it. When the dendrites connect electricity can either go through the trunk or axon of the neuron or it can pass through the branches or dendrites. Due to the development of two different pathways, it causes the amount of time it takes for divergent signals in the two different pathways to get to the end of the axon to be different. When the two wave fronts rejoin there is the chance that electrical interference will be created. An in-depth explanation of this will be given in the section entitled Frequency and Amplitude Modulation

The above framework allows for the manipulation of the impulse's strength through the amount of difference in length and hence possible interference between the electrical charge in the axon and the electrical charge in the dendrite. The change is proposed to occur in a cyclic fashion, and is dependent on the field strength of an endogenous magnetic field. The strength and affect of it are variable because any change in length of the mobile set of neurites - in comparison to the length of the axon it is attached to - is not dependent on incoming electrical impulses, but rather is dependent on the immobile group of dendrites producing the magnetic field. Therefore, increases or decreases in the amount of interference or noise experienced cannot be predetermined by the quality or quantity of the stimulus that created the incoming electrical stimulus. This thereby creates a situation that either increases or decreases the strength of the impulse produced based on an endogenous mechanism that cannot be determined by external stimulation.

In theory, this system is fully capable of producing probability that appears microscopic. Nevertheless, because no specific threshold levels of electromagnetic influence are available in the literature, this statement is hypothetical. However, in electromagnetic theory (Slatter, 1969), a connection between an electrical current, the pulse propagating through a dendrite (or other neuronal process), and a magnetic field surrounding it is possible. Although Marsh (1946); Jaffe(1979); and Poo, M. M. (1979) have found threshold levels of current density (a means by which electrical forces can be equated with magnetic attraction between two charged bodies) in brain studies these findings may or may not be related to model being offered. For one, because the exact dimensions of the dendrites in this hypothesis have not been specifically measured, their dipole charge cannot be precisely calculated. Also, due to the *in vitro* nature of the current densities measured in these previous studies, they cannot directly or accurately describe the necessary forces needed to induce neuronal growth inside an intact and functioning cerebral cortex.

3.6 Hard, Soft, and Softer Connectionism

Before venturing further, a qualification is needed, by which some previous points will be clarified. When an information processing network is defined, it is usually said to be composed of three fundamental parts. Each of the sub-units consists of neurons, or neuron-like facsimiles. These parts, made up of neurons or neuron-like elements, are: input, hidden layer/processing area/computational area, and the output segment. And the connection between these various components is responsible for the network's ability to process information. Furthermore, it is not only the connections that are important but how strongly one connection affects the area it is connected to. This is referred to as its weighting. Stronger weightings are going to be more effective than weaker ones when causing a sub-unit that they are connected to respond. There is also the matter of how pliable the various weightings and connections are to input. Those that are easy to change are 'soft' and those that do not change so readily are 'hard'. That is how a network is described in the theory of connectionism.

Certainly, the current theory does have implications for connectionism. In the evolution of connectionistic theory there have already been many developments. First, there was the old style of connectionism and its various static paradigms were the connections and weightings between the sub-components were hardwired and could not be altered. Continual learning was prohibited by this kind of model. The system's abilities, the sum total of its learned experiences, could not be updated. It was a limitation, as Beitchel (1991) reports that reduced the effectiveness of this kind of paradigm. Beitchel goes on to say that it would be better if the connections were softer and that instead of hard-wired rules, per se, forces could be used instead and this would allow the system to learn and produce new behaviors.

From these and other considerations, came the second-generation of connectionism. It included a series of networks that were not hard-wired and which could change the organization and strength of both their connections and the weightings respectively. Solid, immutable rules could be replaced by more fluid forces that could be termed 'soft'. This was deemed practical because it allowed the forces which were playing upon the system to shape it most effectively. Hard-wired rules could be altered if the connections and weights between the various members of the network were suitably adjusted.

Given these parameters, it could be asked: What if an additional component was added to a traditional network employing 'hard' and 'soft' algorithms? This leads to a form of connectionism that is ‘softer’ than the ‘hard” rules of the first generation of connectionism or even the forces of second-generation connectionism. They are softer because they exist without being restrained. It is a network that works on the basic theories of connectionism but whose scope and actions are expanded by the abilities of an additional processing unit whose weightings and connections are in flux.

Studies by Barsalou (1987, 1989) have found that concepts, the cornerstones of our higher reasonings are variable. If concepts change then the categories and the rules used to classify them are changed as well. Bechtel (1991) states the following.

> From these results Barsalou draws the inference that concepts might not be stored in long-term memory as fixed units, but might be ‘constructed on the fly’ as needed for particular reasoning tasks. It is somewhat difficult to make sense of this view within a rule-based account of cognition, since concepts would seem to be the atoms of such systems, but much easier to make sense of them from a connectionist perspective where what exists in long-term memory are only connections . . . (p. 49)

It is true that for order to be maintained in a system that rules should be consistent, and should therefore not change. Hard-wired systems like computers are programmed to work in this manner. Moreover, neuroscience points to rules within our brains that compel us to fulfill certain biological needs. These are the ‘blind drives’ that were alluded to in section 1.0. These are the emergent behaviors that were also called Bottom-Up learning. The need to drink fluids is such a basic requirement. The need to eat is another. The need to have shelter and warmth are also basic requirements. Because it is paramount for these needs to be retained in each generation's neuronal matrix for the continuation of life, they cannot be altered. In some capacity they have to be met. But, the manner upon which the needs are met should be variable.

Due to these considerations, we have a likely candidate for a Top-Down, Bottom-Up hybrid. Instead of invoking a rule that is rigid and that would be hard to keep relevant inside a developing mind, we have a system of axons and dendrites that produces a phenomenon that enables the brain to produce changing forces. It tentatively describes the nature of the person as the system evolves, similar to 'hard rules' but not completely specified. Whereas standard rules are set, these forces, or 'softer' rules, are very malleable.

3.7 The Binding Problem

An electrical impulse can be described in two ways: by the rate it is produced at and the potential at which the impulse occurs. With current referring to how much electrical activity passes through an area over a period of time or how much passes over a specific part of the system over a specific time period, it could be referred to as the quantity of the signal; whereas, the strength of that signal could be referred to as the quality.

An information system such as the human brain has to manage the quantity of the individual impulses passing through it. Because the quantity (and not quality) of the impulse refers to the temporal aspect of input into the brain, different levels of complexity (as produced by different lengths of neuronal paths) in the information being deciphered and processed would produce incompatible, even dangerous variations in the nature of the electrical impulses inside the system. This concern is commonly called the 'Binding

Problem'. The Binding Problem is related to the realization that in order for the brain to function properly all aspects of an experience have to be processed at the same time. If not, inconsistencies would result in system failure.

There is the promise that by adding a force that is independent of input the Binding Problem may be solved. Evidence for this comes from studies by: Crick and Koch (1990); Desmedt and Tomberg (1994); Gray and Singer (1988); Joliot and Makeig (1994); Kirschfeld (1992); and Pantev, C., Makeig, S., Hoke, M., Galambos, R., Hampson, S., and Gallen, C. (1991). The reports of these researchers indicate that an unspecified but globally occurring population of neurons firing at approximately 40 hertz in all regions of the cortex may be occurring. Researchers have reported that this activity continues regardless of whether or not the nerve cells are being stimulated by sensory input. This finding is consistent with the continuous and global nature of the hypothetical network that was proposed in section 3.5. Based on physiological restrictions and the morphology of certain cell types (Peters, 1984), the sixth layer (VIb) of the cerebral cortex is a prime candidate for the processor producing 'softer' connectionism. This layer of the cortex is fusiform in nature, and hence has the double cone shape already alluded to.

Solving the Binding Problem also solves the Catch 22 dilemma mentioned in the first part of this section. It was stated that is appeared wrong to be adding noise to the system to increase the systems capacity to learn, especially, if the individual senses already had noise in them. However, it has been found by a number of researches (Ditto, W. L. Pecora, L. M. 1993; Garfinkel 1983; Pecora, L. M. and Carroll, T. L. 1990) that adding an internal force or measure of noise can stabilize the system. The theory is that having a primary force within the system to reduce the inconsistencies within it, without destroying the quality of the information present, can suppress these inconsistencies enough so that they will not upset the balance of the system.

3.6 Frequency and Amplitude Modulation

Based on the aforementioned reasons, binding must occur in the human brain. Furthermore, because the human brain must have this ability before any other secondary trait, binding occurs before any other evolutionary modification can take place. To understand how this can transpire, it is best to think of the introduction of noise (or electrical interference) into the system as a kind of 'buffering system'. A buffering system in this case refers to an event that can take a wide range of items occurring inside a group and bringing them closer to a state that is nearer to the average condition of the group as a whole. Subsequently, a neuronal buffering system takes a range of divergent impulse frequencies and keeps them within a range that is not as diverse as they were originally.

Consequently, the frequency of the system is modulated and the quantity (or rate) is averaged. It could be suggested that if a magnetic field could stimulate the neuronal processes around it and do so below the threshold of firing, then when said cells are stimulated they should fire at the rate that is imposed on them by the magnetic field. For example, before the advent of a buffering system the output profile from a nerve cell could be 0 - 10 hertz, and another from 3 - 9 hertz (both arbitrary values). Since both are subjected to the same magnetic field-buffering system, the output could be changed to five for the first one and six for the second. Discrepancies between the individual units are reduced or abolished. By keeping the impulse strength in a certain bandwidth, one volley of impulses will not come out of phase with the others. And, because the frequency is continually modulated, the entire cortex can be buffered as well. This conclusion does not differ from what was mentioned before; it is only added to give a more detailed answer.

Once Frequency Modulation is produced, Amplitude Modulation occurs next. As the electrical stimulation passes through the axon and the dendrites, the divergent signals rejoin when the individual dendrites on the lower portion of the axon meet up with the axon. Interference (noise) may be created if the profile of each of the electrical impulses is different. Although the buffering mechanism has caused all neuronal processes in the area to have the same frequency (or tendency toward it), changes in the length of the mobile processes can make the impulse frequencies occur at different time intervals. Therefore, the amplitude of the output of the axon can be changed. It can be increased if the joined impulses have an electrical profile rate that occurs at the same frequency. And, it can be decreased if this interval rate is dissimilar between the processes involved.

Once the output of the affected axon has been modulated it can interact with another axon and lead to the formation of new stimulus-response pairings. When the signal's amplitude is modulated, this will either cause a decrease or an increase in the firing of the axon. And because the output of this axon is connected to others, it will decrease or increase the firing of these as well. Also, with the probability of this event being changed due to the magnetic field, the forces that occur between the axon modulated and the axon it affects can be controlled. This will permit different parts of the CNS to be stimulated or inhibited in different ways so that pairing optimums can be produced. Finally, this implies that the change in quality that occurs in the axons being processed can spread throughout the cortex as well.

3.7 Additive Variance

In section 2.3 an example of a person trying to solve a difficult problem was given one that they could not originally solve. And it was only with time that they came to a solution. Systematic processing would have you believe that a solution was made possible only after enough linear processing was performed. And yet, this answer seems doubtful. Linear processing, by nature, produces set answers. For a person thinking about a difficult problem in this way, they would have never reached the right answer if they did not have knowledge of the answer before they began considering the problem.

In other words, an organic system like this is akin to a systematic computer performing computations using incomplete logic. Hofstadler (1979) has studied Godel's theorem concerning classical logic. Hofstadler reports and restates Gobel's original conclusion that such systems will always produce statements that it will not be able to solve, even though these system are based on definable logic. However, if we accept non-systematic processing, and the additive variance it can instill, such a system can enhance the human mind's ability to find answers. It is brought about by bringing constrained (but not circumscribed) variation to the network. The longer we think, and the more variation that is added to the output of our traditional systematic processing systems, the more likely new possibilities will come into our consciousness. But it should be stressed that logic is still paramount. Although this system may allow un-thought of connections to be considered so that they may be tried, it is only when they seem to work, that a person must stand back and determine why this possibility actually worked based on previous information. Incomplete logic is added to logic that already existed, and allows it to expand.

Though variation is added, it should be remembered that actually deviation from the primary signal would not happen until the information has passed through the system many times. Each time a signal passes through one of the processes of the axons its amplitude is changed to a small degree. Only a small amount of variance is added to the impulse signal though a small amount of noise based on the diminutive size of the neuronal processes that created it.

In the event that the impulse travels further inside the brain and therefore becomes more removed from the tendencies of the original impulse, the probability that the electrical impulse will experience more and more interference by entering and exiting different binding sites will increase. At all the times the rules of the systematic processor (linear part of the system, no variance) are being respected, but each time the non-systematic processor (non-linear part of the system, variance) acts upon the information passing into it from the systematic processor, divergence becomes a possibility. It is only after many cycles of the signal going through the system (i.e. going back and re-experiencing the systematic as well as the non-systematic processors) will variation flourish. In the terms of changing amplitude, the actual variation is so little that it would not interfere with the primary sensory areas.

Although there is the possibility that the variance created by frequency modulation may overwhelm the system with noise, the structure of the current theory implies that it is not likely. With frequency modulation being a direct result of the magnetic field generated by the immobile group of dendrites, the sub-threshold potentials it creates within the mobile dendrites is continuous and similar throughout the entire population. This occurs because the strength of the field is dictated by the size of the dendrites, which would be relatively equal throughout the cerebral hemispheres.

The buffering affect of frequency modulation is also as result of the interference produced by the dendrites within the immobile layer upon themselves. Since there is the distinct possibility that not all dendrites in this layer will have the same caliber, and hence, will not have the same magnetic field, and thereby, not produce the same sub-threshold field in neighboring populations of mobile dendrites, the variation in such fields will, by a form of negative feedback, will reduce this variation. The reduction or dampening of variation will occur when the magnetic fields produced by regions of dendrites that are not in phase with one another (as it is assumed to occur to a force that is generated in waves) interact with one another. The end result is a reduction in unwanted variation.

When Korestler (1967) was dealing with the topic of free will and the production of a conscious individual in his book, the proposal he made about an open-ended hierarchy in the brain is similar to the topics being currently described in this present article. Korestler writes: "From the objective point of view the decisive factor seems to me to be that the 'degrees of freedom', the physicist's sense, increase in ascending order. Thus, the higher the level to which decision-making is referred, the less predictable the choices; and the ultimate decisions rest with the apex" (p. 216). Based on this statement, it is clear that Korestler believes that free will and the production of a consciousness are derived from a system that builds upon itself – a system, and a hierarchy that becomes, at some point, indeterminate. This is a result that is perhaps due to some basic change in how the brain reads and processes information. Although the system does have its linear aspects so that binding and other mechanical duties can be performed, the higher levels are qualitatively different from the lower ones.

4.0 Can a Person Who Effectively Learns be Conscious?

4.1 Evolving Information System

Considering that non-systematic processing could be a feature of the human brain (and could be, this respect, be referred to as the human mind), does it then imply that a plausible connection with consciousness exists? Before it can be determined if there is a connection between consciousness and learning, or before even deciding what consciousness is, we must decide whether a person needs consciousness. Does consciousness have a purpose or even a function in a human being? Like any other sub-system in a larger system, in order for consciousness to exist in the system (especially one that evolves and sheds superfluous features) it has to perform a function. To understand the question, we must define consciousness in terms of something that can be clearly anchored to an essential characteristic of our selves.

In the introduction of this paper, it was argued that such a feature could be both our ability to learn and what learning endows us with: information on how to survive. Perhaps this is a possible solution for the explanatory gap: consciousness occurs because the original binding mechanism has evolved. The explanatory gap asks the question of why consciousness should occur. Thomas Polger and Owen Flanagan (1997) state in their paper '<u>Zombies and the Function of Consciousness</u>', that according to the idea of 'conscious inessentialism' behaviors can be produced without consciousness. Since reaction to stimuli does not have to logically imply the existence of internal awareness, consciousness of self, there should be no difference between a person and a zombie.

From this, it could be argued that the only things that are necessary for survival are the basic impulses that drive an individual to obtain physical needs, and of course a binding mechanism to hold the system together. Consequently, consciousness is not an essential feature of an advanced form of life. The nuances that come about from being conscious are therefore a secondary attribute. Nevertheless due to the dynamic nature of the human mind and further elaboration of the binding subsystem, an evolution of this subsystem has naturally led to consciousness. The human brain has produced the human mind, which has consciousness.

In addition, since consciousness is a reflection of both the probability field that produces it, and the greater associations it can produce, consciousness is a signpost for such evolution. Therefore, in order to achieve maximal learning consciousness has to be present, but it is only an indication that the creature has reached this capability and has reached an evolutionary stage where a certain quality specific to the individual is evident.

Hence, the *qualia* (or quality) as mentioned by Levine in his 1983 paper could be associated with the specific probability profile that occurs during the phenomenon known as consciousness for all events being witnessed and experienced by the individual. Perhaps, then, part of conscious experience is a result of the magnetic field modulating the amplitude of stimuli as they pass through this part of the human brain. Probability in this instance translates into the chance of more or less electrical stimulation in the brain being produced at a certain instance, leading to more or less stimulation felt by the individual and different neuronal pathways being stimulated during the course of responding to stimuli. How we experience something is based on the specific noise-to-signal profile that is produced by interference. The quality of an experience is unique to the person, because the fluctuating affects of the magnetic field are unique to the person experiencing it.

Therefore, because this idea proposes that binding can lead to consciousness, a kind of hierarchy that builds upon itself is being hypothesized. It is a hierarchy that comes about due to the amount of additive variance' produced by Amplitude Modulation. The Ego emerges out of noise that is the cornerstone of our personalities. This is a theory that is based on the pretext that with the addition of internal noise, an individual can be formed. By continually adding non-linear (in respect to external impulses) modifications to external impulses through varying input to output associations, there is a transformation from the linear or mechanical nature of most of the neuronal impulses, to something or someone that is truly unique.

Some psychologists theorize that to be conscious (and to be conscious of this awareness) involves an understanding in the individual that s/he is a cognizant organism and that s/he is separate and different from the environment. Introspectionists such as William James offer us more insight. This type of study, which involves the individual observing how certain experiences affect the internal state of their own awareness, assumes that the environment is capable of affecting us in different ways. Not because the environment changes, but as a result of the individual themselves being altered in some manner, and thereby changing their experience. These ideas are briefly encapsulated in the following listing from James, (1907) essay Stream of Thought:

> 1) Every thought tends to be part of a personal consciousness; 2) Within each personal consciousness thought is always changing; 3) Within each personal consciousness thought is sensibly continuous; 4) It always appears to deal with objects independent on itself; 5) It is interested in some parts of these objects to the exclusion of others, and welcomes or rejects - chooses from among them, in a word - all the while (p. 225).

Subsequently, this part of James writing can be interpreted to infer that even in the same person an identical stimulus will lead to different responses. Therefore, responses are not completely dependent on the nature of the stimuli. The environment is important in so much as it gives the individual a starting point in which they may manipulate it.

The conscious experience becomes then a mixture of systematic as well as non-systematic types of processing. It is (according to the present attempt to place this theory into a physical setting) partially brought about by the environment's interactions within the first five layers of the cerebral cortex (or any other region in the brain that recognizes and deciphers the patterns of the electrical information going into the brain), and partially the result of the probability profile of the magnetic field in the sixth layer of the cortex (or similar structure(s) that could produce the changes already outlined) modifying input to the brain by adding low levels of noise. Due to the continuous nature of the field in the sixth layer and the interconnected nature of this system as a whole, the sixth layer influences the associations established in the first five layers.

Consciousness and experience is thus unique to the individual because the mechanism, which is built upon the structure in the sixth layer, will be solely characteristic of the person in question. Consciousness could then tentatively be defined as the inherent developing ability of an organism to be aware of his or her own internal capacity to separate themselves from the fixed stimulus-response patterns evident in the environment. This is a separation that permits new and better ways of satisfying our needs and wants from our immediate surroundings.

4.2 Thought as Motion

Is describing consciousness by itself enough to explain what makes each of us an individual? Can this form of philosophy, what some might incorrectly refer to as reductionistic, be capable of eliminating the ambiguous term 'thought'? It may be, but first it is important to deal with the word reductionistic. Whenever a trait is defined, it is assumed that the trait is placed within well-marked terms, and is reduced to a definable element. However, if the term is stochastic, the reduction is not complete. Since it is being assumed our personalities are a result of a stochastic event, we should not ask if thought can be defined but if it is necessary.

Thinking is necessary because motion is necessary. Thinking produces possibilities and consciousness imbues and notifies the individual of its trove of knowledge. Thinking is the verb, and consciousness/experience the resulting nouns. I am because I think in a certain way – I think, therefore, I am (Descartes, 1637). With everything there has to be a start. There has to be a cause. With no unique motion, with no unique noise, with no unique interference, there is nothing. There would be no free will because the person would be nothing more than an extension of the environment. Free will is possible because there is a division in causation. The train of sensations is different from the train of thought. The way a person thinks defines each of us. It is an untiring force that exerts itself on the whole enterprise of life, whereas consciousness is a specific condition because specific items become associated with specific patterns connected to the nature of the person. In other words, thinking is the process of being, it is the quality of the magnetic field acting on the nerves of the brain, and consciousness is the outcome.

5.0 Conclusion

Unlike any other multi-cellular species on the planet, humanity is able to live in almost any environment. We are driven by a solid will that is neither encumbered by unnecessary limitations nor overcome by forced speculations. Efficient and effective integrated optimums are allowed to form. Without this capacity, our actions would be entirely controlled by the features and contingencies of the environments that we are placed in during our lifetimes. Without an ability to prevail over such limitations, a person could be overcome and weakened by an environment devoid of meaningful information, becoming a blank sheet that has no guidance and no possibility of survival. Without an expert - any kind of expert - to teach it, to guide it, a creature would have to rely on unbounded chance, with anything causing anything else to happen. A creature like this could only ever copy the associations evident in its surroundings.

Moreover, because we have been able to overcome these limitations and shape our environment, we are not entirely defined by it. We do not have to wait for a solution to be produced for us, by either the environment or by some accident in our habitats. The chance we rely on is internal. Enabling us to meet our needs better than could be hoped for by the lessons given externally by a capricious environment. External instability has been managed by internal stability. Neuronal acclimation, as brought about by the systems suggested in this paper, imbues the human mind with a form of intra-generational meiosis, giving us both the plasticity to engage the difficulties of the environment we thrive to overcome as well as laying the foundations for phenomenon such as thought and consciousness which define us as a species.

As a consequence of this proposal, this paper makes a suggestion for specific research in the field of Neurohistology. First, to determine whether there is a group of dendrites that produces a constant current in the cerebral cortex, and whether it is in the sixth cortical layer or not. Second, if this is found, to determine if there is movement involved, be it in a dendritic population or something similar. Thirdly, if the first two qualifications are met, a computer program should be constructed that can simulate the model outlined. This would involve writing and implementing a computer program that could simulate the various processes that this theory suggests. This could bring us to a stage of scientific investigation that perhaps will give us a better understanding of why we learn the way we do, and how thought and consciousness are intimately related to the optimization of learning and survival.

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