New Pathways in the Recovery from Brain Injury

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Victims of stroke and other brain damage can take hope from the mounting research evidence that the central nervous system can relearn, re-route and re-grow neural connections.

I

In viewing the rehabilitation and recovery from a stroke or head injury resulting in destruction of brain tissue, a new paradigm needs to be established in the conventional rehabilitation centers. This new model would see the dynamics of recovery as a re-learning process based on mind-body interaction. The relearning process would include plateaus, or periods of seemingly arrested progress.

These concepts emerged from personal experience during the last five years, first in a pilot project on brain plasticity and stroke rehabilitation, and then in my private practice as a Feldenkrais Practitioner.

The project began in Mexico City in December 1975 and formally ended in San Francisco on December 31 1977. The work continued however, not as a pilot project but as a special stroke and head injury group at Garden Jerd Sullivan Hospital Adult Day Care in San Francisco California. The clients themselves sponsored it till 1979.

In 1976 I was introduced to the Feldenkrais Method and recognized it as the tool we were looking for that could stimulate the plastic properties of the nervous system in the most efficient way. I subsequently trained with Dr. Feldenkrais to become a practitioner of his method.

As I tried different approaches to help people who had categorically been told they were permanently disabled, to learn to move again, I watched and observed.

The medical model to date has been a rather negative one in terms of prognosis. If "spontaneous" recovery from paralysis and speech difficulties due to cerebro-cardiovascular accidents hasn't occured within six months to two years, the patient and his family are told categorically that no further advance is possible and that he should "realistically" get used to the idea that he will be a cripple for the rest of his life.

Such a result strengthens the case for the existence of motor plasticity in the adult human nervous system.

Sometimes, even before the acute period of trauma is over, and the patient is just out of surgery, patients have heard their doctors say "You might as well resign yourselves to the fact that John will never walk again," or "Your daughter will never be able to use her arm." One man, who couldn't utter a word after his stroke, told us "I couldn't talk, but I wasn't deaf, and the doctor was talking about me as if I couldn't hear! He said to a group of doctors, this patient will not make it, he won't pull through. I thought, who does he think he is? I was feeling very angry. I reacted and here I am to tell you about it." A man, whose family was told he would never walk again, was unconscious, but heard that, sat up in bed, and said: "Oh! no, doctor, I'm going to walk," and passed out again. Today he is learning ballroom dancing.

These quotes are from people who reacted, sometimes angrily, against the medical edict, rebelled, survived, and walked, talked and recovered to live normal fulfilling lives.

There are two well noted examples in the literature of successful recovery from stroke brain injury.

One is the case of Patricia Neal, whose relearning program is described in a book by Valerie Griffith, *A Stroke in the Family*,[1] and the other is my former husband's father, whom I knew, and whose case is described by Aguilar.[2] My father-in-law had a stroke when he was 65 resulting in severe right handed hemiplegia and aphasia. He was very highly motivated and practiced movement continually, first crawling on the floor to retrieve objects by means of gross motor movement – then, exercising all the muscles over which he had voluntary control. Several months later, he became able to typewrite with one finger, then two and three fingers of the right hand and finally with all fingers. Two years after the stroke he went back to work. Even three years after, he carried a ball in his

right hand coat pocket and would squeeze it many times a day to increase the strength of his hand. The result was that he regained normal speech, gait and motor control, including fine movements such as handwriting. Following death from a coronary occlusion seven years after the stroke, autopsy revealed extensive damage to the corticospinal tract. Less than 2% of fibers were left in the left pryamidal tract of the medulla. Aguilar concluded, "that such a result strengthens the case for the existence of motor plasticity in the adult human nervous system."[2]

Patricia Neal, following brain surgery, lost her speech faculties. Her husband recounts, "When she came out of the hospital in California, she received professional speech therapy for one hour a day for four weeks ... It was easy to see that it was not going to be enough. By the time she arrived in England, she was still about 75% aphasic. She could neither read, write nor handle numbers. She had no initiative. If left alone, she would sit and stare into space and in half an hour a great black cloud of depression would envelop her mind ... Pat, I decided, must be kept occupied at least six hours a day. I made this decision the day we got home. I called in no doctors. It was a matter that had to be resolved entirely within the family. A couple of days later, I had managed to initiate a crash program of amateur teaching."[1]

Patricia Neal was kept alert and busy six hours a day for more than two years, and we all know that she is back in the theatre, acting on television.

He is eased out of rehabilitation programs, his insurance funds are stopped, and he is told that he has reached his maximum in terms of progress.

A prevalent myth in the U.S. is that when a patient or person working on their physical and emotional rehabilitation following cerebro-cardiovascular accidents, plateaus, that is, levels off for a period, he is eased out of rehabilitation programs, his insurance funds are stopped, and he is told that he has reached his maximum in terms of progress.

When one views the dynamics of recovery as a relearning and retraining process of the nervous system, one can see the folly of viewing a learning plateau as a terminal point. A plateau is, in fact, a normal occurrence in learning. "It has been recognized since 1897 that the acquisition of a predominantly perceptual skill ... and the acquisition of a motor skill ... are remarkably similar processes. Each is slow, and has several plateaus or periods of no learning."[2] The recovery from brain injury involves the re-acquisition of perceptual and motor skills, as described above.

The concept of neurological plasticity, of which learning is an implicit part, opens the door for a limitless view of the recovery process following brain injury.

Nonetheless, hundreds of thousands of people in this country are categorically left with the impression, when they reach a learning plateau, that there is no more hope and are not financed for further rehabilitation.

"In modern sciences, ranging from neurophysiology of consciousness to quantum physics, it has become evident that the structure of personal belief systems concerning the nature of self and the universe governs experience.[3]

"Inherent in any system of belief is a self-fulfilling prophecy: what is expected is observed and what is observed confirms the expectation. Any experience occurring outside his cultural, social and individual matrix is dismissed."[3]

A new paradigm is proposed here, which would offer a different belief. The concept of neurological plasticity, of which learning is an implicit part, opens the door for a limitless view of the recovery following brain injury.

Psychological and functional improvement can continue for years after the injury, and can resume, after a long plateau of several years.

This new model for the facilitation of recovery from brain injuries and lesions revolves around the concept of plasticity and psychosomatic health.

The term psychosomatic is not used here as it is currently used, to mean "imaginary," it is used here to convey the concept of the fundamental interaction between the mind and the body which is involved in health maintenance as well as illness.

The entire approach can be seen as humanistic rather than traditionally scientific. As described by Halstead and Halstead,[4] elements in a humanistic approach related to long term health care involved the following elements:

"The problem is seen as illness, not disease. In this case it's a re-education, not a cure.

The physician or therapist's role is seen as that of teacher-learner, not doer-knower.

The patient's, client's or student's role is seen as active rather than passive.

The teacher-learner (physician or therapist) is empathetic, rather than reserved.

The physical setting is personal and patient or client oriented and the outcome of the problem is seen as healing rather than curing."

The deductions in this proposal have come from observation rather than measurement. Nikolaas Tinbergen, Nobel prize winner for Physiology and Medicine says in *Watching and Wondering* ... this basic scientific method is still too often looked down on by those blinded by the glamour of tests, and by the temptation to turn to drugs ... But it is this old method of observation that ... allows [brain injury] (for instance) to be seen in a new light ..."[5]

II: NEUROLOGICAL PLASTICITY

In order to understand the ideas of neurological brain plasticity and neurological learning, some very simple neuro-anatomical descriptions will be sufficient:

A. The Neuron — its function and processes:

The classical definition of a neuron is a "nerve cell body and all of its processes."[6] A nerve is made up of hundreds of neurons grouped together in a common connective sheath. Less than 3 to 10% of the brain is made up of cell

matter. The rest is made up of axons, synapses, and blood vessels. The neuron is the fundamental structure of the nervous system. Over 20 billion of these cells act to coordinate, integrate and ultimately run all the other systems of the body.

The principle function of the neuron is, first, to receive stimuli, second, to conduct or transmit these stimuli or impulses along to the neuron, and last, to pass this information to other structures in the organism. These impulses can be received either from the external environment (exteroceptive stimuli), or the internal environment (proprioceptive and interoceptive stimuli). Next they are transmitted from neuron to neuron or from neuron to non-nervous cells of the body such as muscles and glands.

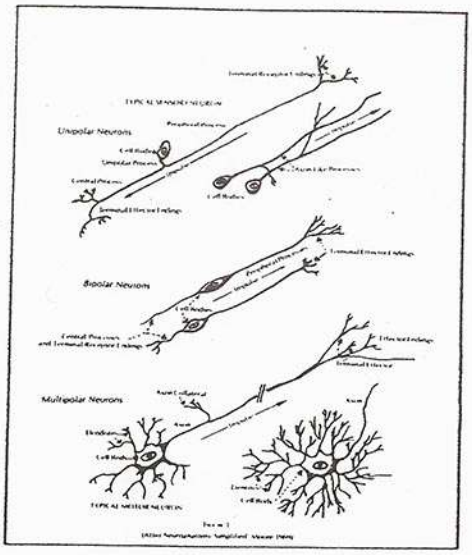
The total organism is dependent upon neurons to keep it operating efficiently and normally, thus maintaining equilibrium or homeostasis. Pathological reaction follows when this system is unbalanced, damaged or excessively strained.

The physician or therapist's role is seen as that of teacher-learner, not doer-knower.

Even though there are many types of neurons, one can basically speak of three types: sensory, motor and interneurons. The latter serve as connections or neuronal bridges between sensory and motor neurons. It is theorized that the major integrative and coordinative functions of the nervous system take place in the interneuronal nerve cells.

Cell bodies of neurons come in different shapes and sizes. Neuronal processes also come in a variety of shapes varying in length and diameter, fig. 1. The diameter of the neuronal processes helps determine the conduction velocity for that neuron. Usually, the larger the axon diameter or neuronal process, the faster the impulse travels and vice versa. Most neuronal processes have an insulating-like substance covering them. It is called myelin. It can be equated to the insulation seen on television cables and household wiring.

Between two neurons is an interval called the synapse. (syn - joining; apse -together). Here, the impulse is relayed from one neuron to the next at a speed of about 0.6 milliseconds. The nervous system is dynamic metabolically. Synapses compete with one another, redeveloping circuits all of our lives. Any new learning involves new synaptic connections, forming new pathways. Genetically there are predisposed pathways but they are continuously modified. If a neuron is destroyed, it dies. But the synaptic collateral grows and bypasses the neuron to reconnect with other neurons.



As the cell grows (fig. 1), the neuron begins to resemble a tree. Dendritic knobs and spines develop and are the place where synapses connect. The neuron body has synapses as well as the axon.[6]

B. Brain and Neural Plasticity and Learning

Neural or brain plasticity implies that when an injury occurs, and brain cells are destroyed, the synapses and dendrites can be rerouted either through existing but normally unused pathways in the nervous system, or through a microscopic sprouting of collateral fibers (of neurons that survived) into the territories of the synapses left "vacant" by the neurons that were lost in the injury.

Dr. A. Starr, at the San Diego Sensory Motor Symposium in 1975 showed slides of dendritic growth, of "sprouting," occurring after destruction of nerve cells. It looked as though the nerve had been "topped," as one tops a tree, and had sprouted laterally with new branches which were lighter in color.[7]

Paul Bach-y-Rita, M.D. in *Brain Mechanisms in Sensory Substitution* has explained not only how the brain may reorganize itself following lesion, but how it can learn to substitute one sense for another. In teaching blind people to learn visual perception through the skin instead of the eye he has shown that the brain can compensate for the total loss of a sense. Visual information which enters through a tactile sense, reaches an area of the brain where learning becomes visual learning, and the subject perceives the objects he is "seeing" as being "out there," in front of him, even though the eye is not involved.

Bach-y-Rita explains that in the case of vision substitution, "the principal plastic changes occur, not in the primary receptors (i.e., rods and cones in vision), but in their neural pathways, their central connections, and the mechanisms which process and integrate the information from the receptors."

"It is tempting to speculate that the neural mechanisms underlying the adaptation to sensory substitution systems may be similar to those related to learning and to the ability to recover from lesions of the central nervous system. Certainly all these situations demand a high degree of brain adaptability."[2]

Impulses are transmitted from neuron to neuron or from neuron to non-nervous cells of the body such as muscles and glands.

Sensory substitution, first described by Bach-y-Rita has been subsequently used successfully to replace sound for deaf people, using tactile input, and using sound or the auditory sense, to replace tactile sensory loss. Dr. Frank Saunders developed the auditory substitution system in San Francisco in 1975, and Y. Rywerant describes, in *Somatics*, Autumn 1979, the use of the auditory sense to teach Hanoch to play the flute again: "...And so the auditory sense provided here an alternative, substitutive channel of feedback for the motor functions of the fingers ..."

The number of synapses may increase with sensory enrichment,[2] and sensory stimulation will increase the blood flow in the receiving and relaying pathways of the central nervous system, thereby playing a role in the acceleration of maturation of synaptic loci.[8]

One of the neural mechanisms underlying learning has to do with the properties of the synapse. Eccles[2] considered the possibility that synaptic terminals in the brain can, themselves, sprout new branches, thus making new synapses, and that an individual synapse may develop a larger fraction of active zone with use. Eccles points out (1965) that the rapid repetitive activation of synapses in the higher levels of the brain build up great synaptic power. We will also see that sensory deprivation reduces the synaptic connections, thereby reducing the establishment of pathways in the nervous system.

In sensory deprivation (such as in strokes, brain injuries or laboratory conditions and experiments), the dendritic knobs on the neuron body and axon recede; there are fewer knobs and some disappear completely. The result is that the synapse cannot connect two neurons and pathways disappear. When therapy and stimulation is introduced which is meaningful and productive to the case involved, the dendritic knobs return and connections are re-established. See fig. 2

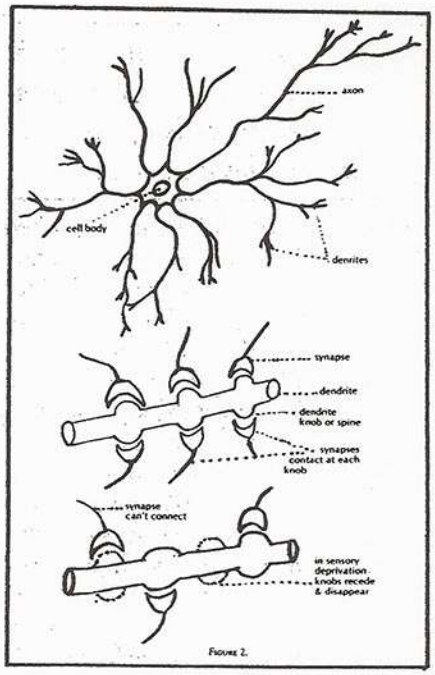


Figure 2.

Classical therapy concentrated on the highest levels of the nervous system, such as cortical learning, and the emphasis was placed on the motor side of the nervous system. The emphasis is now shifting to the sensory side. There is an increased awareness that the sensory receptors play a vital role in helping the organism cope with the internal and external environment. It also appears that the motor system is almost completely subservient to the demands placed on it by the sensory system.[9]

According to Dr. Moore, the classical nerve pathway of information is not correct. It was believed to fire in a single direction, from the cerebral cortex to the third order neuron, to the second order neuron, crossing over the spine, synapsing to the first order neuron and vice-versa. In fact, *there are multiple ways* that the nervous system can get information up to the cortex and vice versa. Information can come in from collaterals of the first order neuron, from the same side of the spinal cord, and the impulses move in and spread up and down the spine at multiple levels. (see fig. 3)

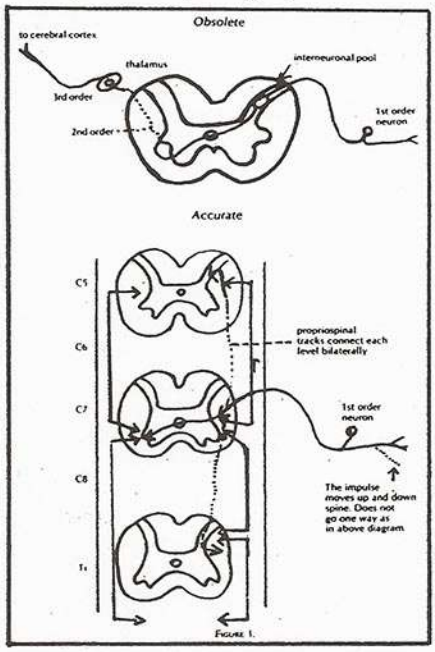


Figure 3.

This creates multiple possibilities of connections and rerouting of information coming in and going out of the central nervous system. There are multiple pathways used, and many more in existence as auxiliary routes, when the main ones stop functioning for some reason.

New research shows a type of learning at the spinal cord level as well: entering neurons and interneurons could learn and have a memory which eventually would create a new response. What is probably happening is that there is an enhancing of synaptic memory and training.

The learning process of getting through a complicated airport to our final destination, after making connections and changing planes en route, is a parallel example of how neuronal and synaptic routes are learned and established in new activities. Another example of pathways being re-established is the following: in the olden days, in order to speak from San Francisco to London, England, you had to be connected to the mid-West, then to New York, then to Ireland, then to London. It took hours to get through, as each point relayed to the next. Nowadays, you dial direct and can speak from San Francisco to London in seconds. This direct line can be compared to the fastest conducting pathways in the brain. If these are destroyed, the old, tedious, laborious route still exists, and is probably the way functional recovery occurs, bit by bit, as one station connects to another, eventually getting to the final goal.[10]

In an experiment involving drugs, Adkins et al[2] "found in cats anesthetized with chloralose, that pyramidal stimulation not only increased the size of cutaneous receptor fields of the recorded cortical neurons, but also revealed responsiveness to sensory modalities which were ineffective in the absence of pyramidal stimulation."

Robertson observed "cells in the cat visual cortex before, during, and after administration of thiopental anesthesia, and found that this increased receptive fields and the types of stimuli to which the cells respond; thiopental makes previously unreceptive cells respond to visual stimuli."[2] Since it is highly unlikely, stipulates Bach-y-Rita, that acutely administered drugs can create new synapses and new pathways, what must be happening is that the drugs are uncovering synapses and pathways already in existence but not utilized under normal circumstances. Lashley states that "in data obtained from a study of humans with lesions of the precentral gyrus or internal capsule strongly support the probability that

some synapses and pathways exist as a "subliminal fringe" in these patients. The degree of paralysis of an affected limb varies from day to day. Indeed, the paralysis may partially disappear during an emotional disturbance, only to recur when the disturbance is over." (Lashley, 1924, cited by Bach-y-Rita, 1970).

Dr. A. Starr showed slides of dendritic growth, of "sprouting," occurring after destruction of nerve cells.

Thus, the clinical results suggest that the central structures and pathways subserving any function are potentially larger in number than in base-line conditions, and under appropriate conditions can be mobilized by the central nervous system. In his book *Brain Mechanisms in Sensory Substitution*, Bach-y-Rita concludes that sensory substitution has shown that "subjective aspects, detailed form information, three-dimensional perceptual concepts, and even visual illusions previously obtained only through the eyes, can be obtained with a tactile sensory substitution system."

"Recovery of functional capacities implies the development of cerebral mechanisms to compensate for those lost or disrupted by the injury. These compensatory mechanisms may be similar to those that operate in the form of a new sensory input, as will sensory substitution."

Another example of the capacity of developing new cerebral mechanisms has been shown by Dr. Richard Balliet in a recent experiment.[11] Normally, there is never any voluntary control of the rotation of the eye around the visual axis. It is exclusively a reflexive movement that occurs when you tilt your head laterally. When you tilt your head, the eyes rotate in the opposite direction at an angle. If the movement is static, the rotation is of 10% of the head tilt. If it's dynamic, the cycloversion (movement of both eyes rotating in the same direction) will stay at 75% of the head tilt.

By training several subjects as well as himself to voluntarily move the eyes in a vestibular occular reflexive arc, Dr. Balliet has shown that you can get voluntary access to central parts of the nervous system where only exclusively reflexive motor action is normally taking place.

Patricia Goldman, of the National Institute of Mental Health, and her colleagues, reports: "monkeys whose prefrontal cortices are removed about two-thirds of the way through gestation can apparently completely overcome the effects of the operation. In fact, one such monkey actually performed within the range of normal monkeys on all the learning tests it was given during a 2½ year period of postnatal development. On killing the monkey at that age, the investigators found that its brain was morphologically very different from the brains of normal monkeys and even from the brains of monkeys whose prefrontal cortices were removed after birth. It had anomalous folds and indentations far from as well as near the site of the lesion. In addition, neurons from the monkey's thalamus, which normally project to the prefrontal cortex, did not degenerate as they do when the operation is performed after birth. Instead, they seemed to have been rerouted to other parts of the brain." According to Goldman, it is tempting to speculate that some or all of the morphological changes in the monkey's brain allowed it to compensate for the loss of its prefrontal cortex. She points out, however, that further study is necessary to establish the nature and causes of these changes.[12 13]

The number of synapses may increase with sensory enrichment and sensory stimulation will increase the blood flow in the pathways of the central nervous system.

These examples of scientific research show that damage to the brain and parts of the nervous system may be reversible and that in fact the brain and nervous system contain plastic properties. This means that many tasks and skills that were and still are considered "impossible to relearn, impossible to reacquire" by the medical establishment, and many illneses that are considered "irrevocable" by the latter, are indeed changeable by the very nature of our nervous systems.

CHAPTER III: THE PSYCHOSOMATIC PROCESS

In a learning program which is based on the idea of the mind and body interacting, a new emphasis is placed on approaches in which the mind plays an equal role to the body, in regulating illness and health.

The paradigm of mind-body interaction oriented towards health is still largely missing in traditional medical methods.

It also appears that the motor system is almost completely subservient to the demands placed on it by the sensory system.

Nikolaas Tinbergen, recipient of the 1973 Nobel prize for Physiology and Medicine, states this concept most succintly. "The more that is being discovered about psychosomatic diseases and in general, about the extremely complex two way traffic between the brain and the rest of the body, the more obvious it has become that too rigid a distinction between the mind and body is of only limited use to men of science and can, in fact, be a hinderance to its advance,"[5] Kenneth Pelleier, in his book *Mind as Healer, Mind as Slayer*, says: "Several major medical researchers of this century, such as Claude Bernard, Harold G. Wolf, Ivan Pavlov, Walter Buchanan, Hans Selye, H.E.W. Simeons and Tinbergen have created a substantial foundation for a more comprehensive understanding of the relationship between mind and body. One immediate implication is that all disorders are psychosomatic in the sense that both mind and body are involved in their etiology. Any disorder is created out of a complex interaction of social factors, physical and psychological stress, the personality of the person subjected to these influences, and the inability of the person to adapt adequately to pressure."

By the same token, since any disorder can be created out of the complex interaction just mentioned, a reordering, a healing, a recovery process will also involve the same complex factors.

"Present therapeutic interventions in psychosomatic disorders," Pelletier continues, are far from encouraging. Treatment of the hypertensive patient, "[i.e.], usually involves one or a combination of drugs to regulate blood pressure. Unfortunately, the side effects of these drugs can be more disturbing than the disorders themselves. The cost and the necessity of continued pharmacological dependence for extended periods of time make chemotherapy a rather unsatisfactory way of dealing with such a prevalent problem. For the common disorder of simple nervous tension an alarming number of tranquilizers and barbiturates are prescribed each year."

Strongly support the probability that some synapses and pathways exist as a "subliminal fringe" in these patients.

In the setting of a physical rehabilitation hospital, the concept of self responsibility of the patient towards his disease, how it came about, and how he can overcome it, are virtually non-existent. People are given treatments in the form of therapists manipulating one part of their body over and over, sometimes with passive resistance so that the person resists against pressure in the movement so there is some participation, but it's a mechanical approach that only deals with the arms, or the wrists, or the shoulders of the affected person, and not the whole person.

The marriage of mind and body is especially seen in the behavior of muscles. Thoughts, emotions and feelings evoke muscle activity. In times of stress or imagined stress, the muscles tense up and become ready to react.[17]

By the same token, studies using various relaxation techniques to achieve states of tranquility show significant reduction in muscle spasm. These techniques use no external apparatus or method, and therefore rely on mental activity, that passively and subconsciously affects the cerebral mechanisms that are involved in muscle response.[14]

Jacobsen demonstrated that learned relaxation of the muscles can generalize to smooth, (involuntary) muscles and can cause relaxation of the gastrointestinal and cardiovascular systems.

He also demonstrated that imagination is a powerful tool in changing the body physiology. He conducted a series of experiments which recorded the physiologic effects of imagination. For instance, people were asked to pretend they were operating an old-fashioned telegraph key with the middle finger, without moving a muscle. As they imagined pressing the key, there were bursts of muscle activity only in those muscles involved in moving the middle finger to tap the key.[14]

Feldenkrais developed his movement re-education work, with among many other ideas, this idea in mind: that thought alone can teach the body a movement it has never tried before.[15] (see Chapter V.)

In sports, John Uelses, former pole-vaulting champion, visalized winning before each meet, and he saw himself clearly clearing the bar at a certain height ... He felt certain that the resulting memory traces influenced his actual performance during the meet. Jack Nicklaus daydreams before each tournament to attain what he calls "the winning feeling."[16]

Another example of the effect of the mind on the body's physiologic response is the "placebo effect."

Placebo is usual defined as "an inactive substance or preparation given to satisfy the patient's symbolic need for drug therapy and used in control studies to determine the efficacy of medicinal substances. Also, a procedure with no intrinsic theapeutic value performed for such purposes."[3]

The investigators found that its brain was morphologically very different from the brains of normal monkeys.

"Placebo" has come to connote any aspect of the healing process which cannot be attributed to a physical or pharmacological effect. Included in this category are the patient's volition, doctor-patient interaction, lifestyle changes and a host of other variables which are essential features of a holistic model. Disdain for "placebo effect" is not justified even in traditional medicine, since the existence of curative placebo effects is well substantiated in the treatment of a wide variety of diseases ranging from hayfever to rheumatoid arthritis."[3]

Writing in the Journal of the American Medical Association, Herbert Benson and Mark V. Epstein of Harvard Medical School noted "patient and physician attitudes that create a sound doctor-patient relationship contribute to the production of the placebo effect. The placebo effect in most instances enhances the well being of the patient and this is an essential aspect of medicine ... More emphasis on the potency of the placebo and its positive effect is needed."[17]

Too rigid a distinction between the mind and body is of only limited use to men of science and can, in fact, be a hinderance to its advance.

Other types of placebo effects can be seen when the patient becomes an active participant in the healing process.

It is obvious that the inherent self-fulfilling prophecy mechanism is tied to the placebo effect.

A belief in survival or in one's abilities to recover is an intrinsic necessity in the recovery from most illnesses and injuries, including brain injury, and one that was cultivated in the special stroke and head injuries program in San Francisco.

Lashley[2] showed that emotional facilitation activates brain activity. A strong belief is an emotion that can set the tone for what is happening physiologically in the body.

"Placebo" which is usually used as a pejorative term by clinicians and researchers, is seen here as an important part of the subtle factors which enhance healing.

These are just a few examples of how the mind and the body work in close connection, and how this fact is largely ignored in the medical world at large.

A successful and easier recovery from brain injury would entail learning about this interaction and using all the tools available to allow communication with, and awareness of internal states. We'll explore some of these tools next.

IV: SELF REGULATORY TOOLS THAT FACILITATE PLASTICITY

Two basic things need to happen before a brain-injured person may start showing functional and emotional improvement, after having plateaued for two or more years:

1. They have to believe that change is possible, that there is a possibility of improvement.

2. They have to learn awareness of themselves, of their bodies, of their habitual reaction to stressful events, increase their participation in their own re-education process, in short, assume responsibility for their own health improvement.

Clear communication and attitudes of the therapist or teacher are primary forces in initiating these attitudes. Before anything happens at all, rapport needs to be established between the teacher, theapist or group leader, and the participant. (See Section VI).

Presenting a health recovery and relearning program, based on the assumption of *invisible* things is not easy, but it is possible.

The plasticity of the nervous system is itself a fairly newly discovered property. In the case of recovery from brain injury, it has not been scientifically determined in human studies of electroencephalograms, for instance. However, the evidence strongly suggests it to be the mechanism which allows for relearning of lost functional movement, speech, etc. (See Section II.)

The marriage of mind and body is especially seen in the behavior of muscles.

All the self regulatory tools proposed in this stroke re-education program are 'esoteric,' internal, based on the assumption of the existence of an inhibited, unconscious area of the mind, which can be used as an ally to produce desired changes in motor behavior, general behavior and perception of self.

They are all hard to quantify. Even EMG biofeedback training, which is a measurable device, relies on all the techniques of relaxation that will be discussed.

A. The Unconscious

The term subconscious, or unconscious, is almost never heard in physical rehabilitation settings because it belongs in the realm of psychology and psychiatry. But one cannot divorce any aspect of the mind from the body least of all, when an integrative rehabilitation process is necessary. An education process is necessary to allow patients to be comfortable with the concept and begin to have an understanding of the dynamics of the mind, and the control that they can have over themselves and their experience, by tapping into the unconscious processes of their very own mind.

"For most individuals the recognition of the subtle interaction between mind and body first occurs during a period of illness. According to cancer researcher Carl Simonton,[18] in order to really grasp the concept that they, the patients, can mentally influence their body's immune mechanism, they eventually realize that their minds and emotions and their bodies act as a unit and can't be separated, that there was a mental and psychological participation as well as a physical one in the development of their disease. (Simonton and Simonton, 1975).

Discoveries in the field of neurophysiology and neuroanatomy tend to conform the hypothesis first formulated by psychologists such as Janet, Freud and June, of the existence of a dynamic unconscious. Part of the unconscious process is formed as a defense mechanism. As the person is innundated with perceptual information, it learns to block out most of it, in order not to become confused.[3] It becomes selectively conscious of only part of the field. In the same manner, unhappy feelings are blocked out as well as drives or reactions which are not socially accepted. This information is stored at different levels of the brain, in complicated memory engrams.

Repression, which can show up as motivated forgetting for example, thus has neurophysiological correlates in the brain. Inhibition is one of the key elements in learning. A synapse can relay a message to higher cortical levels, or divert it to another route of nerves. The cortex on the other hand can control the experience of pain as well as other feelings we don't want to have. Behavior of the individual and past experience will modify the content of the information which enters the nervous system and is relayed to higher cortical levels. There is a constant interaction between receptors which affect the information received, and those that recode it at neuronal levels.[10]

A belief in one's abilities to recover is an intrinsic necessity in the recovery from most illnesses and injuries, including brain injury.

In a recent book called, *Understanding The Brain*,[19] Sir John Eccles discloses new information about the right and left hemispheres of the brain which would tend to validate Janet's Freud's and Jung's arguments for a dynamic unconscious.)

Apparently, definitive experimental tests by Sperry, have been applied that show that the dominant left hemisphere is in liason with the conscious self, but the minor hemisphere has no such liason when the corpus callosum is severed. If the corpus callosum, which separates the two hemispheres, is severed, the conscious subject has no idea of what the right hemisphere is doing. To put it in neurological terms, "after commisurotomy, none of the neuronal events in the minor hemisphere is recognized by the conscious subject."[19]

The right hemisphere has been found to be a very highly developed brain except that it "cannot express itself in language and is not able to disclose any experience or consciousness that we can recognize at the present time. On the other hand, the left hemisphere has normal linguistic performance so it can be recognized as being associated with the prior existence of the ego or self with all the memories of the past before the commissural section."[19]

With the corpus callosum intact, neuronal activities of a special character may be generated in the minor hemisphere that give it some liason with the self-conscious mind. This occurs for instance, for the con-

tribution of the minor hemisphere of dreams, creative imagination, holistic images, pictorial and pattern sense, etc. However, in our western culture and education, these tend to be ignored. Other properties of the minor hemisphere are that it is almost non-verbal, it is musical, shows synthesis over time, is holistic and good at geometrics and imagery.

B. Hypnosis and Autosuggestion

Hypnosis is one well known approach that bridges the gap between the conscious and the unconscious parts of the brain. Post-hypnotic suggestion as been known to alter, among other things, behavior patterns.

The application of hypnosis, say Dr. Frank Caprio and Joseph Berger, is based solely on the known psychological relationship between the conscious and unconscious minds. The unconscious having no power to reason, accepts and acts upon any fact or suggestion given to it by the conscious mind.[20]

The suggestions can come in the form of the spoken word or by images and visualizations. When the conscious mind, with its ideas of limitations is repressed and set aside temporarily, a channel, a pathway of communication is set up with the area of the brain which has unconscious properties. The right hemispheres receives pictures and images unquestioningly.

Dr. Maxwell Maltz, a New York based author and surgeon explains the phenomenon thus: "Your nervous system cannot tell the difference between an imagined experience and a real experience. In either case, it reacts automatically to information that you give it from your forebrain. It reacts appropriately to what you think or imagine to be true."[16]

"In a study of severely burned patients (*Journal of American Medical Association*, May, 1955, p. 95) the suggestions directed by the physicians to the subconscious minds of these patients activated energies resident in the human body and brought about speedy and almost miraculous recovery."[20]

The role of autosuggestion is perhaps the most important method of giving direction of the subconscious, as well as that of creating healthy emotional attitudes.

Emotionally empowered thought has a direct, immediate impact on bodily functions.

All hypnosis could be described as autosuggestion, and autosuggestion as self hypnosis. In describing autosuggestion, which is the tool used in this program, John K. Williams says: "If the subconscious is to be the servant of the conscious mind, it is important to know how it can be reached and by what method direction and information can be given it ... The subconscious is reached, first of all, by what we generally term "autosuggestion." By this term one thing is meant; talking to one's self. Since the subconscious is a part of the person, the person is certainly talking to himself when he talks to his subconscious. Conscious mind can control the creative power of the subconscious only by direction, by autosuggestion. The technique of autosuggestion is simply the subconscious realization of an idea which tends to transfer itself into action. It is based on the principle that what you tell yourself repeatedly with confidence and expectancy you will eventually believe and that this belief will be realized in your experience.

"The statement made popular by the great French psychiatrist Coué, 'every day in every way I am getting better and better,' was sound psychology.

"... The role of autosuggestion in everyday life is far greater than is ordinarily believed ... One of the oldest items in the physicians 'bag of tricks' is the placebo ... a massive dose of pure suggestion mixed with some innocuous substance ..."

Since the patient was able to walk while his leg was completely anesthetized, he must have been using alternative pathways.

A reference to the phenomenon of hypnosis may help in understanding the role of autosuggestion in controlling subconscious activity ... In hypnosis the thing that happens seems to be this: as the result of suggestion on the part of the operator, and the acceptance on the part of the subject, the latter's conscious mind steps aside, its functions and activity temporarily suspended, and a direct channel to the subconscious is opened. In this state, suggestions and directions can be planted directly in the subconscious area.

Inhibition is one of the key elements in learning.

... There is complete evidence that the hypnotic trance can produce analgesia ... Under hypnotic trance, the effect of an anesthetic previously administered can also be reversed. A hospital patient whose leg had been *completely immobilized* by the use of drugs was told that he could walk. This he did in a perfectly normal manner."[21]

Since the patient was able to walk while his leg was completely anesthetized, he must have been using alternative pathways, as described by Bach-y-Rita in the chloralose experiment. (Section II).

C. Imagery — Visualizations:

Meditation, guided imagery, visualizations, day dreaming or autosuggestion are all tools in reaching areas of the brain and pathways that are usually inhibited or dormant. They are all tools in altering one's belief system and both motor and psychological behavior. They all seem to require the suspension of the rational purposive brain, an emptying, as it were, of the critical, judgmental mind, to allow imagery and suggestions to reprogram our thinking.

In an article entitled Daydream A Little ... when the world is too much for you, Eugene Raudsepp describes the way various illustrious men, both past and present, achieve a state of creativity for constructive problem solving. "Incessant and conscious effort at solving a problem is one of the most inefficient ways of tackling it," he says. "While conscious initial effort is always necessary, effective solutions to especially severe problems frequently occur when conscious attempts at solving them have been suspended. Inability to relax, to let go of a problem, often prevents its solution ..."

Thomas Edison, to name one of the many examples he quoted, knew the value of "half-waking" states. "When-

ever confronted with what seemed an insurmountable hitch defying all efforts, he would stretch out ... and let fantasies flood his mind ... John Dewey recognized the importance of reverie in creative work and Cesar Frank is said to have walked around with a dream-like gaze while composing, seemingly totally unaware of his surroundings."[16]

D. Meditation

Pelletier, in *Mind as Healer, Mind as Slayer*,[3] describes all kinds of research on meditation and this preliminary research indicates that the conscientious practice of meditation increases autonomic stability, aids in the habituation to repeated stresses, and produces a state of relaxation deeper in some respects than that achieved during sleep.

In addition, the characteristic physiological pattern of a person during meditation is virtually opposite to that of the neurophysiological stress pattern. These effects of the meditation can carry over and extend into the post-meditation stage of daily activity.

When the conscious mind is repressed, a pathway of communication is set up with the area of the brain which has unconscious properties.

His theories imply that regular meditation can be an effective means of stress alleviation, and measurements in various experiments indicated that in addition to the physiological state of deep relaxation, the mind was also in a relaxed but alert state.

"The significance of meditation as a means of alleviating stress in daily life would be slight if its effects were temporary and limited to periods per se. In any critical evaluation of a procedure like meditation, it is important to note that whatever positive improvement takes place should be assessed in terms of its carryover effect into the person's daily activity. If this carryover does not take place, then despite the marked degree of improvement in the clinical situation, the therapy is probably minimally effective. Conversely, if the effects of the meditation carry over and transform the individual in a more permanent way, it is more likely to be of value. Research evidence indicates that such a carryover effect is a reality. Meditators have been found to be more psychologically stable, automatically stable, less anxious and to experience an internal locus of control which indicates an individual sense of being effective in the world rather than a passive victim of environmental circumstances."[3]

This alone, for a person who's had a stroke and often feels like a complete victim is a very important factor and a very important benefit of meditation.

The stress of the disease itself, the stress of the injury, the stress of the body's non-functioning is a tremendous burden to the person afflicted by a stroke or a head injury or the kind of brain damage that causes a change in their body functions. The techniques of progressive relaxation taken from Jacobsen, from yoga, meditation techniques, which I use in my program help reduce the stress so that then the person can mobilize his energies into producing a healthy state of mind, a positive state of mind and freeing his energy to relearn the movements that were lost.

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