RIGHT BRAIN, LEFT BRAIN[†]

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In the ancient world there were two great libraries. There was the library of Alexandria, one of the wonders of the Ancient World, a monument to the ambition of the Ptolemaic kings, successors of Alexander the Great. And there was also the library of Pergamum, its rival, pervaded by the stoic ideal. The Stoic ideal being that the virtuous man attains happiness through knowledge, the legacy of Socrates.

The scholars in Alexandria were dedicated to the literal interpretation of the text. They toiled to preserve accuracy and authenticity, frequently deleting text when of dubious origin. They rarely added words and never embellished text. The scholars in Pergamum were of a different mind. To them deep meanings were hidden behind the classical themes. Fidelity as to the letter of the text was of minor importance in comparison to the allegory within.

The subject of tonight's brief talk is the brain. Specifically, the right and left cerebral hemispheres. Stephen Cole spoke to us in a most eloquent and informative way several years ago on the cerebellum and my hope is that this talk will complement his excellent presentation. I would offer my credentials for this task if I had any. Perhaps the only thing that might resemble qualifications is that I did manage to pass neuroanatomy in my freshman year of medical school, twenty-three years ago.

Why are we interested in the brain? From the perspective of its gross anatomy it would appear to be an aesthetic flop. An exhibit at the art museum of brain paintings would attract few admirers. We are interested in the brain, the three and one half pound mass of pate, the overgrown walnut, for the simple reason that it is home to something quite magnificent, the human mind. And we are interested in the human mind because it is the engine of human use.

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The brain is composed of approximately one trillion cells, one hundred billion of which are neurons or specialized nerve cells. Each neuron is said to be analogous to a computer and each neuron has discrete connections through branches called axons and dendrites to as many as six hundred other neurons. Seventy per cent of the neurons are found in the cortex of the brain. Different regions of the cortex have morphologically unique neurons, the differences being primarily in the degree of branching of the axons and dendrites.

Unlike other cells in the body, which for the most part have the ability to regenerate and multiply, we are born with our full complement of neurons and it is down hill all the way thereafter. In fact, in the development of the fetal nervous system there is a phase of programmed cell death during which as many as eighty-five percent of the cells in certain areas are eliminated.

Thinkers of antiquity believed that the mind resided in the human heart. Evidence suggests that Hippocrates, the father of Western medicine, was the first to perceive the true scheme of things; that the mind resides in the brain. It was Swedenborg who announced that the cerebral cortex was the locus of consciousness. Now here it is important to point out that mind is not synonymous with consciousness but that consciousness is derivative of the mind.

Permit a brief digression here. Julian Jaynes, professor of psychology at Princeton University, in his remarkable book, *The Origin of Consciousness in the Breakdown of the Bicameral Mind*, demonstrates how rarely we are really conscious of our actions. He also postulates that consciousness, as we know it, is of relatively recent vintage in terms of human history. Before man spoke, he thought, and these thoughts, these inner voices were perceived to be messages and instructions from the gods. While we would argue with the accuracy of his conclusions, Dr. Jaynes' basic premise should be of more than passing interest, for obvious reasons, to those who are aware of New Church teachings concerning the Most Ancient Church.

In discussing right brain, left brain it should be made clear from the start that it is really the right and left cerebral hemispheres of which we speak. It was only a little more than a century and one half ago that it began to be appreciated by the scientific community that there were in fact

specific areas of the hemispheres which controlled, managed, or facilitated certain functions. Marc Dax, a country doctor in France, read a short paper in 1836 before the local medical society in Montpellier describing his observations in a number of stroke patients. He was curious about the relationship between paralysis on the right side of the body and loss of speech. He did not observe loss of speech in his patients who were paralyzed on the left side. Sadly for Dax, the paper went unnoticed .

Franz Gall, a German neuroanatomist, was the first to propose that different mental functions are associated with different areas in the brain. He was also unfortunately a phrenologist and claimed that the regions of the brain responsible for the qualities of one's character were impressed upon the skull and could be felt by skilled and trained hands. In 1861, about a generation after Dax, a young surgeon named Paul Broca heard a lecture before the Society of Anthropology in Paris. The lecturer proposed that the center for speech was located in the frontal lobes of the cerebrum. Just a few days after the lecture Broca had the opportunity to perform a post mortem examination on one of his patients with long standing right sided paralysis and loss of speech. Broca discovered not only that the lesion responsible for the loss of speech was in the frontal lobe, but that it was in the left frontal lobe, a spot now designated as Broca's area.

Not long afterwards, Karl Wernicke, a German neurologist, announced that he had localized the center for the *understanding* (reception), of speech to a specific locus in the posterior portion of the left temporal lobe. By the end of the Nineteenth Century, the left hemisphere had become well accepted as the portion of the brain responsible for the *reception* of speech and the *expression* of speech, both written and spoken.

Now let us jump ahead about fifty years to the early 1940's. By this time Wilder Penfield at the Montreal Neurological Institute and others had demonstrated by using low current electric probes on living, awake human subjects undergoing neurosurgery for severe epilepsy, that various areas of the cortex could be mapped according to function. Furthermore, he demonstrated that memory of remote experiences could be brought back to active consciousness by probing the temporal lobe with two to three volts of electrical power. Dr. Penfield was astonished at such a direct demonstration that the cerebral cortex was the abode of the memory and mind.

Now at about the same time that Wilder Penfield was mapping the living human brain in Montreal other neurosurgeons were beginning to perform a radical new procedure for controlling severe epilepsy, a procedure called commissurotomy. Central to our discussion this evening is the understanding of how the hemispheres are connected. There are several discrete structures called commissures which are tightly packed bundles of nerve fibers which connect all the points of the left hemisphere with all the mirror image points in the right hemisphere. All told there are approximately two hundred million nerve fibers passing through the commissures.

The largest of the commissures,by far, is the corpus callosum. By surgically dividing the corpus callosum, and the other commissures, the hemispheres are permanently isolated from one another, for the fibers of the commissures do not regenerate or heal back together. This capacity is lacking in the central nervous system. Now the hemispheres are not completely isolated from one another but they are for the senses and cognition. Some residual cross talk occurs between the hemispheres through the brain stem, especially for activity with emotional content. It should be mentioned that animal experiments had demonstrated the relative safety and efficacy of commissurotomy before it was ever performed on humans.

The first so called split brain procedures were performed by Dr. William Van Wagenen, a neurosurgeon in Rochester, New York. Because only the anterior commissure and anterior portion of the corpus callosum were divided, the results were rather unpredictable in terms of controlling epilepsy and, psychological studies on these patients performed by psychologist Andrew Akelaitis showed no residual deficits.

Not long afterwards Drs. Philip Vogel and Joseph Bogen in Los Angeles began performing complete commissurotomies. Their rate of success in controlling otherwise severe and uncontrollable epilepsy was quite good. Approximately two dozen patients had undergone the procedure and these people became the subjects for the intensive and ingenious testing designed and performed by Roger W. Sperry at the California Institute of Technology in Pasadena. Dr. Sperry was awarded the Nobel Prize in Medicine or Physiology in 1981 for his research with these patients.

Now in order to understand how these tests were performed and the significance of the results, it will be necessary to explain some basic

neuroanatomy. First, because many of the experiments involved visual stimuli, the basic pathways should be explained. Vision is divided into hemifields, right and left, and they are projected to the occipital area on the back of the opposite hemisphere. That is to say, the right half of the right eye and the right half of the left eye, each divided vertically down the exact center of the eye project fibers to the left hemisphere only. The left half of the left eye and left half of the right eye project fibers to the right hemisphere only. Sperry and others devised various ways to present visual stimuli to the isolated right or left hemifields, or in some cases different visual stimuli to both at the same time.

One means of isolating the hemifields is by use of the tachistoscope. The subject stares at a dot on a screen in front of him at the same time that an image is projected for a split second onto the screen either to the left or right of the dot. The subject does not have sufficient time to move the eye and as such catches the object or symbol only out of the corner of his eyes, in reality only the hemifield to which side the object was projected. The image perceived is then projected to the visual cortex in the occipital lobe of the opposite hemisphere. In split brain patients no information corresponding to the image can be sent to the opposite hemisphere.

Auditory stimuli, that is sound perceived by the ear, is transmitted to both the near hemisphere by ipsilateral fibers and the opposite, contralateral hemisphere via contralateral fibers. In humans, the ipsilateral or same side fibers are weaker and the contralateral fibers are stronger. Odors are transmitted via the olfactory nerves exclusively to the ipsilateral hemisphere.

Sense of touch is transmitted from the extremities primarily to the contralateral or opposite hemisphere. Sense of touch from the torso and face is carried to both hemispheres almost equally. A small number of ipsilateral fibers allow control of the hand and arm on the same side but the control is coarse and limited to movements of the extremity as a whole such as in pointing. Fine, precise movements in the hand are controlled by fibers from the contralateral hemisphere.

Although most so-called split brain patients appear to behave quite normally, occasionally some rather bizarre behavior has been observed. For example, a man who when attempting to pull up his pants with one hand had to struggle against the other hand trying just as forcefully to pull

them off. Or consider the unfortunate woman who always grasped an article of clothing she had not visually selected and, unable to put it down or replace it, had to call her daughter for assistance. Another example is the young man of above average intelligence who while working as a stock boy removed each item from the shelf with his left hand as soon as it was placed on the shelf with the right hand.

These examples, while rare, have suggested that much of the information transmitted via the commissars is inhibitory in nature. The property of inhibition is in fact, every bit as important as activation for the smooth and orderly operation of the central nervous system. This is a very important concept in understanding the dynamics of the brain.

Beside the more dramatic examples given above, there are frequently more subtle deficits in the split brain patient. Some patients have reported extreme difficulty with geometry. Absence of dreaming has been reported in some subjects but has not been confirmed by any well controlled studies.

What have the studies of Sperry and others revealed about the right hemisphere? Opinions vary as to whether the right hemisphere has intrinsic language function. The general opinion among neurobiologists is that the right hemisphere is essentially non-linguistic. However, some testing has suggested a vocabulary level on the right side equivalent to that of a ten-year-old child. The right hemisphere seems to be primarily concerned with processing complex visuo-spatial information.

In tests relating parts to a whole, or in judging the size of a circle given only a small arc of its circumference, the right hemisphere was superior to the left. Additionally, in split brain patients, cube drawing is invariably done better with the left hand, a function of course of the right hemisphere. Precisely why this is so has been debated and various opinions have been offered. Perhaps there are various physiological reasons including the fact that the right hemisphere is superior in visuo-spatial manipulation.

Some of the experiments performed to investigate these questions include asking the subjects to identify as tall or short the lower case analog of an upper case letter flashed either to the right or left hemisphere. Split brain patients when used as subjects consistently performed better when the capital letters were flashed to the left hemisphere via the right hemifield.

However, when split brain subjects were asked to identify rotated letters as either normal or backward, they did consistently better when the images were presented to the right hemisphere.

When split brain patients are presented tachistoscopically with composite photographs of faces, called chimeric figures, in which the right and left halves of the photograph are of different people, and are subsequently asked to match the composite to a whole, the half face presented to the right hemisphere is usually chosen.

If you think that's complicated, listen to this. Researcher Jerre Levy states, "hemispheric activation does not depend on a hemisphere's real aptitude or even on its actual processing strategy on a given occasion but rather on what it thinks it can do."

One of Roger Sperry's most famous experiments was performed on a young woman who had undergone commissurotomy. A photograph of a naked lady was presented very briefly to the right hemisphere via her left visual field. She blushed with embarrassment but when asked what she had seen could only say, "Doctor, that's quite a machine you have there!" Emotional content may flow to the opposite hemisphere via brain stem commissures, and other physiologic changes perceived by one hemisphere may be read by the other via "cross cuing."

The left hemisphere is seen to function in terms of sequential processing derived from auditory patterns and stimuli, the right hemisphere functions by simultaneous processing, a holistic or synthetic type of approach rather than the logical stepwise strategy of the left brain. The right hemisphere utilizes primarily visual stimuli and visual memory. Furthermore, hemispheric specialization is not an all-or-nothing phenomenon, but more or less falls on a continuum. Functions of the right hemisphere have proven to be more elusive than the left.

In the early 1950's, two researchers, Mortimer Mishkin and Donald Forgays, discovered that normal right-handed people were better at identifying English words flashed to the right side of the visual field, in other words to the left hemisphere, than they were at identifying words presented briefly to the left hemifield. However, when Yiddish words were presented there was a slight advantage noted for the left visual field.

Knowing what was said earlier about how sounds and spoken words are perceived, that the stronger pathways are projected to the opposite

cerebral hemisphere, let's look at some experiments done with hearing. If different sounds are presented to the right and left ears simultaneously, the stimuli are called dichotic. If the dichotic stimuli are spoken words, the right ear has an advantage because it projects to the left, linguistically skilled hemisphere. This explains why we tend to tilt our right ear forward to better hear conversation in a crowded or noisy room.

Split brain patients, however, show an exaggerated response to dichotically presented stimuli. They will report right ear stimuli accurately but can only guess at words presented simultaneously to the left ear. This is thought to be because the weaker ipsilateral fibers are suppressed when presented with dichotic stimuli. There is no difference in the ability to recognize words when presented one at a time to right or left in split brain patients.

It is interesting to note that the left ear has a distinct advantage in dichotic experiments for recognizing melodic excerpts from musical passages and for recognizing environmental sounds, such as animal noises, sounds of machinery, baby sounds, wind and rain. The right hemisphere is also responsible for producing and perceiving color and intonation in speech which can modify the literal meaning of words and phrases. This component of sound-based language is known as prosody.

Further evidence for information processing differences can be found in the study of the two forms of the Japanese language, Kana and Kanji. The Kana form is sound-based; its written character represents the sound of a syllable without any meaning. It has sixty characters in each of two versions. The alternate form, Kanji, uses meaning-based characters. Knowledge of at least three thousand characters is necessary to read a newspaper in the ideographic Kanji-based language. Each character in Kanji may have several possible meanings and from one to four syllables depending on the meaning.

In Japan people have strokes just like in the United States. Remarkably, however, a left-sided stroke in a Japanese patient causes loss only of the ability to understand Kana based language. The ability to communicate with Kanji remains intact. In a much smaller number of patients the reverse is true. This is analogous to the situation in which an object is flashed to the right hemisphere in a split-brain patient and he is asked to identify it verbally and to then select the object from beneath a screen with

his left hand. He will not be able to identify the object verbally but will have no difficulty whatsoever in selecting the correct object by touch.

In trying to synthesize what we have learned so far it might be worth considering the words of Sri Aurobindo, a Yogic philosopher, uttered over eighty years ago. "The intellect is an organ composed of several groups of functions, divisible into two important classes, the functions and faculties of the right hand, the functions and faculties of the left. The faculties of the right hand are comprehensive, creative and synthetic; the faculties of the left hand critical and analytic…The left limits itself to the ascertained truth, the right grasps that which is still elusive and or unascertained. Both are essential to the completeness of the human reason. These important functions of the machine have all to be raised to their highest and finest working power, if the education of the child is not to be imperfect and one-sided."

The pre-theological works of Swedenborg say almost nothing regarding the differences between the right and left cerebral hemispheres. In his large work entitled *The Brain*, however, the discussion of the corpus callosum, the great commissure, anticipates some of the remarks we have considered this evening.

For example, in 430a. "The corpus callosum concentrates in itself all the medulla of the whole cerebrum with the exception of that part which, above and below, is dispatched towards the medulla oblongata." Or in 428, "On this account also the corpus callosum connects the upper parts with the lower, and those of one side with those of the other; and it thus forms a knot, not unlike the Gordian which cannot be solved except by dissection of its body. By its means also the hemispheres and the parts contained within the hemispheres intercommunicate with one another."

The revelatory Writings of Swedenborg are much more explicit and comprehensive in regard to the correspondential functions of the right and left hemispheres. At times, however, the Writings seem to contradict themselves in this regard and we should be much indebted to Dr. Norman Berridge for his assistance in sorting out some confusing passages.

> Moreover such is the correspondence of the brain with the Grand Man, that they who are in the first principles or beginnings of good have relation to those things in the brain which are the

> beginnings, and are called glands or cortical substances: whereas they who are in the first principles of truth relate to those things in the brain that flow out from these beginnings; and are called the fibers; and yet with this difference, that those who correspond to the right side of the brain are those who are in the will of good and thereby in the will of truth; whereas those who correspond to the left side of the brain are those who are in the understanding of good and truth and thereby in the affection of them…The former are celestial, the latter called spiritual. (AC 4052)

"The left side of the brain corresponds to the rational or intellectual things but the right to the affections or things of the will" (AC 3884).

"To the left hemisphere pertain the intellectual faculties, and to the right those of the will" (AC 644).

> …things of the understanding of spirits and angels flow into the left part of the head or brain, and things of the will into the right; and it is the same with respect to the face. When angelic spirits flow in, they do so gently like the softest breath of air; but when evil spirits flow in, it is like an inundation into the left part of the brain with dreadful phantasies and persuasions, and into the right with cupidities… (AC 641)

"On the left side of the head are those who have despised things which are good, on the right side those who have despised truths" (SD 1018).

"On the left part of the brain, or in its left hemisphere, are presented those things which are false as to affections, and on the right those which relate to doctrinal matters; or on the left are those things which regard good, and on the right those which regard truth" (SD 1023).

"The brain is also divided into two hemispheres…and the right relates to the good of truth and the left to the truth of good" (T 384).

Dr. Berridge in his book *The Natural Basis of Spiritual Reality*, notes a passage from the *Spiritual Diary* in which Swedenborg notes a sensation in his right nostril and palm of the right hand when spirits acted on the left side of his brain. Berridge points out that sensation in the nostril is not transmitted via the olfactory nerves and that the complex crossing of sensory fibers from the nostrils has only recently been mapped out.

Roger Sperry, after years of research in neuroscience leading to the Nobel Prize, developed a personal philosophy which attempts to reconcile the skepticism appropriate to the scientist and what he perceived to be true regarding the mind brain problem. He states:"I have come around today to rejecting the materialist doctrine of twentieth-century science and its claim that everything in the universe can be accounted for in strictly physical, mass-energy terms without reference to mental or conscious forces. As a brain scientist, I now believe in the causal reality of conscious mental powers as emergent properties of brain activity and consider subjective belief to be a potent cognitive force, which above any other, shapes the course of human affairs and events in the civilized world." In response to this I will quote from *Arcana Coelestia* 444: "If the soul were mere thought, man would have no need of so much brain, the whole brain being organic of the interior senses…"

The right brain, left brain model which can be derived from reflecting on both what modern neuroscience has discovered and what the Writings reveal, generates an interesting paradigm which can be seen again and again in the natural world and in the world of man's creation. For example consider the creation of Thomas Mann, the Nobel Prize winning author of *The Magic Mountain.*

There are three principle characters in *The Magic Mountain* which is the description of life in a tuberculosis sanatarium in Davos, Switzerland. First there is Hans Castorp, the central figure whose opinions are at best neutral, but who acts as a conduit for the remarkable discussion between his fellow patients, Settembrini and Nafta. Settembrini is exemplified in his statement, "Truth and justice are the immediate jewels of personal morality…" Nafta, the Jewish Jesuit states, "Liberation and development of the individual are not the key to our age, they are not what our age demands. What it needs, what it wrestles after, what it will create—is terror. Small wonder that the Nazis burned as many copies of *The Magic Mountain* as they could find.

It seems fairly obvious that the benign, humanitarian Settembrini is a right brain analog, and that the cold, analytical Nafta is a model for the left brain. I won't belabor the point by comparing the left hemisphere and the Ishmael rational, but Dan Goodenough's excellent sermon on the subject back in the 60's is worth reviewing in this regard. Hans Castorp, himself

uncommitted, perhaps a bit confused by his friends, plays the role of corpus callosum, as a conduit for conversation between the two.

It will be perhaps enlightening to consider the right hemisphere, left hemisphere paradigm as an intermediary sort of model to the doctrines concerning good and truth which we see everywhere. From the correspondences of the Renaissance and the Reformation in history, to right and left hand configurations of various chemical compounds, the "cosmic asymmetry" of Louis Pasteur is, to the informed observer, certain evidence of the Divine Love and Wisdom which sustains Creation. ❑

CONFERENCE ON SWEDENBORG IN RUSSIA

The Russian Academy of Sciences and the Russian Swedenborg Society are jointly sponsoring an international conference titled "Swedenborg in Russia." It will be held November 13-17, 1994, at the Academy's Institute of Man in the center of Moscow. Scholars from Moscow, St. Petersburg, Kiev, Riga and other places are expected to participate, and scholars from America and Western Europe are also invited. Cost for foreign participants for meals and internal transportation will be about $US600, in addition to travel costs to and from Moscow.

If you are interested in participating, contact Dr. Vladimir Maliavin, Vice-chairman of the organizing committee in Moscow, FAX 095-203-9169 or preferably 095-272-5021, or Dr. Erland J. Brock, Box 717, Bryn Athyn, PA 19009, FAX 215-938-2658.