Term Paper

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Emotions in digital circuitry and analogue wave patterns:

a brain analysis

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Recent brain research has focused on neuronal-synaptic impulses and bio-chemical reactions to understand emotions. The holonomic brain theory addresses another important aspect of brain activity explaining human emotions. The interplay of the circuitry and chemical models with the wave pattern holonomic model adds another dimension to our understanding of human relatedness. Clinical experience will be used to illustrate the digital-type circuitry and analogue-type spectral processes and their intersections. We will be seeking to understand physiologically not only the emotional response to today's trigger, but also the trigger's ability to call-up an emotional response from the past.

A 64 year old client is relaying his dismay at having to watch his dinner cool down while his wife finishes a phone call from a friend. He asks her, "Why do you answer the phone? Someone always calls at dinnertime and you talk to them for a long time. It's a matter of thermodynamics: the meat gets cold and the ice tea gets hot." As he describes his discomfort, the therapist notices increasing anxiety. She asks if this relates to anything in childhood. He pauses, his face begins to change in color, he takes a deep breath, and says, "My father. I 've never liked telephones. I was the youngest child and my father was a salesman away from home during the week. When he called home, my four older brothers and sister always got to talk to him, but by the time it was my turn he'd run out of time. He never had time for me." The client was gently sobbing as he described his disappointment. He was not just annoyed about his cold dinner, but was also deeply hurt that she had telephone time for her friends, something he had missed from his father.

What mechanism in the brain allows a 60 year old memory to surface? Where has that memory been all this time? What process relates emotions from today to emotions from the past. How can a sixty year old memory create powerful emotions today? These are important questions for scientists as well as psychotherapists. Both the digital circuitry and analogue wave pattern theories will address these questions of memory and emotion.

In the 1940's there were two general opinions about nervous system operations and perception. Donald Hebb in his classic volume, The Organization of Behavior (1949), postulated that perception depended on the excitation of certain cells at a point in time in the central nervous system. This view was substantiated to show that nerve impulses were generated and transmitted across connections between nerves. The second hypothesis held that perception depended upon a pattern of excitation whose location was not important. Wolfgang Kohler argued for the Gestalt view of neurological fields with electrical potentials. Kohler as well as Karl Pribram and others experimented to show the correlation between direct current fields and neural function and behavior (Gumnit, 1961; Stamm, 1961; Morrell, 1961). The first opinion we will call the circuitry or digital theory. The second we will name the wave pattern or analogue theory.

The Circuitry Theory

Microelectrode evidence accumulated for Hebb's theory of circuit conductivity (Jung,1961; Mountcastle, 1957; Hubel and Wiesel, 1962). Neural units were found to be responsive to specific features of a stimulating event. Microelectrodes were placed on specific areas of the brain to determine which actions or responses related to those parts of the brain.

In psychology books today the brain is described in terms of circuitry or wired communication. A popular psychophysiological book, Mapping the Brain (Carter, 1998), describes the corpus callosum as "a thick band of axons...which connect the brain cells in one hemisphere to those in the other." She goes on to say that brain scanning and psychosurgery are now "showing just how precisely it is possible to pin down even the most sophisticated and complex machinations of the human brain." Locations of particular memories are delineated: procedural memory in the caudate nucleus; fear memories in the amygdala; episodic memory in the cortex; and semantic memory in the temporal lobe (Carter, 1998).

In the circuitry theory the nervous system is described as a discontinuous physical system comprised of neurons, cells which are totally separated by membranous barriers but connected by electrical impulses. Neurons act as individual units by discharging an electrical potential. Sir Charles Sherrington (1947) in electrophysiological experiments showed that the neural system was a circuitry consisting of neurons and synapses, areas between neurons. He further ascribed to the synapses the cause for delays in reflex or behavior as opposed to immediate electrical conduction in the system. Circuitry theorists resolved this problem by discovering neurotransmitters, chemicals released by the cell when it is fired. Neurotransmitters trigger neighboring cells to fire creating a chain reaction (Carter, 1998).

The Dana Alliance for Brain Initiatives describes the brain as a command center for the body and mind (Dana, 1998). In their words, "Each neuron communicates with one or more others by sending a particular chemical messenger, called a neurotransmitter, across the gap that separates them." Thus, 100 billion neurons each form connections with an average of 10 thousand others (Dana, 1998).

Hebb (1949) hypothesized that learning involved simultaneous activation of two cells creating a change in neural functioning such that one cell might later have the ability to cause the other to fire. Hebbian plasticity, as this phenomena is called, was verified with the discovery of long term potentiation (LTP) in the hippocampal area. Further studies showed that the glutamate receptor NMDA actually formed associations between cells during firing, thus supporting the Hebbian rule (Cotman, et al, 1988; Bliss & Collingridge, 1993). Joseph LeDoux and others located LTP and the blockage of NMDA in the amygdala related to fear conditioning (Clugnet & LeDoux, 1990; Rogan & LeDoux, 1995). LeDoux describes the amygdala as the "hub of the wheel" for fear in the brain (1996). He suggests that fear memories are, "indelibly burned into the brain" and "sometimes the things that are imprinted in the amygdala's circuits are maladaptive" (LeDoux, 1996). In the circuitry theory there is only a one-way passage, fear is laid down never to be removed. In matters of implicit memories underlying anxiety disorders LeDoux suggests, " the best we can hope for is to exercise control over them."

Given LeDoux's analysis our client would be doomed to feelings of dismay each time his wife answers the phone at dinnertime. Nothing could be changed about his feelings, locked as they are in the amygdala according to the circuitry model. We learned from our client's wife that she was driven by internal processes as well. She had to answer the phone because of her giving temperament and her own neglect in childhood. To not answer the phone, to even turn it off would cause her anxiety. According to LeDoux and the circuitry model, such a couple must buckle down and control their emotions. Yet, such control may put further stress on the somatic system.

Another area that has been uncovered in the circuitry model is related to attention. Neuropsychological studies have discovered attentional mechanisms involved in memory formation (Nakamura, 1995). These include tuning, adaptive filtering, sustained activation, selection, and association. Tuning, for instance, draws the attention toward a subject. This would then account for our client's tuning in to his telephone reactions.

Neuroscientists, however, have yet to identify the triggers that formulate this sensory reaction. They suggest that with the selection mechanism, neurons in the inferior temporal cortex are ready to respond to the selected subject. They reason that monkeys trained to find a familiar object have neurons coded for other objects suppressed. The author admits, however, that none of these studies have addressed the issues pertaining to long-term memory (Nakamura, 1995).

So then in this model our client has neurons ready to respond to his wife picking up the telephone at dinnertime. However, with this attention heightened does he at the same time have other attending neurons turned off. Might those non-responsive neurons be the ones that notice that his wife has fixed him a delicious meal. So, he notices her disturbing phone response, but ignores her delighting culinary efforts. Many discoveries based on the circuitry theory have uncovered relationships between the various parts of the brain and emotions. Yet, much is unknown.

The Triune Brain Theory

As part of the circuitry model, the triune brain theory postulates that circuits in certain parts of the brain operate differently than in others. Paul D. MacLean, neurophysiologist, divides the human brain into three sections, the reptilian, the paleomammalian or limbic and the neomammalian or neo-cortex. He calls this extensively interconnected collective the triune brain. Different in chemistry, structure, and evolutionary development, the three formations are described as interconnected biological computers with their own particular intelligence, subjectivity, sense of time and space, memory, motor, and other functions (MacLean, 1993). Evidence suggests that despite their extensive interconnections, each of the three 'brains' are capable of operating independently to a degree. Unlike the neomammilian formation, the reptilian and paleomammalian formations lack the power of verbal communication. MacLean describes the neural chassis as the midbrain, pons, medulla, and spinal cord which together contain the neural machinery for self-preservation and the preservation of the species. The three formations of the triune forebrain become the drivers of the neural chassis.

In the triune brain theory the human counterpart of the reptilian forebrain is represented by the ganglia including the olfactostriatum, corpus striatum (caudate nucleus and putamen), globus pallidus, and satellite gray matter (MacLean, 1993). The theory postulates that the reptilian brain or R complex is related to five interoperative behaviors: 1) isopraxic: behaviors of the same activity by two or more individuals; 2) perseverative: repetitious acts; 3) reenactment: behaviors representing obedience to precedent; 4) tropistic: positive or negative responses to representations or "fixed action patterns"; and 5) deceptive: using artifice and deceitful tactics (MacLean, 1993).

Findings relevant to the reptilian brain and nonverbal, species-typical behavior were developed from experiments on more than 100 squirrel monkeys. Bilateral lesions of the paleo and neomammalian formations had no or transient effect on genetically constituted, species-typical, prosematic behavior. However, bilateral lesions of the pallidal part of the R-complex or interruption of its main pathways caused monkeys to lose their species-typical behavior (MacLean, 1973). This lead to the conclusion that the reptilian brain was the only portion of the triune brain driving the genetically constituted, prosematic behavior.

MacLean used the nineteenth century anatomist, Broca's, term limbic, "forming a border around" for the second evolutionary brain, the paleomammalian brain. Broca referred to the "great limbic lobe" surrounding the brain stem and common to all mammals (Broca, 1878). Limbic system is MacLean's designation for the limbic cortex and those parts of the brain stem to which it has primary connections: the anterior thalamic nuclei, hypothalamus, medial forebrain bundle, pituitary, olfactory, amygdala, septum, fornix, cingulate gyrus, hippocampus and parahippocampal gyrus (MacLean, 1952).

Electrophysiological studies indicate that the paleomammalian brain, while differing among higher and lower mammals, has a basic pattern of organization which is anatomically and functionally an integrated system. Forty years of clinical and experimental evidence has shown that the limbic system uses information in terms of

emotional feelings to guide behavior related to two basic life principles: self-preservation and the preservation of the species. By recording single nerve cells from awake, sitting monkeys, MacLean was able to show that the limbic system receives information from not only the olfactory and visceral system, but also from the visual, auditory, and somatic senses (MacLean, 1973A). He suggests that the combined reception of information from the outer and inner worlds is critical to the sensation of individuality and personal identity found in the limbic system (MacLean, 1993).

MacLean notes that despite the conviction of such noted scholars as Plato and Piaget that emotion and reason cannot be separated, in fact psychomotor epilepsy studies show that "thought" and "emotion" can occur independently as products of different brain mechanisms . Epileptic discharges in or near the limbic cortex result in many vivid emotional feelings and confine themselves to the limbic system without involving the neocortex (MacLean, 1954). Thus, there are conflicts between "what we know" and "what we feel". MacLean further postulates that limbic discharges may result in symptoms of mental illness such as depersonalization, distortions of perception, paranoid delusions and hallucinations, as well as oceanic feelings of mystical revelation (MacLean, 1973A).

MacLean divides the paleomammalian brain or limbic system into three subdivisions (MacLean, 58). The two older divisions are related to the olfactory apparatus and evidence suggests that these divisions are relevant to feeding and mating. The third subdivision, most highly developed in the human brain, relates to the visual and other influences in socio-sexual behavior rather than olfactory apparatus. MacLean speculates that this subdivision together with the prefrontal cortex of the neomammalian brain has provided for the development of human empathy.

Evidence has shown that destruction of the pathways to and from the hypothalamus and subthalamic region greatly incapacitated monkeys. They recovered enough to feed themselves and move around, but no longer retained species-typical simian behavior. Since the major pathways to and from the reptilian and paleomammalian brains pass through the hypothalamus and subthalamic region, MacLean concludes that these pathways provide a connection to the basic personality.

The neomammalian brain "promotes the preservation and procreation of ideas" (MacLean, 1973C). The neocortex as computer receives information from the outer world through the visual, auditory, and somatic systems, providing a large neural screen for reading, writing, and arithmetic.

MacLean divides the triune brain functions into three types of mentation: protomentation, emotomentation, and ratiomentation. Protomentation in the reptillian brain refers to prototypical behavior as well as propensions or mental states such as drives, impulses, compulsions, and obsessions. Emotomentation in the mammalian brain refers to emotions. Ratiomentation in the neo-cortex refers to mental exercises related to thinking. MacLean, however, does not use his theory to explain memory. The three portions of the brain appear to describe the emanation of responses: thought processes,

emotions, and reactions. In the triune brain theory there does not appear to be an explanation for the trigger or mechanism which causes these responses.

The triune brain theory can be used to analyze the brain physiology of our client and his wife. When our client is describing his situation as a thermodynamic problem of cold meat and hot ‘iced tea’, his neo-cortex appears to be rationalizing reasons for discomfort. In this theory his feelings of frustration and hurt would be registering in the limbic or paleomammalian system. His wife’s guilt at not responding to her friends as she was not responded to in childhood could also be seen in this theory to take place in the limbic system. It is also possible that his wife’s drive to answer the phone might be related to an innate temperament drive which emanates from her reptilian brain. However, knowing the location in the brain for these responses, does not help us to understand the mechanism of memory and the trigger.

A Bio-Chemical Theory of the Brian

Another theory which creates a bridge between the circuitry and wave pattern theories involves experimentation with the bio-chemical aspects of brain process. Candace Pert in her book, Molecules of Emotion (1997), challenges the mechanistic circuitry theory of the body being driven by the brain, with electrical charges beating the heart and snapping synapses. Instead she sees the mind and body as an intelligent dynamic system with a rapid and massive simultaneous exchange of information

She describes her notion of "undigested emotions"suppressed in the mind-body network affecting the normal flow. She reasons that this disease or trauma related stress prevents "the molecules of emotion from flowing freely where needed." Thus, the autonomic processes "regulated by peptide flow, such as breathing, blood flow, immunity, digestion, and elimination, collapse down to a few simple feedback loops and upset the normal healing response." Using her own experiences with meditation she experimented with the release of highly charged emotional memories stored in the psychosomatic network. She found that releasing long-buried thoughts and feelings allowed the peptides to flow again, returning the body and the emotions to health. Releasing to Pert was: 1.) re-experiencing the emotions which originated in a stressful event and 2.)bringing into cognitive awareness the thoughts which accompanied the original stressful event. Her experience-experiments were supported by research on rats in the 1950's where tumors were transplanted into rats. Those rats who were placed in stressful situations grew larger tumors (Pert, 1997,p.242).

Pert also describes a fifth force of physics, an "extracorporeal peptide reaching" beyond electromagnetic, energy, gravity and nuclear forces weak and strong. For Pert this fifth force is a form of emotional resonance that happens when receptors are vibrating together in seemingly separate systems. Pert experiences this when reciting a prayer.

Information theory with verifiable laws and theories fits well with Pert’s description of the psychosomatic network of biological systems. She refers to neuropeptides and their receptors as "the biochemicals we call information molecules that are using a coded

language to communicate via a mind-body network" . For Pert there is a two-way wave-like exchange of information, not a push-pull or digital one-way circuitry system of chemical reactions. This information transcends time and space, being beyond the confines of matter and energy, differing for each recipient or participant observer. Thus, emotions, dependent as they are on biochemical information outside of time and space, must exist prior to the physical realm or outside physical reality. Pert suggests that "emotions are the informational content that is exchanged via the psychosomatic network, with the many systems, organs, and cells participating in the process." Emotions, then, are able to go between the two realms of mind and body, "as the peptides and their receptors in the physical realm, and as the feelings we experience and call emotions in the nonmaterial realm.

Happiness for Pert is the experience of neuropeptides and their receptors open and flowing freely throughout the psychosomatic network integrating and coordinating in a smooth and rhythmic movement. Blockages consist of "unhealed feeling" the accumulation of "bruised emotions." Research has shown that abused and neglected children have a higher incidence of depression which is related to the hypothalamic-pituitary-adrenal axis. The hypothalamus, part of the limbic system, has neurons with axons which secrete a neuropeptide, CRF (cortical releasing factor) into the pituitary gland which is then stimulated to secrete ACTH (an informational substance) which travels through the blood stream to bind onto specific receptors on adrenal cells. Adrenaline causes the fight or flight alarm response, the body's natural, unconscious reaction to threats, real or imagined. The adrenal glands also respond to ACTH by making the steroid corticosterone, necessary for healing and damage control. Depressed people are in a chronic state of ACTH activation with high levels of stress steroids. Their disrupted feedback loop fails to signal when there are sufficient levels of steroid in the blood.

Pert describes CRF as the peptide of negative expectations, as it was probably stimulated by negative experiences in childhood. Animal studies show that neglected and abused monkey babies have high levels of CRF and stress steroids. "Depressed people are stuck in a disruptive feedback loop" curtailing the fluctuation of other peptides throughout the organism. The result in humans can be limited patterns of behavior and response. In addition, these feelings are retained down to the cellular level where receptors for CRF are desensitized, shrinking in size and decreasing in number. "The memory of the trauma is stored by these and other changes at the level of the neuropeptide receptor, some occurring deep in the interior of the cell at the very roots of the receptor" bodywide.

Fortunately, this process can be reversed. Monkey studies have shown that neglected monkey babies with all the stress symptoms of depression and trauma were cured by 'monkey hug therapists', older monkeys who constantly hugged and cuddled the stressed baby monkeys. The hugging broke the feedback loop. Pert emphasizes the deleterious effects of exogenous drugs which are potentially harmful to the bodywide system. She advocates natural healing through touch and the expression of blocked emotions so that the biochemicals can flow freely (Pert, 1997, p276). In addition Pert's research with

endorphins showed that the power of touch can also stimulate and regulate natural chemicals to maximize feelings of health and well-being. Pert stipulates that physiology and emotions cannot be separated (1997, p265).

The bio-chemical theory seems to explain more about our client than the previous circuitry theories. With this theory we can see that our client's neglect by his father in childhood caused his hypothalamus to secrete the neuropeptide, CRF into his pituitary gland. This gland then secreted ACTH which traveled through his blood stream to bind onto adrenal cell receptors. His body was then in a constant unconscious reaction to threat around the telephone so that his adrenal glands responded by making the steroid corticosterone. He was in a chronic state of ACTH activation with high levels of stress steroids. One could surmise that each incidence of dinnertime phone answering by his wife would fortify the stress level which had started in childhood. Pert believes that the memories are stored at cell level. While Pert's bio-chemical theory amply explains the activation of stress at the cellular level and, unlike the circuitry model, even suggests processes for resolution or healing, it does not address the question of memory. The analogue theory will be needed to explain memory at the wave level.

The Analogue Theory:

Sherrington's discovery of the importance of the synapses between neurons may have been oversimplified in the circuitry model. Sherrington believed that the complexity of behavior and psychological processes was related to the complexity of processes in the synaptic mechanisms. Theorists from the second view, the analogue or wave pattern theory, believe that more is happening in the synapses than simple conduction of electrical energy from one neuron to another. Karl Lashley (1960) countered the circuitry theory by arguing that "once an associated

reaction has been established, the same reaction will be elicited by the excitation of sensory cells which were never stimulated in that way during the course of training." Circuits that had never received the original electrical impulse are reacting as though they had. The analogue or wave pattern view proposes that not only nerve impulses, but also microprocesses take place at the junctions between neurons.

The Holonomic Brain Theory:

The Holonomic Brain theory embraces the possibility of a two-process model of brain activity. Pribram postulates that there are not only neuronal impulses carrying information from one place to another, but also wave patterns of information going from everywhere to everywhere. The arrival and departure patterns called microstructures form a neurological mechanism explaining the holistic properties of perception. These slow potentials are sharply localized at the junctions between neurons or in dendrites. Post-synaptic slow potentials are generated when nerve impulses arrive at synapses. Their arrival and departure constitutes a pattern or wave front (Pribram,1971,p.113).

Karl Lashley (1942) proposed the dilemma,"Nerve impulses are transmitted over definite, restricted paths in the sensory and motor nerves and in the central nervous system from cell to cell.....yet all behavior seems to be determined by masses of excitation...within general fields of activity, without regard to particular nerve cells. It is the pattern and not the element that counts."

Lashley in his explanations of the wave pattern theory referred to EEG recordings which reflect graded polarizations (hyper and depolarizations) of synapses and the web of fine-fibered axonic and dendritic cortical connections (Pribram, 1998). In the holonomic theory the patterns of excitation and inhibition lie in the graded polarizations and not in an array of nerve impulses in the circuitry.

Karl Pribram (1971, p.105) suggested that the circuitry model and the wave pattern model function reciprocally. In his holonomic brain theory nerve impulses arrive at synapses and generate a graded potential dendritic microprocess which interacts with the microprocess already present creating a design dependent upon previous ‘experience’. Brain cortex recordings with the same microelectrode, with low and high pass amplification showed that depolarizations and hyperpolarizations take place before the generation of action potentials or spikes. Thus, the wave pattern is affected before the circuitry responds.

The question of memory storage returns us to the dendritic wave patterns described above. The holonomic brain theory suggests that our conscious experience takes place in the "fluctuating (oscillating) polarizations -depolarizations and hyperpolarizations of the electrical potential differences in the membranes of the fine (teledendron and dendritic web) fibers (Pribram, 1999)." Likewise our automatic or reflex experience is organized by electrical impulses as explained in the circuitry model where inputs and outputs need no delays for matching and can be fast paced. Pribram suggests that we become aware or conscious of those experiences which need the process matching which takes place in the wave patterns of the dendritic fibers or the synaptodendritic processing.

Mathematics and quantum mechanics can help us to understand this microprocessing structure. In the circuitry model information or memory is seen to be located or stored in parts of the brain, such as fear in the amygdala (LeDoux, 1997). Yet, studies have shown that brain lesions to certain areas in the brain have not destroyed memory of items supposedly related to those areas. For example Galambos, et.al. (1967) destroyed 98% of the visual tracts of cats who were still able to discriminate between a right side and upside down letter F. Pribram further states that, "When a patient suffers a stroke that wipes out half or more of his visual system, he does not go home to recognize only half of his family (Pribram, 1975)." Another experiment showed that small macroelectrodes implanted in the striate cortex of awake monkeys evoked differential configurations in varying patterns when the animal was exposed to flashes of circles and of stripes. These differential responses were reliable for months.

Pribram (1975) therefore argues that information is distributed in a holographic way throughout the system. Lashley in his earlier studies found a congruity between the

properties of the hologram and the perceptual imaging and engram encoding properties of the brain (Pribram, 1982). The hologram was invented by Dennis Gabor (1946) as a mathematical exercise based on the Fourier transform. In a hologram the data needed to create an image is distributed throughout the area of the image. In the case of Galambos's cats the engrams or imprints of memory for the letter F were distributed and only a non-damaged channel was necessary to retrieve the image. The holonomic brain theory divides memory into two structures: a deep structure which is distributed and a surface structure which is a retrieval mechanism with nerve impulse circuits (Pribram,1999). Thus, destruction of a portion of the brain would not affect the deep memory structure as the memory is distributed over the total structure not over certain parts.

Neurons, in fact, can be part of many different assemblies which together may affect vision or other somatosensory processes, whereas individual neurons do not operate individually. Neurons are sensitive to various sensory inputs and with each sensitivity they join other neurons in a wave of oscillating de-polarizations and hyper-polarizations in the dendritic web. .Hebb (1949) described the overlapping functions of cell assembles as "phase sequences." These phases allow for important "flexibility in assembling neural ensembles (Pribram, 1999)." Numerous studies in visual processing have shown that nerve impulses do not play a part in the web ensembles. Pribram and others speculate that they do not play a part in the synaptodendritic processing web as well (Pribram, 1999).

The mathematics of holography refers to the Fourier transform. "The Fourier theorem states that any pattern, no matter how complex, can be decomposed into a set of component, completely regular, sine waves. The Fourier transform of an image is formed by encoding these component waveforms ...in the transformed record, each point indicates the presence of a particular component waveform rather than the corresponding local intensity, as in an ordinary record.(Pribram, 1982)." A Fourier hologram can be made by linearly superimposing two Fourier-transformed records. This consists of "adding the waveforms together" (Pribram, 1982). In the holographic or spectral domain, geometry disappears because "the whole becomes enfolded and distributed into every part" (Pribram, 1982). The advantage of such a seemingly cumbersome process of transforming is in the instant correlations. These properties are readily seen in computer programming to reconstruct imaging through CAT scan tomography.

Moving into transformations and phases we move into the spectral domain of quantum physics. Information from space and time moves with a transformation into wave patterns in the spectral domain and back into space and time with a transformation. It is accepted that the lens of the eye performs such a transformation. The holonomic theory suggests that movement is involved in all transformations. The motor cortices, "areas around the primary sensory areas which, when stimulated, produce motor responses" are central to transformations in this theory (Pribram, 1999). The precentral motor cortex is the transformer or lens for the somatosensory cortex. Eye movements, for instance, group data or dots from the spectral domain into patterns which are then seen as an image. Magnetic Image Processing is based on quantum holographic principles.

Using the visual system model as a metaphor to understand the other sensory experiences may be helpful. Functional dendritic fields of wave patterns in the visual system were mapped by many laboratories including Pribram's in the 1960's and 1970's (Pribram, 1991). Pribram (1971) describes imaging as a neurological mechanism that creates and retains for use, a "spatially encoded representation of experience".

Pribram (1971) found evidence that the graded microprocesses, thought to be occurring in dendrites, recorded with low pass filtering, are coordinated with awareness. The learning of a habit through experience and habituation creates a reflex action which infers the absence of an orienting action or awareness. Using EEG, eye movement, galvanic skin response and other measures, subjects no longer display orienting responses when unchanging input in an unchanging situation is repeated. The subject no longer notices the events or context of the task. The subject would seem to have developed a neural model of the environment, an expectancy, a memory mechanism for matching inputs. The nervous system is thus constantly tuning itself with new inputs in order to process additional inputs (Pribram, 1971p105).

In the case of our client he was tuned early in life to dislike the telephone and to be hurt by it's use to the exclusion of his needs. His sensory system had created a model of the environment which expected to be neglected where the telephone was concerned. When his wife answered the telephone at dinnertime, his memory mechanism matched the input with the old information. This answers the question of where the memory is stored. The circuitry theory would say that the memory is stored in the amygdala. The holonomic theory suggests that memory is stored in the spectral domain with wave patterns oscillating throughout the brain.

There are several advantages to having holographic encoding in the brain memory system: 1.) damage to a large part of the system will not erase the encoding, 2.) there is a large memory capacity, 3.) part of the input can cause recall of the whole, 4.) recognition and recall can take place with out regard to the size or position of the input, 5.) there is instant cross-correlation between and among stored and input patterns, 6.) the original is restored with all its textural details (Pribram, 1975). Information from everywhere once experienced can be housed everywhere in the brain for later correlation and recall.

In the case of our client, his encoded memory of neglect by his father was recalled in detail along with the emotions of a four year old. The stimulation or trigger seemed to come from the image of his wife talking to, giving time to someone else on the telephone. The whole picture was not present, but the old memory was restored with all its somatic responses. This is often seen in therapy when a client is asked, "and what does that remind you of?" There seems to be an instantaneous recall of prior experiences.

To delve deeper into the nature of the trigger or transformer, we must ask whether it was the image of his wife on the phone or the feelings that image aroused. William James posed the question a century ago asking whether emotion preceded perception or the reverse. When asked later, the client said that he had not remembered the incidents with his father and the telephone for many years and had never connected them to his wife's

behavior at dinnertime. As a clinician practice has taught that clients can most readily associate present to past events when they are in a higher than normal emotional state. In the case of our client he had several symptoms of arousal: flushed face, eye movement sideways, head hung down, voice tone strained. His emotions seemed more intense, somewhat inappropriate to the circumstance. He had started in a lighthearted joking way to complain about his wife's behavior, referring to the thermodynamics. As he talked and began to feel emotions about his wife's neglect, it became apparent that he was also feeling emotions from his childhood, but was unaware of their origin. It was only at the point of noticing an increased emotional reaction that the therapist asked if the incident reminded him of anything in the past. His body took on even more somatic arousal as he came to the realization of his father's neglect.

It would seem that access to the deeper memory was made possible by the emotional reaction to the similar event in the present. The holonomic theory might describe the emotion as a movement or trigger which causes a Fourier transform to recall the deeper memory and all its somatic responses. Thus, the frustration about his wife's dinnertime phoning acts as a trigger or transformer to recall the old memory of his father's neglect from the spectral domain into a present image and emotions of hurt and anger. Unlike the prior theories the holonomic theory explains the deep memory, the transformation trigger and the immediacy of feelings from the past.

It would appear that the presence of electrical activation in the limbic system during episodes of emotion might refer to the locations of transformation rather than to the location of imprinted memory. Le Doux's location of fear in the amygdala may be accurate in so far as the amygdala is involved in the transformation process of activating fear emotions from the past and concomitantly transforming fear emotions from the present into long term memory. It would appear, however, that LeDoux is incorrect in ascribing memory to the amygdala.

The holonomic brain theory, an analogue, wave pattern theory, seems to answer all our questions about our client and his emotional responsiveness to his wife's behavior. Both circuitry and wave patterns were involved in his brain physiology as he explained his situation, had emotions about his situation and evoked an old memory which had been causing an underlying stress with the event.

Prologue

As an addendum it might be interesting to use the theories to analyze the therapeutic healing which resulted from the therapist's intervention in the client's revolving past and present emotions about the telephone. The client was revealing his situation to not only the therapist and his wife, but also to a gathering of therapists and spouses. As he dissolved in tears about his father's neglect, the therapist called up several men to play his father and support him in his emotional pain. The surrogate father replayed the client's childhood with an idealized situation of supportive, repentant fathering. Subsequently, the client was held by those men who had supported him in the role play

and by others. After this support the client's wife joined the men and expressed her regret at her dinnertime behavior and promised to create a different scenario in the future.

Six months later at another therapist gathering the client reported to the therapist that his life had been changed by the intervention. He was now able to relate to his son and grandsons, something that had not happened during his son's childhood. His relationship with his wife was closer than ever and there were no problems at dinner. In fact he was not as disturbed by the telephone.

What can explain these changes. The circuitry model would say they are impossible as the offending memory was indelibly imprinted onto the amygdala or some other part of the limbic system. The bio-chemical theory would say that the emotion was released, and the client was held, thereby changing the molecules of emotion, intervening in the chronic CRF response. The holonomic theory would consider the intervention a reconstruction of memory so that the spectral domain now held a positive memory of fathering engendered in the intervention. The stress response would no longer be needed.

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