

# WILL AND UNDERSTANDING, OR THE SOUL, SEEN AS THE RESULT OF HUMAN BRAIN STRUCTURE AND FUNCTION AND ITS RELATIONSHIP WITH THE ENVIRONMENT

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And his heart was moved, and the heart of his people, as the trees of the wood are moved with the wind. (Isaiah 7:2)

The wind bloweth where it listeth . . . (John 3:8) (King James Version)

## INTRODUCTION

**S**wedenborg says the following in *Arcana Coelestia* 7021:

By “soul” in the Word is meant every living thing, and it is attributable also to animals; but “soul” is properly predicated of man, and when of man, the term is used in various senses. Man himself is called a “soul,” because his life in general is so called, also specifically his intellectual life, or understanding, and likewise his voluntary life, or will.

In this article I try to describe the form of the brain by starting as if it were a tree, moulded by nature and nurture, and then progress to man and how man describes his “soul” or mind in terms of the environment which now includes modern neurodynamics and anatomy. In fact, the body and brain form a unit, the body-brain (BB), in this order as the body is prior to the brain. I shall call it the BB in this article.

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Starting with the tree, it has no way of describing itself other than in terms of the wind. It cannot say to itself or to a third party that this particular leaf has been moved, say, so many degrees to the north, because that is outside the specified vocabulary or its terms of reference. It has a very limited vocabulary. The only way it can express itself is to move around a particular point in space. It has a primitive form of memory in that it always moves back to its original position when the wind ceases.

A pragmatic method of studying brain function is the electroencephalogram (EEG). This is comparable to the flickering pattern of wind-stirred leaves, which mirror the invisible wind, much as the EEG mirrors the invisible mind. The mind is thus a product of the anatomy of the brain and the “wind” of the environment, and can only be described in terms of the environment, which includes the EEG, either to itself or by a third party.

The advance from the vocabulary allowed to the tree to that of the vocabulary of a modern scientist using terms such as EEG and more detailed brain anatomy is like describing the wind or soul in neurodynamic and anatomical terms, but the principle is the same as is used in the tree-wind interplay. The soul has to be described in the terms of the world, which include neurodynamics et cetera. Swedenborg assisted importantly in this process, and modern advances in science can be seen from the *The New Philosophy* view point as a continuing attempt to delineate the soul.

Let us move from a tree as we know it to that of a human in an arboreal form, so it can describe its shape and the change in its shape with all the skill and vocabulary of a human, but still limited to the domain of wind. Direction or meaning is still describe in terms of the wind, just in more detail, but still only in terms of wind. The Lord sends the wind so to speak, but the BB in the form of a tree makes sense of its own life in terms of the wind it experiences from tiny cotyledon to mighty oak.

Now let us become human and leave the tree metaphor. Although the tree-BB metaphor for the mind avoids the immense complexities of the human BB, it gives a very inadequate and simplified idea of the movement and flexibility of the brain as the billions of nerve cells alter their mutual connections in a chemical, electrical, and anatomical way, all at a microscopic level and hidden from view by the carapace of the skull or by the actual laboratory techniques needed to examine them. This latter activity

is like cutting a branch off to examine it; we cut off the wind at the same time. In this metaphor the wind is the meaning, the spirit, recorded for and by the tree in the movement of the leaves. The wind blows where it listeth but only those trees with leaves can record or be aware of what it listeth, or attribute listing or bending to the wind. To list is to will in old English, as a boat lists before the wind.

Dualism, the separation of mind and matter has been the subject of debate ever since Descartes. Swedenborg in his descriptions of heaven and hell make clear that the body is inextricably bound to the soul, and dualism is not part of his philosophy. Using his terms, I suggest that the soul is a something which can be described as the will and understanding of a person. A man's mind or soul is based on a brain which we share in many respects with all other animals, as the quotation above from *Arcana Coelestia* 7021 supports.

This article relates these two aspects, will and understanding, of animate forms of life on this earth, the structures of the vertebrate brain, and modern ideas of brain anatomy and function, especially on the use of EEG monitoring and its analysis by the math of chaos theory. These reflect our deepening knowledge about brain function and confirm the insights of Swedenborg, especially his theological ones. The brain is a much more flexible object than Swedenborg and most people realise, even today. The soul, the will and understanding, is one with the BB, but an ignorance of the enormous functional abilities of the brain, both human and animal, have fooled many people into thinking that there must be something supernatural, disembodied or even magic about it, a view that Swedenborg contradicts in his revelations about the spiritual world. After all, four animals in *Apocalypse Explained* 462 signify the third heaven.

## BOUNDARIES

A fundamental property of anything is that it has an edge or boundary which separates it from anything else, a limbus or limit (see for example *Arcana Coelestia* 9496 in reference to "the border of the ark"). This can be a time boundary or spatial one, or a mixture of these. Edges, so to speak, started at the Big Bang with the creation of finite things. Self-conscious

creatures are aware of an “explanatory gap”<sup>1</sup> at the edge of themselves and the surrounding universe. There is a spatial or temporal assonance or dissonance for an animal as it moves in its surroundings. Meaning is found and formed (and in man expressed in words) by the animal’s action in the world and the resulting sensory changes. “In an extreme view the world can be seen as connections, nothing else.”<sup>2</sup> Motor activity causes sensory activity, and that process makes sense (preference) of the environment in terms of the animal. Meaning, truth being a form of good, is explained with reference to the environment as if it were something separate from the individual; and because knowledge of the mechanics of the BB is not adequate to describe it fully, a soul is attributed to man (AC 7021) to cover the ignorance of that relationship.

### Animal Shape and Movement

An animal’s shape or form is defined by its environment. In order to survive all plants and animals have to obtain food. They all have a surface or external, an edge, which divides them from the environment, and picks up stimuli or nourishment from it, and an internal, which is enclosed by the external. This automatically forces an orientation or moulding of the animal. For example, it will have an inner and an outer, a left and right side, a head end and a tail end, and, in human beings, an extraordinary correspondence, a one-to-one match of a sense experience of the world with some kind of imprint in the brain (Eccles’ “engram”). In Swedenborg’s terms, the sensation on a lower plane has a cause-effect relationship with the mental idea on a higher plane of the mind, expressed in metaphors drawn from the world which make up and express man’s mind.<sup>3</sup>

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<sup>1</sup> J. Levine, “Materialism and Qualia: The Explanatory Gap.” In *Towards a Science of Consciousness III: The Third Tucson Discussions and Debates*, by S.R. Hameroff, A.W. Kaszniak, D. Chalmers, editors (Cambridge, Mass. & London, England: MIT Press, 1999), 1.

<sup>2</sup> T. Berners-Lee, *Weaving the Web: The Past, Present and Future of the World Wide Web by Its Inventor* (Orion Business Books, 1999).

<sup>3</sup> W.J. Freeman, *How Brains make up their Minds* (Phoenix: An imprint of Orion Books, 2000).

## LIFE AS A METAPHOR FOR MOVEMENT

Life is contingent on movement. All animals move; in fact this can be taken as a definition of an animal, as Swedenborg suggests in his book *The Dynamics of the Soul's Domain*. Plants move, but so slowly that they are usually not thought to be animated in the same sense, and they will be ignored in this article. The continents drift on the surface of this earth. The stars orbit the earth in one view and were once endowed with angelic movers. As Newton emphasised, the natural state is motion rather than stasis, and one does not need an anima to make an animal or something that moves; it is inbuilt into the system so to speak. "In an instant of time nothing exists" as Bertrand Russell says, so anything which lasts longer than an instant moves even if only at the subatomic level.

Without relative movement, meaning does not exist. It requires a direction or orientation, a change in a particular direction rather than at random, needing effort or force to a lesser or greater degree depending on the compatibility of the environment with the animal. For this we use the word "Will." A change takes place both in the shape of the animal as seen by other animals, and as a continual moulding of the BB from the microscopic to the macroscopic level, felt in a thousand ways by other animals or by the animal itself. The past is a *sine qua non* for the present. The form of the will can be called the Understanding which describes the features of the animal, both internal and external, which it assumes in relationship to the environment and which a person describes in metaphors drawn from his or her environment.

The degrees of the Will are called, in Swedenborg's terms, degrees of goodness from best to worst, assisting or hindering the survival of the animal, both in this world, and for man, in the spiritual one. The environment and where it impinges or mirrors the animal is also the shape, vessel, or form for these degrees of good, and these are aspects of Understanding or Truth, the vessel for the good.

The relationship between an animal and its environment has been well described by James Gibson in his book *The Senses Considered as Perceptual Systems* in which he outlines the perceptual role of the five

senses and the resulting “affordances” of the environment for the creature. Affordances are the “uses,” in Swedenborg’s sense, which the creature gets out of the environment. Gibson says, for example, that the “environment consists of opportunities for perception.”<sup>4</sup> The animal chooses a small sample of the environment at a time, for example the prey she is after. She filters out the rest, orienting herself to a particular aspect of the environment, and if self aware, learns more about herself as well as her surroundings by catching her prey and eating it.

This interplay between the environment and other separated “selves,” from the incorporation of environmental energy into energy rich molecular bonds in the primeval soup to the extraordinary complexities of man, has been and is still a constant feature of biological life on this earth. The anatomy and function of the brain in vertebrates mirrors the phylogenetic history of man as a vertebrate and the invertebrates who preceded her. The structure of the brain corresponds to or forms the basic elements of will and understanding for an animal expressed by bodily shape and movement, expressed in addition as good and truth by speaking man, and to the structure of the heavens and hells by the angels as described by Swedenborg.

### **The meaning of movement**

Movement, change in shape, is a feature of the universe, but its meaning for man has been much discussed over the years. This reflects the inbuilt search for meaning which biological systems possess. Swedenborg lived during a great transition period between the medieval, scholastic, explanations for this, and the dawn of the scientific age. For example, in the Europe of 1300 “physiology” divided the soul into three parts, vegetative, sensitive, and rational, operating through three faculties, the natural spirit in the liver, the vital spirit in the heart, and the animal spirit in the brain. In the brain the animal spirit worked as imagination, reason, and

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<sup>4</sup>J.J. Gibson, *The Senses Considered as Perceptual Systems* (Boston: Houghton Mifflin, 1966), 23.

memory. The body was moved by animal spirits moving along arteries and nerves.<sup>5</sup>

These views were first given an anatomical or mechanical basis by the work of Descartes which is very well summarized in a lecture by O.M. Ramström, Professor of Anatomy in the University of Uppsala to the International Swedenborg Congress in 1910 in London.<sup>6</sup>

Swedenborg, in his search for the soul, explored the anatomy of the brain both by reading his contemporary authorities and by personal dissection. He shared the general knowledge of his time, but also its misconceptions, in his pre-theological works. In the *Economy of the Animal Kingdom* (*Economia Regni Animalis*) Swedenborg says:

Here and there I have taken the liberty to throw in the results of my own experience; but this only sparingly; for on deeply considering the matter, I deemed it best to make use of the facts supplied by others. Indeed there are some that seem born for experimental observation, and endowed with a sharper insight than others, as if they possessed naturally a finer acumen: such as Eustachius, Ruysch, Leewenhoek, Lancisi etc. (EAKI, 18)

The need for meaning is inherent in biological systems, but only man is aware of this and feels it needs an explanation. Do we need to give meaning to movement? We cannot help it; our survival depends on it. Descartes invoked a soul or a “meaning” to interact with an otherwise meaningless machine to give it meaning. Julian Jaynes, in what he admits is a rather fanciful description, which however fits the known facts, describes a youthful experience of Descartes which may have suggested to him his mechanical analogy for a soul-body interaction, making the pineal gland the seat of the soul. I think a machine produces its own meaning, but

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<sup>5</sup> G. Holmes, *Dante. Past Masters*, edited by Keith Thomas (Oxford: Oxford University Press, 1980).

<sup>6</sup> O.M. Ramström, “Swedenborg on the Cerebral Cortex as the Seat of Psychological Activity.” In *Transactions of the International Swedenborg Congress, Held in Connection with the Celebration of the Swedenborg Society’s Centenary, London, July 4–8, 1910* (London: The Swedenborg Society, 1910), 56.

because of the conceptual difficulty we have in describing this “degree change” using Swedenborg’s definition of degree (see below), we have to introduce the idea of the soul. If the pineal gland, a mechanical device, is the “seat” of the soul, why cannot the whole body be the seat of the soul? It seems to me that Paul Churchland’s concept of “eliminative materialism” can be applied here. The mechanical function of the BB remains the same during the process of regeneration, but meaning is transformed, in the same way as Swedenborg’s concepts of meanings changed from his pretheological to his theological periods. It was as if a soul had been born or “born again,” or was it there before in an unrecognized form, like falling in love?

When he was eighteen, recovering from a period of mental depression, Descartes was staying in Saint-Germain outside Paris on the river Seine.<sup>7</sup> He was impressed by some moving bronze statues created by the Francini brothers for the French Queen’s water gardens. The statues could be moved in a primitive but *seemingly* meaningful way, powered by a system of hydraulics, the pressure being supplied by the water in the Seine River at a higher level. A hydraulic metaphor suggested itself to Descartes to explain the movement of the human body. The brain ventricles were seen as the source of spirituous fluid, directed by the pineal gland which was both the seat of the soul and acted as a valve directing the ventricular fluid down the nerve tubes to the appropriate muscles. He imagined the nerves as “water” pipes down which ventricular fluid passed to swell and shorten the muscles, as for example the biceps, which seem to expand when you flex the elbow. This idea was disproved very soon afterward by Swammerdam who showed with a plethysmograph that the muscles of frog’s legs actually decreased in volume when made to contract. In fact, how can meaning alter or move anything except other meanings? Metaphor can modify other metaphors but nothing else, but the mechanical analogy dies hard.

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<sup>7</sup>J. Jaynes, “The Problem of Animate Motion in the Seventeenth Century,” *Journal of the History of Ideas* 31 (1970): 219–234.

Descartes also suggested that human beings were the only animals with pineal glands, an observation soon revealed as untrue by Nicolaus Steno (cited in Jaynes 1970) in his *Lectures on the Anatomy of the Brain* (1669), but because Descartes' ideas were so easy to grasp, they formed the basis for the popular dualism between soul and body which we enjoy today.

Professor Ramström reproduces pictures done by Descartes to illustrate his theories in brain function in his treatise "De Homine" (Concerning Man). On the motor side, Descartes describes numerous openings of nerve tubes, leading from the ventricles to the body. He imagined the pineal gland as acting like a kind of movable valve, directing the *spiritus animalis*, thickened with purer blood, down the appropriate tubes or nerves for body movement under the direction of the soul. Animals did not have souls, so the mechanical initiation of their movement is not explained. They are automata. He did not comment on the slow growth or movement of plants.

On the sensory side, Descartes thought that the "spiritus animalis" streamed through the nerves from the sensory receptors on the surface of the body to form an image on the inside of ventricles, like a modern slide show or PowerPoint presentation. The pineal gland, the seat of the soul, was able to view the product of the eye or any other sensory input on the wall of the ventricle.

A more modern term for this "picture" could be a simulacrum (a term which I will use later) of the environment, to express the way the form of the brain mirrors the environment, and is thought to "describe" the soul. "The face of all things is changed as the state of reception is changed" (AE 876). It is easy to see how our own or other peoples' bodies move in relationship with environment. For example, they shiver in the cold. What is less visible is the "shivering" of the brain, which enables the owner of the BB to say "I think it is cold."

Descartes described a mechanical basis for the soul's interaction with the body. His famous axiom "I think therefore I am" breaks down immediately if the environment is too "unfriendly," or in this example, so cold as to destroy the "I" of the sentence. Life immediately loses meaning, and the sense of the meaning or soul is destroyed. This also occurs in mad people

due to malfunction not of the environment but of the brain (the PowerPoint projector) and leads to a metaphor for hell.

### ADVANCES IN ANATOMY

I will now try to describe how a better understanding of the brain tells us how it forms a simulacrum of its environment, rather like the way the changing shape of a tree is a simulacrum of the wind's force and direction. Just before and during Swedenborg's lifetime, especially with the development of the microscope, analysis of brain structure took off in a big way. In his book on the brain, Swedenborg cites Leeuwenhoek, who developed the first microscope and describes the cerebral cortex as a "pellucid, vitreous, oily substance by reason of the position of the globules swimming therein."<sup>8</sup> Examination of the medulla suggested a network.<sup>9</sup>

Swedenborg had a remarkably clear idea for his time, expressed in his pretheological works on the brain, about the psychological and physical effects of damage to the cerebral cortex, which suggests a connection (though never explicitly stated by him) with the structure of heavenly and hellish societies described later in his theological works. Modern understanding of healthy brain anatomy and function describe the harmonious whole much like the societies of heaven. A diseased or damaged brain supplies an earthly metaphor for the dysfunctional workings of hell.

The basic structural unit of the body and brain, the cell, was first described more fully by Rudolph Virchow in about 1858. He introduced the idea of the cell as a basic building block in his book *Cellularpathologie*, in which he laid down his famous dictum "Omnis cellula a cellula."<sup>10</sup> This insight was in turn used by Santiago Ramón y Cajal, cited in Kandel et al,<sup>11</sup>

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<sup>8</sup> E. Swedenborg, *Three Transactions on the Cerebrum, a Posthumous Work by Emanuel Swedenborg*, trans. by Alfred Acton (Philadelphia, Penna.: Swedenborg Scientific Association, 1938).

<sup>9</sup> Swedenborg, vol. I, 37.

<sup>10</sup> R.H. Major, *Classic Descriptions of Disease* (Springfield Illinois, USA: Charles C. Thomas Publisher, 1959), 509.

<sup>11</sup> E.R. Kandel, J.H. Schwartz, and T.M. Jessell, *Principles of Neural Science* (New York: McGraw-Hill, 2000).

using Camillo Golgi's silver stain, to describe the cellular anatomy of the brain. Cajal was the first to suggest the brain was made of cells, for which idea he and Golgi received the Nobel Prize, though Golgi denied to his dying day the presence of gaps between the cells. He saw the brain as a network. C.S. Sherrington<sup>12</sup> suggested the word "synapse" for the gaps envisaged by Cajal. Nerves communicate both by chemical stimuli across synapses and by direct electrical links across so called tight junctions, so both Cajal and Golgi were right!

Golgi's silver stain outlines a small fraction (1.5%) of the cortical neurons, so a very inadequate idea of its complexity is actually gathered from his pictures. This has led cognitive scientists to the mistaken idea that the cortex can be likened to a computer network.<sup>13</sup>

In examining the cortex, Freeman, in his book *Society of Brains*,<sup>14</sup> describes the unimaginable structural complexity of the neuronal network of the cortex and the deeper collections of neurons, called ganglia, within the brain. Swedenborg suggests this complexity. In his book *The Cerebrum* he describes "subduplicate-degrees [of brain structure are] appearing at last like the differentials of infinite calculus, which as compared with finite and constant things are equal to nothing."<sup>15</sup>

In order to stress the uniqueness of this structure, Freeman has invented a new term, "neuropil," from "neuron," Greek for nerve, and "pilus," carpet. He says that there is no other substance like it in the universe, and it is found only in molluscs (octopus), crustaceans, and vertebrae.<sup>16</sup> He rejects attempts to base brain function on computer analogies on the grounds that the neuropil is quite unlike a computer. He calls himself a pragmatist to express his disagreement with those like cognitive psychologists who liken the brain to a computer.

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<sup>12</sup> M. Foster, and C.S. Sherrington, *A Textbook of Physiology: The Central Nervous System*, 7th ed. (London: Macmillan, 1897). Cited by Walter J. Freeman in *Societies of Brains* (Hillsdale, New Jersey & Howe, United Kingdom: Laurence Erlbaum Associates, 1995), 33.

<sup>13</sup> W.J. Freeman, "Tutorial on Neurobiology: From Single Neuron to Brain Chaos," *International Journal of Bifurcation and Chaos* 2: 3 (1992): 451-482.

<sup>14</sup> W.J. Freeman, *Society of Brains: A Study in the Neuroscience of Love and Hate* (Hillsdale, New Jersey, USA: Lawrence Erlbaum Associates, 1995), 37.

<sup>15</sup> Swedenborg, vol. I, 60.

<sup>16</sup> Freeman, (1995), 39.

In the cortex, the nerve cells or neurons are laminated in a horizontal plane and divided perpendicular to the surface into ever shifting columns (like leaves blown by the wind on a tree), to form a layered and vertically divided neuropil. The human cerebral cortex has more than  $10^{10}$  neurons. The branches of the neurons, called dendrites and axons, go in and out respectively in all directions, linking the brain and the body in one homogeneous whole. Each cell in the cortical neuropil makes contact with 5,000 to 10,000 other cells, but as Freeman says, the chances of any one pair of neurons being in contact is less than a million to one.<sup>17</sup>

Deep in the brain are other collections of nerve cells or ganglia, an important one being the corpus striatum. These were known to Swedenborg, who rightly thought that they helped transmit messages from the cortex to the body.<sup>18</sup>

One ganglion or collection of cells in the striatum is the hippocampus, so called because on cross section the grey matter resembles a sea horse. Primitive forms of the hippocampus together with the sensory and motor cortices form a very ancient part of the neuropil. For example, the hippocampus or association cortex is found in the pea-sized cerebrum of the Tiger Salamander, which has inhabited the earth for 450 million years and lies between amphibian and vertebrates on the phylogenetic scale.<sup>19</sup> C.J. Herrick says on page fourteen of his book, *The Brain of the Tiger Salamander, Ambystoma Tigrinum*, that salamanders “occupy a strategic position in the phylogenetic series, that is between the most primitive extant fishes, but organised on a higher plane, so that it can be more readily be compared with those of reptiles, lower mammals and man.”

### Brain function and the formation of meaning

The word “cerebrum” comes from the Latin word for wax, as this is what it looked like to Roman soldiers as they wiped it off their swords.

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<sup>17</sup> Ibid., 48.

<sup>18</sup> O.M. Ramström, “Swedenborg on the Cerebral Cortex as the Seat of Psychological Activity.” In *Transactions of the International Swedenborg Congress, Held in Connection with the Celebration of the Swedenborg Society’s Centenary, London, July 4–8, 1910* (London: Swedenborg Society, 1910), 67.

<sup>19</sup> C.J. Herrick, *The Brain of the Tiger Salamander, Ambystoma tigrinum* (Chicago and London: University of Chicago Press, 1948).

Aristotle thought that the heart was the site for intellectual activity, as did Isaiah, the brain being used for cooling the body mechanically. There was no idea of the brain's extraordinary properties, which made it necessary to invoke such ideas as the soul.

Swedenborg seems to follow a hydraulic analogy of Descartes in his pre-theological writings, but makes the cortical spherules, illustrated in a figure taken from Bidloo in *Anatomia Tab. X fig. 2*, the origin of the fluid from the ventricles. He says these spherules do not secrete "liquor" but an essence suitable for the "spirits"; nor is the nerve a "tube" but a "fiber."<sup>20</sup> The contents of the fiber, to prevent them "flying away," are associated with blood, and thus become nervous juice. Swedenborg classifies arteries, veins, and nerves as fibers. These fibers find their way into the entire body, so that the soul can control the entire body, as if it was a separate entity governing the body. There is a dualism here which disappears in his theological writings. Here the environment is, so to speak, the soul—the correspondence between the two is so close, as he describes in his book *Heaven and Hell*.

### Swedenborg's concepts of degrees

In attempting to describe the way sensations are experienced, Swedenborg employs the concept of degrees. By this I think he means that the degree, or the anatomical category, of say the skin and cerebrum, must not be confused with the "ideas" which they form. Using the idea of degrees, he avoids what might be called category mistakes. Gilbert Ryle<sup>21</sup> illustrates this well by his remark that a university must not be confused with the buildings. In the same way the structure of the brain must not be confused with the ideas it contains.

When I use the word "contain" I mean this in a spiritual sense, a degree change from a natural to a spiritual plane. The brain is a natural object placed behind the eyes and made of grey and white matter. It

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<sup>20</sup> Swedenborg, 57, and in volume II under Bidloo.

<sup>21</sup> G. Ryle, *The Concept of Mind* (London: Hutchinson, 1949).

contains the mind only in a metaphorical sense, and this is a cognition of truth (AC 9544). The content of the mind can be anywhere, though it is easier to envisage it as sharing the same locus as the brain behind the eyes, rather than say up in a corner of the room or in the house next door.

The mode whereby modification of sensation passes over from the organ of one degree to those of the other, and this without stopping except in the first and the last can in some measure be concluded from the mode whereby it [sensation] is transmitted from the external organs to the cerebrum itself.<sup>22</sup>

Here Swedenborg is describing the way a sensation in the skin results in a motor response. For example, the result of stimulating the sensory receptors in the skin reveals itself in the motor effects of the limb—if you touch something hot, you become conscious of it in the cerebrum (see the well known picture from Descartes). What happens between the two is a category or “degree” change, meaning (or “being”!!) is inserted, which is very difficult to understand unless one has a modern concept of the BB and its relationship to the environment. The complexities are hinted at by Swedenborg in his reference to differential calculus.

To make degree change clearer, perhaps the concept of domains—a source domain and a target domain—can be used. A simple example: think of three objects on a table (the source domain) and then the domain of arithmetic, with idea of “number” 3 which converts the three natural objects into the idea of number in the target domain. The natural world is transformed into the domain of intellectual meaning.<sup>23</sup> Descartes then transformed numbers into points on a line and made so called Cartesian space and calculus possible, enabling the intellect to deal with infinitesimal objects.

Many attempts have been made to understand this “degree” changing facility in brain function since Swedenborg’s time, using contemporary technology as analogies for brain function. Following Descartes’ hydraulic

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<sup>22</sup> Swedenborg, vol. I, 56 .

<sup>23</sup> G. Lakoff, and R.E. Nunez, *Where Mathematics Comes From* (Basic Books, 2000).

analogies, other mechanical analogies like telephone exchanges, radios, computers, and artificially intelligent robots have followed each other.

Various imaginary structures or organs (reminiscent of the medieval faculties of imagination, reason, and memory, not identifiable by anatomical neuroscience) have been suggested. For example, based on the idea of connectionism in computers, Cognitive Psychology posits such “organs” as Face Recognition Units (for recognizing faces), Person Identity Nodes (where a face is classified as belonging to a known person), Semantic Information Units (where the occupation of a person is registered), Lexical Outputs (where the words are manufactured).<sup>24</sup>

Daniel Dennett in the book, wonderfully full of examples, *Explaining Consciousness*,<sup>25</sup> demonstrates convincingly that there is no central “Cartesian Theatre” within the brain where consciousness or meaning is to be found as intuition might suggest. Dennett posits a Multiple Draft Model (MDM), for the way the brain finally produces a unified concept of anything.

To avoid positing a structural analogy such as those of Cognitive Psychology or even those of Dennett’s MDM, Freeman has suggested what he calls a “Pragmatic” approach. Besides inventing a new word “neuropil” to describe the structure of the nerve cells of the brain, he has coined the word “neurodynamics” to describe the neuropil function. It is based on the patterns of the Electroencephalogram (EEG) and their analysis by the mathematics of chaotic dynamic and circular causality. This again reminds one of Swedenborg’s remarks on the calculus being a way of dealing with the domain of brain anatomy and the domain of meaning for the animal.

## EEG PATTERNS SEEN AS A BASIS OF MEANING

Freeman has done some very interesting work analyzing and philosophizing on the implications of his EEG tracings obtained from the neuropil of the olfactory bulbs (smell nerves) and olfactory cortex (olfactory cortical

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<sup>24</sup> N. Braiby, and A. Gellatly, *Cognitive Psychology* (Oxford: Oxford University Press, 2005).

<sup>25</sup> D. Dennett, *Explaining Consciousness* (Boston: Little Brown and Company, 1991).

neuropil) of rabbits. He finds brain activity expressed by EEG gamma wave patterns, frequencies between 35 and 85Hz, much quicker than fluttering leaves. These are unique to each animal, being, however, never the same more than once but recognizably unique to that particular animal (like human finger prints if you can imagine them changing all the time). It is pragmatic because his ideas do not call for any known mechanical metaphor drawn from the world. He merely describes an EEG pattern which varies with the experience of the rabbit and demonstrates the way the “form” of the brain alters as a whole in response to the environment, with the creation of “meaning” in this way. Freeman describes the way the “brain forms a simulacrum of, or copy of the environment that is comparable with the history and goals of the organism. This is the basic process of assimilation, the enactment of the unidirectional [from the environment to the brain] relation of the self to the world.”<sup>26</sup>

Other work on the EEG patterns of the brain makes the metaphor of the tree for the ever changing “shape” of the brain in its response to the environment even clearer. One has to remember that the tree does not alter its shape in response to say a particularly strong blast of wind by closing some of its leaves, but the brain itself is able to alter the EEG in response to a conditioning stimulus as it becomes more alert to an environmental change (believe it or not there are tiny muscles in brain cells!) This has been shown in investigation of the EEG of the olfactory bulbs, part of the smell brain at the top of the nose in mammals. The olfactory bulb structure is much simpler than the cortex of the brain, and so gives a simpler model of the leaflike fluttering of the EEG. But what is true of the bulbs is also true of the rest of the brain.

The EEG pattern of the bulbs exhibits a particular pattern on quiet breathing, as “wind” passes in and out of the nose. This alters immediately if a smell or scent is included in the wind, and the pattern never returns to the original one, although remaining specific in a recognizable way, like human finger prints, for the particular individual rabbit or cat for example. The alteration is produced by the shape of the molecules in the

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<sup>26</sup> W.J. Freeman, *How Brains make up their Minds* (Phoenix: An imprint of Orion Books, 2000).

smell, locking so to speak on receptors on the surface of the bulb, but also by an active change in the sensitivity of the bulbs to a particular smell. This process by which the brain makes itself more sensitive to the environment is called "preaffference." In a sense this process alters the environment from the point of view of the individual though not necessarily from the point of view of other people even if they share that environment. The "shape" of the environment depends on each animal or person's particular history, interests, and situation. Preaffference also enables the animal to distinguish changes in the environment from changes in itself, but again this phenomenon is private to each individual. Preaffference perhaps explains the changing appearance of the spiritual world for each individual as described by Swedenborg.

The cognitive shape of the brain can be described by such terms as "attention, perception and thinking. These are dynamic continually changing processes with both momentary and sustained fixations of different degrees [on the spiritual plane]. The time constants of dynamic perturbations of organised electricity, such as periodicities, coherences, and spatial distribution of amplitudes [of the EEG] are more congruent with the time constants of information processing"<sup>27</sup> than any other metaphor. Again the movements of leaves of a tree "mirror" the wind in an easily imaginable way, just as the brain mirrors the "wind" of the ever changing environment.

To make it easier to understand the development of these "cognitive shapes," imagine a little baby in its cot moving its arms about in a random way. Its hand will inevitably come in contact with something, and the brain-body unit will inevitably be shaped by that contact. This will continue throughout life until the body and the environment, by continual interchange, in turn form a unit. An affordance or use will be constructed between the world and the organism. This process can be called assimilation (*adæquatio*, making equal) following Aquinas. The will of the baby cannot be as yet defined by truth, because the vessel needs to be con-

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<sup>27</sup> D.E. Steer, "Sensory and Cognitive 40-Hz Event Related Potentials: Behavioural Correlates, Brain Function and Clinical Application." In *Brain Dynamics*, eds E. Basar, and TH. Bullock (Berlin: Springer-Verlag, 1898), 339–374.

structured by continuous interaction between baby and world. In a sense there is no gap between vessel and content. They are still one until incongruities between the individual and the environment make the “gap” noticeable. (Adam discovers so to speak that he is naked. The wind feels cold!) There is at first a vague image of the will in the baby’s brain. As the baby develops, his or her loves will be more explicitly formed by the way he or she acts on the world and the world feeds back on him or her. Meaning or the soul develops by this continual interaction or influx to eternity. The meaning or soul of the world for the baby is created by the baby’s BB as it develops.

### **The EEG reflects the ruling love of an individual**

Swedenborg would describe the goals of the organism as its ruling love. In *Arcana Coelestia* he writes the following:

For the very love that is felt within the external belongs to the internal, namely that which acts in response to it, in order that some effect may be realized, and as the active force is the cause and what reacts to it is the product of the cause, reaction belongs to the active force just as the product of a cause belongs to that cause. (6262)

The anatomical center for this complex relationship between the organism and the environment is the hippocampus and its associated nuclei, the amygdala and the nucleus accumbens, all part of the corpus striatum.

Freeman suggest the idea of circular rather than linear causality for this concept and describes the dynamics of chaos (as opposed to noise) to describe the activity of the neuropil. Our daily lives seem to depend on linear causality. We ascribe reasons for things happening using its apparent logic. However, circular causality is a better way of describing the relation between the infinite complexities between ourselves, the environment, and the Lord as mentioned above in *Arcana Coelestia* 6262. It is useless for every day life, however, where we need a linear causality

The idea of intention, as developed by Thomas Aquinas, must have been part of the Swedenborg’s philosophical background. His anatomical

and theological experiences modified his insights and his vocabulary. Aquinas' intention perhaps becomes Swedenborg's Will. Freeman links his EEG findings with the idea of intention as described by Thomas Aquinas and illustrated by the medieval surgical term, still used in the phrase "healing by first intention," which describes the way a cut in the skin heals as if intended by the soul. Freeman suggests very plausibly that the center of intention, the center of action in animal and human behavior, is the hippocampus which, as shown by Herrick, is a very ancient part of the brain. This intention becomes "visible" or meaningful by the way an animal changes her environment, which includes her own body, by movement. "On s'engage et puis en vois" (You jump and then see what to do) as Napoleon remarked.

If we consider the structure of many animals, the main sensory organs—the eyes, the nose, the taste organs—are at the front. This is because the front of the animal indicates an orientation to the environment, enabling it to access the sources of its ruling love, which is survival. The positioning of the main sensory organs at the head, or ruling end, supports Swedenborg's ideas about what rules an animal's behavior and accelerates the formation of meaning, good or bad, for the animal, in the EEG pattern of its brain. The nose is the most primitive part of this set of orientation equipment and leads into the smell brain, which includes the hippocampus, the septal nuclei (nucleus accumbens in man), the amygdala, and the closely associated hypothalamus which turns EEG activity into hormone production, and the will for flight, fight, feeding, freezing, and reproducing.

### THE WIND AND THE WILL

We see the leaves of a tree moving in the wind. The wind, like the will or spirit, is invisible, and we only know its presence by its sound, the feel on our cheek or the sight of the tree's flickering leaves. The soul, or meaning of life, is invisible, and we only know its presence by our actions and those of other animated creatures on the world and in the flickering patterns of their EEGs. Meaning is neither in the environment, nor in those flickerings, but in the relationship between the two. Its form exists only

momentarily, for an “ungraspable instant,”<sup>28</sup> and then changes as quickly as it is formed. “A creature’s basic behaviors do not normally change but are contextually dependant in a spatial, temporal and dynamic sense . . . cognition tak[ing] place in the real time of ongoing change in the environment, the body and the nervous system. Dynamic analyses show the structure of cognition *mutually simultaneously influencing change*” (italics in original).<sup>29</sup>

### CONCLUSION

Swedenborg says that all things are made of the two principles, good and truth, reflected at the human level in will and understanding, the soul being the whole man. Humans also liken the soul to the wind as if it animated an inanimate environment and their own bodies. Expressing the problem in terms of structural and functional neurodynamics may enlighten understanding of the nature of the soul. □

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<sup>28</sup> M. Frayn, *The Human Touch: Our Part in the Creation of the Universe* (London: Faber and Faber, 2006).

<sup>29</sup> M. Sheets-Johnstone, “Consciousness: a Natural History,” *Journal of Consciousness Studies* 5: 3 (1998): 260–94.