Chapter 3
How does learning happen?:
Deep within my whole biochemical being?

This *anthropos* must be studied not only in [her] skull,
not only in [her] skeleton,
not only in [her] musculature, but as a whole living being.
This is not about the soul or body.
According to the doctrine taught by Aristotle and Thomas Aquinas
and aided by the power of constant, living observation
I say: 'There is only a *single*, there is only *one* human compound'.
To speak of a body and a soul separately is to operate an unwarranted vivisection…
Marcel Jousse

Introduction

In this chapter I will provide an account of my understanding of the biochemical nature of learning by examining the scientific literature presented out of the lived experiences of a number of scientists engaged in human biology, physiology and human expression.

Is Chemistry everywhere?

I recall that when I taught Chemistry 1 students at ML Sultan Technikon from 1987 until 2000, I frequently used the statement – "Chemistry is everywhere". I would say this to make the students more aware of chemistry and chemical reactions, all the chemical changes - in every experience of their everyday lives. When I started taking a keen interest in 'active learning', as the co-ordinator of the Effective Learning Centre in 2001, I asked myself: "So, if chemistry is everywhere, where is the

chemistry in learning?" I then soon realized that in the human body where all biological processes are interdependent, it is not about the chemistry but rather the biochemistry since in the human being biochemical reactions are taking place all the time. I reasoned that these biochemical reactions are about changes that are continuously occurring in my body. I experience a variety of biochemical changes during my respiration process, my digestion process, the circulation of myblood and other such processes in myeveryday life. So I decided to try to find out what the biochemical changes are that occur when I am learning. This raised even more questions for me such as, "Is there any learning-change?" "Where is the learning-change occurring?" "What is the nature of the learning-change?" "How do I know that learning-change is happening?" "What evidence of learning-change is apparent?" "How can I measure the evidence of learning-change?"

What have I learnt about learning as change?

I am unhappy about the term active learning since I understand that it is a tautology to say that learning is active. Learning by its very nature is about change. Historically and currently, theories of learning understand learning as a process of change. Change as an understanding of learning is demonstrated as behavioural change as a result of experience (Maples & Webster 1980 in Merriam & Caffarella 1991:124; (Merriam and Caffarella 1998). Four orientations of learning - with some main theorists - are generally behaviourist (Skinner 1973), cognitivist (Piaget 1926; Maslow 1968; Bruner 1977; Gagne 1985), humanist, (Rogers and Freiberg 1993) and situational (Lave and Wenger 1991). The locus of learning respectively in each of these orientations is stimuli in external environment, internal cognitive structuring, affective and cognitive needs, and the relationship between people and their environment. Sensory stimulation theory supports the notion that for greater learning to take place, multi-senses need to be stimulated but it does not provide the answer as to what is happening in the body when this stimulation occurs (Laird 1985).

The gap identified in these theories is that none of them addresses the locus of learning as a biochemical process within the whole being - the whole mind and the body (Conolly and Timm 2005). Whole being learning has a variety of understandings (Laird 1985; Hill and George 1996; Hill 1999; Jousse 2000) but only Jousse identifies that learning is the result of "intussusception" (Jousse, 2000:576) and that knowledge is visceral. According to Holdstock (1987), the discipline of education does not take cognisance of the fact that everything starts with the nature of my being – my whole human biochemical being.

What have I learnt about head-brain learning?

As a starting point to discover what is happening biochemically when I, as a human being, learn, I thought it would be useful to explore the world of neuroscience. My understanding at that point was that my learning happens in the neurons and there are neurons in my brain. I read many books and journal articles on the neuroscience of learning, on how the brain works, on the biology of the mind, the biology of belief, learning and education (Fagnou and Tuchek 1995; Bownds 1999; Andreas 2000; Zull 2002; Blackmore 2004; Goswami 2004; Wilson 2004a; Wilson 2004b; Leaf 2005; Lipton 2005; Ansari and Coch 2006; Goswami 2006; Wolfe, Pat 2006; Zull 2006; Silva 2007; Goswami 2008; Barnacle 2009; Reis *et al.* 2009; Carew and Magsamen 2010). As I read, I came to realize that learning does not only happen in my head-brain but that there were other 'brains' in my body with neural activity. As I read, I realized the significance of neurons and the neuronal network throughout the body. I found understanding of these neuronal networks by reading amongst others, the work of Zull (2002), Leaf (2005) and Lipton (2005).

Caroline Leaf in her book *Switch on your brain* (2005) says the following about learning:

> …most learning, around 90%, actually takes place on levels that go beyond conscious, to what I call metacognitive thinking levels that include the non-conscious, in ways we never dreamt of before (Leaf 2005:2) (…) learning does not just happen at school or university, but from birth to death, 24 hours a day (Leaf 2005:58).

I am interested to note that Leaf's thinking is different from the thinking of many educators that most learning takes place when we are consciously aware of what we are doing like reading or taking notes. Leaf maintains that learning involves something above conscious and non-conscious levels. Leaf believes that the neural network dominates all that I do. Leaf focuses only on the neural network in the brain, but I am aware that this neural network operates throughout the body including the heart and the stomach. At that point I realized that I had to discover as much as I could about the whole of my neuronal network. I started with the brain, my brain.

> Your brain is a very busy organ. It is on duty all the time, receiving vast amounts of information from your eyes, ears, nose and other sense organs. It even receives information while you are asleep (Leaf 2005 :75).

My brain receives the information in the form of electrical impulses from the sense organs which includes the skin all over my body which is my sense organ of touch. I am reminded by Robinson and Aronica (2009) that in addition to the five senses of sight, sound, smell, taste and touch, we have four more:

> …sense of temperature (thermoception) (…) different from our sense of touch. We don't need to be touching anything to feel hot or cold. (…) sense of pain (nociception) (…) registering pain that originates from the inside or the outside of our bodies (…) vestibular sense (equilibrioception), which includes our sense of balance and acceleration (…) kinesthetic sense (proprioception), which gives us our understanding of where our limbs and the rest of our body are in space and in relation to each other. (…) all of these senses contribute to our feelings of being in the world and to our ability to function in it (Robinson and Aronica 2009:32-33)

Thus I feel and receive the electrical impulses not only through the organs in my head but throughout my body. The neural network operates throughout my body through the chemical messengers called neurotransmitters. The neurons are also involved in the process of receiving information, storing it in my memory and making it available. (Reis *et al.* 2009). Each person is

> born with approximately 200 trillion neurons. Half of those were used for growth in the womb, birth, adjustment to life outside of the womb and the basic milestones – language, sitting walking and so on. That leaves 100 trillion neurons for you to learn with (Leaf 2005 :84).

The neurons in my brain do not reproduce but they mature or develop structurally. My brain has its full complement of neuronal learning cells from birth. As I grow, the interconnectedness of the neurons and density of my brain increases. As I learn, the network of neurons grows and these networks make memories possible. How do they grow? The receptors in mysense organs change the information they receive into electrical impulses which fire to and fro across the network in my hippocampus and corpus callosum. These impulses stimulate branches – called dendrites - to grow from the nerve cell body of the neurons thus establishing the network. The more electrical impulses I receive, the greater the number of dendrites on my nerve cells. The lengths of the neurons as well as the number of dendrites on my neurons vary across the network. My neurons vary from millimeters in length to meters long. The dendrites branching off from the neurons also vary, from a few, to a few thousand, all making connections with dendrites of my other cells. Dendritic spines on the dendrite have electrical impulses and these spines interconnect to form the neural network.

The electrical impulses on the dendrites move across the synapses. These synapses are the points of contact between the axons and dendrites. The axons collect signals from the dendrites and send them away from the nerve cell body. The axons are covered with myelin. The myelin helps the signal to pass more quickly along the axons. (I will discuss the role of myelin later.) An electrochemical reaction occurs in the fluid of the synapses due to the electrical impulse. This electrochemical reaction releases the neurotransmitters which result in the growth of the dendrites. Hence the greater the number of electrical impulses received and processed, the greater the amount of brain chemicals produced, the greater the network and the greater the memories. These brain chemicals, neuropeptides – opiates and the opiate receptors - are produced in the limbic system of my brain.

My limbic system is comprised of the thalamus, hypothalamus, amygdala and pituitary and it is directly linked to my emotions, pleasure and pain, and sense perception. My emotions play an important role in building of good and bad memories. When I feel fear and anger, chemicals are secreted that affect my memory negatively. This causes “memory fatigue, confusion, lack of concentration and memory loss” (Leaf 2005: 92). Hence, I reasoned, learning would happen more easily when the positive emotions of fun and pleasure are experienced. Pert believes “when we are playing we are stretching our emotional expressive ranges, loosening up our biochemical flow of information, getting unstuck, and healing our feelings” (Pert 1999:277). When we play we let the emotions and neuropeptides flow.

What have I learnt about the chemistry of emotions?

I became very interested in finding out more about the relationship between brain chemicals and emotions. In this quest, I came across the work of Candace Pert and Eric Kandell. Eric Kandell, from Columbia University won the Nobel prize in 2001 for his brain research. He showed that learning can dramatically change the effectiveness of a synapse and that the number of neurotransmitters at some synapses varies after learning and increases with repetition. Candace Pert in *Molecules of Emotion* cites the work of Eric Kandell

> Dr Eric Kandell and his associates at Columbia University College of Physicians and Surgeons have proved that biochemical change wrought at the receptor level is the molecular basis of memory. When a receptor is flooded with a ligand, it changes the cell membrane in such a way that the probability of an electrical impulse travelling across the membrane where the receptor resides is facilitated or inhibited, thereafter affecting the choice of neuronal circuitry that will be used. These recent discoveries are important for appreciating how memories are stored not only in the brain, but in a *psychosomatic network* extending into the body, particularly in the ubiquitous receptors between nerves and bundles of cell bodies called ganglia, which are distributed not just in and near the spinal cord, but all the way out along pathways to internal organs and the very surface of our skin. The decision about what becomes a thought rising to consciousness and what remains undigested thought pattern buried at a deeper level in the body is mediated by the receptors. I’d say that the fact that memory is encoded or stored at the receptor level means the memory processes are emotion –driven and unconscious (but, like other receptor –mediated processes, can sometimes be made conscious) (Pert 1999 :143).

Thus I have molecules of emotion not only in my brain, but *“in the psychosomatic network”(ibid).*

Pert discovered that peptide and protein molecules known as endorphins and opiate receptors are the biochemical substrates for emotions and she coined the term ‘molecules of emotion’ (Pert 1999; Pert 2006). The opiate receptor binds with specific ligands in mycells that are of the opiate group such as endorphins, morphine or heroin. The ligands are smaller molecules than the receptors and they are classified as neurotransmitters, steroids and neuropeptides. The neurotransmitters are generally made in the limbic system of mybrain, the steroids include the hormones and the neuropeptides which are made up of building blocks, the amino acids. The neuropeptides constitute about 95% of the ligands and they play a wide role in regulating practically all of mylife processes. These neuropeptides are distributed throughout mybody’s nerves as the molecules of emotion. Due to this distribution of neuropeptides throughout mybody, I am able to experience numerous ways for myconscious mind to access and change myunconscious mind and mybody.

The neuropeptides (endorphins) and receptors (protein molecules such as opiates) form ion channels to pump ions in and out of the cell in a rhythmic pulsating movement (Reis *et al.* 2009) or as Pert mentions “moving, dancing in a rhythmic, vibratory way” (Pert 1999:23) as they bind with a ligand resulting in the chemical transfer of information into the cell. This pulsating movement creates an impulse that meanders through the body generating an electric current throughout the bodymind which keeps me awake, alert and conscious. The electric current also influences the state of excitability or relaxation of the entire organism. The excitability varies from place to place in the organism and from individual to individual depending on which receptors are occupied by which peptides. As mycells change, on a global level, I experience changes in behavior, physical activity and mood (Reis *et al.* 2009). Thus the current flow between individuals can be very different and may need to be modulated especially in relationships between people (Pert 2008).

The movement and change happens internally at the individual level and externally. When I place my hand on my chest, I feel the rhythm of my heart beat. My body is filled with rhythm and oscillations. There is power of rhythm in nature and in the human body. This rhythm can also exist in the classroom. However, the 'technological advances have obscured our intuitive harmony with nature's rhythms' (Miller, B 2009:7) we have lost touch with the natural rhythms and hence have experienced a disconnection and lack of interaction with nature.

Goleman reminds us too that

> …we are wired to connect. Neuroscience has discovered that our brain's very design makes it *sociable,* inexorably drawn into an intimate brain-to-brain linkup whenever we engage with another person. The neural bridge lets us affect the brain- and so the body – of everyone we interact with, just as they do us. Even our most routine encounters act as regulators in the brain, priming our emotions, some desirable, some not. The more strongly connected we are with someone emotionally, the greater the mutual force. Our most potent exchanges occur with those people with whom we spend the most time of day in and out, year after year – particularly those we care about the most. During these neural linkups, our brains engage in an emotional tango, a dance of feelings. Our social interactions operate as modulators, something like interpersonal thermostats that continually reset key aspects of our brain function as they orchestrate our emotions. The resulting feelings have far-reaching consequences that ripple throughout our body, sending out cascades of hormones that regulate biological systems from our heart to our immune cells. … our relationships mould not just our experience but our biology. The brain-to-brain link allows our strongest relationships to shape us on matters as benign as whether we laugh at the same jokes or as profound as which genes are (or not) activated in T-cells, the immune system's foot soldiers in the constant battle against invading bacteria and viruses (Goleman 2007:4-5).

I have provided a description of the brain and the central nervous system functioning as an electrical communication system as well as a chemical-based system throughout my body. I am interested to know that this discovery made in the 1970's of the 'chemical brain' was possible due to the technology available to measure the second nervous system. I am awed to realize that my chemical brain is more ancient and far more basic than the electrical network based on neuron-axon-dendrite-neurotransmitter connections. The neuropeptides were made inside my cells long

before there were dendrites, axons or neurons or even brains. As the neuropeptides move through extracellular space, flowing in my blood and cerebrospinal fluid, I experience complex and fundamental changes in my cells throughout my body. According to Elmer Green, a Mayo clinic Physician, as cited by Pert,

> Every change in the physiological state is accompanied by an appropriate change in the mental emotional state, conscious or unconscious, and conversely, every change in the mental emotional state, conscious or unconscious, is accompanied by an appropriate change in the physiological state (Pert 1999 :137).

The molecules of emotion are not only in the head brain they are throughout the body and clusters of them exist in certain 'nodal' points in the body. The stomach and the heart each have an aggregation of these molecules as dense as that in the head-brain. Since the nervous system is a network throughout the body not just in the head-brain, is the change that occurs in learning only in the head-brain? Does it start in the head-brain or end in the head-brain?

I believe Pert when she says "the body is the unconscious mind" (Pert 1999:141) supporting the view that there are infinite ways for the conscious mind to access and modify the unconscious mind and the body. Hence my emotional brain is no longer confined to my limbic system. I have high concentrations of almost every neuropeptide receptor in other areas of my body like my spinal cord and where information from any of my nine senses – sight, sound, smell, taste, touch, thermoception, nociception, equilibrioception, proprioception, (Robinson and Aronica 2009:32-33) enters the nervous system. my neuropeptides process information, prioritise it and bias it to cause neurophysiological change within me. My emotions and bodily sensations are intricately intertwined in a multidirectional network. I experience each one altering the other, sometimes at an unconscious level or at times, at a conscious level. Furthermore, Candace Pert reminds me to:

> Think of the brain as a machine for not merely filtering and storing this sensory input, but for associating it with other events or stimuli occurring simultaneously at any synapse or receptor along the way- that is, learning (Pert 1999 : 142).

Pert continues to state that

> Emotional states are produced by the various neuropeptide ligands. An experience of an emotion or a feeling is a mechanism for activating a particular neuronal circuit-*simultaneously throughout the brain and the body*- which generates a behavior involving the whole creature, with all the necessary physiological changes that behavior would require. This fits nicely with Paul Ekman's elegant formulation that each emotion is experienced throughout the organism and not just in the head or the body, and has a corresponding facial expression. It's part of the constellation of bodily changes that occurs with each shift of subjective feeling (Pert 1999 :145).

I experience a change in my receptors, both in sensitivity and in the structure of the cell membrane thus providing a biochemical potential for change and growth, learning. My neuropeptides direct my attention by their activities and I am not consciously involved in deciding what gets processed, remembered and learned. I experience these changes at the subconscious level but they can be brought into consciousness by amongst other means, intentional training. Thus quite often, I am not aware of what I have actually learnt until an opportunity arises that actually brings it up consciously.

Furthermore, Pert says:

> …peptides serve to weave the body's organs and systems into a single web that reacts to both internal and external environmental changes with complex, subtly orchestrated responses. Peptides are the sheet containing the music notes, phrases, and rhythms that allow the orchestra – your body- to play as an integrated entity. And the music that results is the tone or feeling that you experience subjectively as your emotions (Pert 1999 : 148).

This weaving that Pert mentions reminds me of the psychosomatic network mentioned earlier which I would like to connect with the belief that

> Neurons that fire together, wire together. …neurons do not work alone, they form networks of connected information. All brains contain the same basic structures, but the networks in each brain are as unique as that person's fingerprints (Childre *et al.* 1999 :36).

Through these networks of connected information I experience a flow, a constant exchange and processing and storage of information, which is what happens as neuropeptides and their receptors bind across the systems within my body. I observe that a network does not necessarily have a hierarchical structure, rather entry can be gained at any nodal point allowing quick access to any other point

hence the locations are equal in theory to direct the flow of information within my body. I experience the flow as living circuits across my body.

What have I learnt about the chemistry of memory?

According to Dr George Bartzokis, a UCLA neurologist and myelin researcher

> All skills, all language, all music, all movements, are made of living circuits, and all circuits grow (Coyle 2009:6).

I discovered a book by Daniel Coyle the talent code (2009) which provides an explanation of the transformation of the wiring of our head-brains through myelination, as we approach tasks in our lives. In writing this book, Coyle drew on the work of a wide array of neurologists, psychologists and scientists and his own experiences. Having read Coyle's book, I think that by focusing on the head-brain only, he has missed the point. my whole body is wired and there is myelin sheath on the nerve fibers that are distributed throughout my whole body. I experience an increase in myelination - the growth of the myelin sheath - as my neural impulse activity increases (Fields 2005). my neural impulse activity increases as my senses are activated in my body.

I believe that the role of myelin is thus critical in the learning process. The myelin is a phospholipids membrane, a dense fat that wraps around the nerve fiber that is attached to the neuron cell body. Myelin is a neural insulator wrapped over my nerve fibers resulting in an increased signal strength, speed and accuracy of my living neural circuit. Each time my circuit is set up, my myelin layer is optimized around my nerve fibers. Having passion and persistence for something, working harder at it, spending energy and time all contributes to the growth of the myelin in the circuit (Fields 2005; Fields 2008b). The more I work at something, like developing a skill and thus my neuron circuit, the less aware I am that I am actually using it and the skill becomes spontaneous or automatic and stored in my subconscious mind. This process is called automaticity and I experience it as my myelin, the fat layer increases or grows. I have observed that the general focus of research has been on the neurons and the synapse with not much attention paid to the myelin, until recent

studies showed that not only synapses increase in brains as they are stimulated, but also the myelin increases (Fields 2005; Fields 2008b; Fields 2008a). Fields provides a description of how the myelin grows through the role of the supporter cells oligodendrocytes and astrocytes. These cells result in the growth of the myelin layer on the nerve fibers as a response to the nerve firing. Thus the firing of the nerves is proportional to the growth of the myelin layer which is proportional to the speed of the signal through the fiber. The exact mechanism of this process of myelin growth and the subsequent increase in neuron functioning, impulse speed and hence skill is still to be defined. Diseases such as multiple sclerosis result in the loss of skill and associated loss of myelin whilst the neuron connections remains intact (Fields 2008a). Myelin plays a role in how learning manifests itself together with the synaptic change that is key to learning.

Myelin is a living tissue that responds to actions such as urgent repetition of nerve firing. Myelination happens only in one way over a sustained period of time. Thus it is hard to break old habits except through doing new things often enough. The myelin will not 'unwrap' except by age and disease. There is a net gain of myelin until about age fifty after which it slows down yet still continues to grow though at a smaller rate again dependant on the nerve firing. The growth of myelin process is similar to what happens when the body grows muscle by pushing itself to the outer edges of physical ability (Bartzokis 2008).

Another point to consider now is that talent is no longer to be understood in terms of genes and environmental influences but also in terms of practicing more deeply and learning more skill (Miller, EM 1994; Casey 2000; Klingberg 2000; Fields 2005; Ullen 2005; Pujol 2006; Walhovd and Fjell 2007).

I understand the psychosomatic portion of the network as comprising the *psyche* which is generally nonmaterial in nature, such as the mind, emotion and soul and the *soma* which is the material world of molecules, cells and organs. Most of the

emphasis on understanding of learning thus far has been on the mind with less on the emotion and even less on the soul as far as the psyche is concerned (Wolfe, Pat and Brandt 1998; Bownds 1999; Brandt 1999; Ralph 2000; Strother 2007; Bakhurst 2008). With regards to the soma, there has been emphasis on the head-brain as the organ of learning, with not much about the molecules and cells and other possible organs (Byrne 1986; Caine and Caine 1995; Caine and Caine 1998b; D'Arcangelo 1998; Bransford *et al.* 2000; Pascale *et al.* 2001; David 2003; Ben *et al.* 2004; Ashby and Maddox 2005; Leaf 2005).

I am reminded of the words of James Zull, a Professor of Biology, who says:

> Ultimately, our understanding of learning must be consistent with the biological properties of the learning organ. In fact, no matter how widely accepted they may be, all current theories will automatically be reconsidered and revisited as our knowledge about the brain continues to grow (Armour and Ardell 1984 :8).

This quote led me to explore whether the head-brain is the learning organ and also where is the brain in the human body – is it just in the head or elsewhere in the body? According to Candace Pert, the *mobile brain* is an appropriate term to describe the psychosomatic network since the head-brain is integrated so well at the molecular level with the rest of the body (Pert 1999: 188).

What have I learnt about the chemistry of gut-brain learning?

More recently, Barnacle (2009) in her article *Gut Instinct: The body and learning* cites the work of Wilson, who draws on clinical data to show how

> hierarchical models which situate the central nervous system and cognition above and in control of the so called lower functions of the enteric nervous system cannot account for what actually occurs in both bodily and psychological processes and events . … the nervous system extends well beyond the skull, and as it so travels through the body it takes the psyche with it (Wilson 2004b: 47).

So it is clear that the gut is capable of complex emotional responses and it is seen to be operating independently from the head-brain. From this I understand that the gut

is autonomous, producing my gut insights should play a role in my knowing and learning.

At about this time of my inquiry, I was alerted to an insert in a local newspaper (Brown, H 2005) that referred to the work of Dr Michael D. Gershon who had written a book entitled “The Second Brain” (Gershon 1998). Dr Michael Gershon is a neurobiologist whose research has focussed on understanding the nervous system that runs the bowel. The extract in the newspaper that I could relate to was

> Two brains are better than one. At least that is the rationale for the close relationship between the human body’s two brains, the one at the top of the spinal cord and the hidden but powerful brain in the gut known as the enteric nervous system, which directs all of the functions of the gastrointestinal, or GI, system. In fact, anyone whose stomach has ever felt a little unsettled before giving a speech or had a bout of intestinal urgency the night before an examination has experienced the actions of the dual nervous system (Brown, H 2005).

I have felt and continue to feel that ‘unsettled stomach’ many times when conducting a staff development workshop or before delivering a sermon in church even though I have prepared everything in advance. I still experience the bouts of “intestinal urgency” (ibid) before examinations. I recall having had just that experience as recently as last year before I sat for a three-hour examination session on South African Church History as part of my B Theology studies. Even though I had done very well in all the assignments and prepared for the examination by going over all the pre-examination exercises, I still made at least two visits to the toilet within the half hour before writing due to the “intestinal urgency” (ibid) I experienced.

I thus proceeded to search for the text referred to in the newspaper article to obtain the primary source of the article. Through internet searches and the inter-library loans system at DUT, I located an article published by David Gershon in *Hospital Practice* (Gershon 1999a) and I obtained a copy of *The Second Brain* (Gershon 1998).

David Gershon believes that

> Descartes said “I think, therefore I am,” because his gut prompted him to say so. The brain in the bowel has got to work right or no one will have the luxury to think at all. No one thinks straight when his mind is focussed on the toilet (Gershon 1998:xv)

and that

> Rediscovery is every bit as good as discovery, if what is rediscovered is important and was forgotten. It is better still when the rediscovered information has the capacity to improve the lives of those around us... What I [Gershon] have done, with a great deal of help from colleagues around the world, is to find it [existence of the second brain] again and return it to scientific consciousness (Gershon 1998:3).

Gershon cites the laboratory work of Bayliss and Starling who deduced that the enteric nervous system was a self-contained hub of neuronal activity that operated largely independent of the central nervous system input (Gershon 1998:3-5). My enteric nervous system which is the local nervous mechanism of my bowel has properties like those of the head-brain and the spinal cord. My bowel contains a complex network, or *plexus,* of nerve cells and fibers. This network is made up of the Auerbach’s plexus and the Meissner’s plexus found in between the muscles encircling my gut. I have more nerve cells in the enteric nervous system- a few million - than those that connect the head-brain to the bowel- a few thousand motor fibers. My neurotransmitters are the chemicals involved in the communication between nerve cells. I thus have a large number of neurotransmitters in the bowel and the bowel can get along without hearing from the head-brain. All the classes of my neurotransmitters in the head-brain are found in the enteric nervous system. When my enteric nervous system fails and the gut does not work so well, all my brain functions also seem to fail (Gershon 1998).

My neurotransmitters in the body as the communicating chemicals belong to the same group as the molecules of emotion discovered by Candace Pert (1999). Gershon (1998) emphasizes acetylcholine and norepinephrine as the first two neurotransmitters discovered in the peripheral nervous system. Acetylcholine is the neurotransmitter that excites the ganglia linking the first nerve cell to the second nerve cell of the parasympathetic nerves, the sympathetic nerves as well as at the

second nerve cell junction, the neuroeffector, where the signal is sent to the effector under the control of the nerve cell. Norepinephrine is the neurotransmitter at the sympathetic neuroeffector junction. Once my nerve cells are excited, they express receptor molecules that bind the neurotransmitters and eventually lead to a physiological change within me. These receptors are molecules expressed on the cell surfaces enabling my cells to respond to specific chemicals in their environments. Serotonin was later discovered to be the neurotransmitter that was manufactured and stored in the bowel. Approximately 1% of the serotonin in my body is manufactured in my head-brain. (Gershon 1998).

I can thus understand how the enteric nervous system has been recognised as a "complex, integrative brain in its own right" (Gershon 1998:31) and as such can be seen as the second brain in my body in that all the classes of chemicals that transmit instructions in my head-brain are also represented in my enteric nervous system. The relationship between my cerebral and enteric brain is very close and to quote Gershon, "it is easy to become confused which is doing the talking" (Gershon 1999b:41) thus the 'two brains' can be seen as a whole or as one.

I understand that these chemicals, the neuropeptides and receptors, the biochemicals of emotion, are the messengers that link all the major systems of my body into the bodymind. My emotions are cellular signals involved in the translation of information into physical reality and they are thus the nexus between matter and mind.

Furthermore, I understand according to Lipton(2005), that my conscious mind not only "reads" the flow of the cellular co-ordinating signals that comprise my body's "mind" it can also generate emotions, which are manifested through the controlled release of regulatory signals by my nervous system (Lipton 2005: 101). I see how my limbic system can now sense and co-ordinate the flow of behaviour-regulating signals within my cellular community.

What have I learnt about the chemistry of the heart-brain learning?

I believe my molecules of emotion are also found in my heart. I understand the heart is generally considered only in terms of its physiological function of being a multichanneled muscular organ with electrical circuitry. My heart is thus the central rhythmic force of my being. my experience of good health is a delicate balance of the rhythm with dis-ease resulting from dys-rhythm. I believe that my rhythms are regulated by love, an emotion that I feel as a human being. I ask myself, "Why then is the emotional definition of the heart and its effect on the physical body not considered by western conventional medicine?" Am I losing sight of the whole person, largely because of the body/mind split of Descartes? I have observed new practices to heal the mind/body split that are integrative and holistic or complementary (Dossey 2009). I believe that the heart with all its intelligence should not just be confined to religion and philosophy. I see the work done in this regard by the HeartMath Institute which combines scientific research with emotional wisdom as being very useful to explain all aspects of my heart. The Institute has coined the term "heart intelligence" which is

> …the intelligent flow of awareness and insight that we experience once the mind and emotions are brought into balance and coherence through a self-initiated process. This form of intelligence is experienced as direct, intuitive knowing that manifests in thoughts and emotions that are beneficial for ourselves and others (Childre *et al.* 1999:6).

In exploring the biochemical link to learning through the functioning of the heart, I set about trying to understand the 'intelligent flow' between my heart, my head-brain and the rest of my body.

The heart is linked to the aspects of our lives such as wisdom, love, compassion, courage and strength that associate us with being human. The common sayings such as 'speaking from the heart'- when I consider people saying things that are sincere, or when people do something 'with all their heart' meaning that they throw themselves into an activity. Other idioms used are 'thinking with the head and not the heart', or 'becoming disheartened'. All these expressions are also linked to my

gestures of pointing to my heart when I point to myself. In many religions, the heart is referred to as the ‘seat of the soul’ and it is the connecting place between spirit and humanness.

The Mesopotamians, the Egyptians, the Babylonians and the Greeks – all of these ancient cultures- maintained that the heart was the primary organ capable of influencing and directing our emotions, our morality and our decision-making ability (RSV 1975).

When I reflect on my own Christian faith and read the Bible I also see the importance placed on the heart in both the Old Testament and the New Testament. Two examples of many more are from the book of Proverbs in the Old Testament refers to “For as a man thinketh in his heart, so is he” – Proverbs 23:7, and in the New Testament in Luke 5:22 “What reason ye in your hearts?” (RSV 1975). From my interactions with peoples of other faiths, I discovered that it is not only in the Christian faith, but also in other traditions such as the Judaic, Yogic, and in Chinese medicine that the heart has an ‘intelligence’ that operates independently of the brain yet in communication with it. However all this is generally not considered to be linked to science and hence not to be very sophisticated scientific thinking.

I recall that in biology lessons taught at school, the heart was considered to be just another working part of the body, devoid of independent intelligence or emotion. The heart of an unborn foetus starts beating before the head-brain is formed. The head-brain starts developing from the brainstem, then the emotional centres- the amygdala and the hippocampus emerge. Thus, the head-brain grows out of the emotional region. An unborn child has a beating heart before even an emotional brain and a rational brain.

I know that my heartbeat is autorhythmic with the timing of the beat thought to be controlled through the autonomic nervous system (Childre *et al.* 1999). my heart does not need a hardwired connection to the head-brain to keep it beating. my heart has at least forty thousand nerve cells which are as many as found in the subcortical centers in the head-brain (Armour and Ardell 1984). There is communications sent to the head-brain from the heart that affect the amygdala, the thalamus and the cortex. Physiologists John and Beatrice Lacey of the Fels Research Institute found that the heart did not merely mechanically respond to a signal from the head-brain (Lacey and Lacey 1970). My heart's response appeared to depend on the nature of the task at hand and the type of mental processing it required. Furthermore, the messages from my heart may actually influence my behavior. My heartbeat significantly influences how I perceive and react to the world (Lacey and Lacey 1970). Researchers in the later years discovered that the electrical activity of the higher head-brain centers involved in cognitive and emotional processing is directly affected by neural impulses which are as a result of the transformation of the rhythmic beating patterns of the heart (Schandry *et al.* 1986; Frysinger and Harper 1990; McCraty *et al.* 1996). The neural impulses change patterns of activity in the nervous system either by reducing activities such as releasing hormones, or flow in blood vessels or increasing the heart rate, or immune responses. Thus I experience biochemical change in my body involving change in hormone levels and reactions of the neuropeptides. So yet again I see the neuropeptides, and with them their receptors, as the biochemical basis of emotion.

> The heart thus communicates with the body neurologically (through the transmission of nerve impulses), biochemically (through hormones and neurotransmitters), biophysically (through pressure waves) and energetically (through magnetic field interactions) (Childre *et al.* 1999: 28).

All these communication routes from my heart to my head-brain influence my physiological, mental and emotional processes in my body. The human "emotional system" is thus not confined to the head-brain but is a network distributed in a network that extends throughout the entire body as postulated by Candace Pert (1999). The emotional state of my body can be measured by the heart rate variability (HRV) which is the measurement of beat-to-beat changes in the heart rate. Smooth and harmonious HRV rhythms are generated by feelings of appreciation, love, compassion and care. These types of rhythms are less stressful to the body's

systems and result in more efficient communications between the heart and other organs. my bodies function at optimum capacity that includes learning, when the head and heart are attuned to each other and working together. This inner coherence can be considered to be a benchmark of intelligence and essential to effective living and learning.

I find the linking of intelligence to the heart rather different to the view of intelligence which has been measured as the cognitive ability and intellect through Intelligent Quotient (IQ) tests. The IQ scores of people did not change when measured at kindergarten and then in adulthood regardless of education received which led people to argue then that intelligence is inherited, fixed and cannot be changed (Goleman 2006). However, understandings of intelligence has changed due to the work of Howard Gardner (Gardner 2006), Daniel Goleman (1998; 2006; 2007) and many others on discovering multiple intelligences, emotional intelligence, social intelligence and spiritual intelligence. The HeartMath Institute has worked at finding an answer to Goleman's question: *"How can we bring intelligence to our emotions – and civility to our streets and caring to our communal life?" (Goleman 2006 : xxiv)*. The Institute believes that the answer is in heart intelligence which is the source of emotional intelligence.

> From our research at the Institute of HeartMath, we've concluded that *intelligence* and *intuition* are heightened when we learn to listen more deeply to our own heart. It's through learning how to decipher the messages we receive from our heart that we gain the keen perception needed to effectively manage our emotions in the midst of life's situations and challenges. The more we learn to listen and follow our heart intelligence, the more educated, balanced, and coherent our emotions become. (Childre *et al.* 1999 : 13)

I find the link between emotions and heart intelligence very interesting and important. The molecules of emotion that Candace Pert (1999) discovered, are the messengers that carry the message from my heart to my head-brain and to my whole body. Goleman (2006) shares a discussion that he had with Gardner on why he (Gardner) emphasised thoughts about feelings more than on emotions themselves, he (Gardner) said :

> When I first wrote about the personal intelligences, I *was* talking about emotion, especially in my notion of intrapersonal intelligence – one component is emotionally tuning in to yourself. It's the visceral-feeling signals you get that are essential for interpersonal intelligence. But as it has developed in practice, the theory of multiple intelligence has evolved to focus more on metacognition rather than on the full range of emotional abilities (Goleman 2006:41).

The visceral feelings are the feelings felt throughout my body. These feelings provide evidence of our humanity and the emotions that enrich us. The higher values of the human heart of faith, hope, devotion and love are missed from the cognitive view. These values are intricately linked to our emotions which enrich our lives and our learning. Albert Einstein reminds us that:

> The most beautiful and profound emotion we can experience is the sensation of the mystical. It is the power of all true science (Lipton 2005:152).

One way of understanding the mysteries of the universe is to use Newtonian linear thinking as well as quantum physics. From a quantum physics approach, we understand the universe as one indivisible dynamic whole in which energy and matter are entangled such that they cannot be considered as independent elements (Lipton 2005). Newtonian linear thinking on the other hand, provides categories of space, time and solid matter (Zohar and Marshall 1994). These categories lead to separateness, distance and causality resulting in either/or ways of thinking. Quantum physics provides us with a means of both/and kind of thinking. An example of this is in the case of light being both wavelike and particle-like at the same time.

Earlier on, I stated that matter and energy are entangled which leads to the corollary that mind (energy) and body (matter) are similarly bound. The reality of a quantum universe reconnects what Descartes took apart. The mind (energy) arises from the physical body and the physical body can be influenced by the material mind. Thought "energy" can activate or inhibit the cell's functioning proteins via the mechanics of constructive and destructive interference (Lipton 2005:95). Laws of quantum physics control a molecule's life-generating movements (Lipton 2005).

What have I learnt about learning related to human beliefs?

I read in Lipton's *Biology of Belief* (2005) that the mind is generally subdivided into the conscious and the unconscious which are actually interdependent. Furthermore, the conscious mind is the creative one, the one that conjures up positive thoughts. In contrast, the subconscious mind is a repository of stimulus response tapes derived from instincts and learned experiences. The subconscious mind is strictly habitual: it will play the same behavioural responses to life's signals over and over again. When it comes to sheer neurological processing abilities, the subconscious mind is millions of times more powerful than the conscious mind (Lipton 2005:97). I began to see that reason or thinking does not govern the subconscious mind whose actions are reflexive in nature. Thus I have the capacity to consciously evaluate my responses to environmental stimuli and change old responses any time desire as long as I deal with the powerful subconscious mind.

According to Candace Pert,

> Awareness is the property of the whole organism; and in the psychosomatic network we see the conscious and [subconscious] mind infusing every aspect of the physical body, the body **is** the subconscious mind (Pert 2008:18).

My responses to environmental stimuli are controlled by perceptions which can be true or false. These controlling perceptions can be referred to as beliefs. I believe what I choose to believe. When I choose to believe then I will something into being, making it a reality, making it true. As I choose to believe, I thus change my mind. I agree then that

> Beliefs control biology.... when the mind changes, it absolutely affects your biology. (Lipton 2005:111)

Synaptic pathways are hardwired in our subconscious minds by observing the beliefs, behaviours and attitudes of others around us. Our life experiences are thus downloaded and hardwired as stimulus response behaviours into our subconscious minds. The behavior activating stimuli are signals detected from the external world and/or signals that arise through biochemical reactions from within the body such as emotions, pleasure and pain.

Siegel (2008) also states that as I am mindfully aware and pay attention to my experiences, scientifically recognized changes in my physiology, my mental functions and interpersonal relationships are created. I can be mindfully aware of my inner self as well as of the other person in a relationship as I focus my attention either on myself or on the internal world of the other in the present moment. In so doing I "feel felt" and connected in a relationship that is vibrant and alive, an immediate experience (Siegel 2008:62,77). Feeling felt leads to feeling understood and feeling at peace as we are able to recognize and understand the energetic emotional signals from others.

Mindfulness thus results in amongst other attributes, patience, self-compassion and wisdom (Siegel 2008: 67). When I am mindfully aware, I also become more aware of my own awareness. Thus I reflect on my inner life moment by moment with curiosity, openness, acceptance and love - (COAL) (Siegel 2008:70). I realize that when I am without COAL, then I am not living a life being kind to myself or to others. I am not attuned and not in a caring relationship, not promoting kindness, respect and love, I am not mindfully aware. This is because functions of mindful awareness such as empathy, balancing emotions, attuning to others, being in touch with intuition are all associated with the growth of neural fibers in the prefrontal cortex just behind the forehead. These fibers are distributed throughout the body and are the underlying mechanisms leading to resonate feelings of connectedness and love between persons in a relationship.

My beliefs act like filters and change how I see the world. And my biology adapts to those beliefs (Lipton 2005; Church 2008). It is not my genes that control my life, it is my beliefs. I need to learn how to harness my mind to promote growth. Teachers can remove hope by programming me to believe I am powerless.

Your beliefs become your thoughts

Your thoughts become your words

Your words become your actions

Your actions become your habits

Your habits become your values

Your values become your destiny

Mahatma Gandhi (Lipton 2005:114)

When considering the quantum world, I need to remember that my presence and expectations alter what I see since I cannot isolate myself from a situation in which I find myself. This is because the universe from a quantum perspective is an integration of interdependent energy fields that are entangled in a meshwork of interactions. The flow of information is holistic. Thus the cellular constituents, proteins and neuropeptides are woven into a complex web of crosstalk, feedback and communication loops throughout the body (Lipton 2005:73).

What have I learnt about the value of energy in learning?

Jousse provides us with the theory of visceral intussusception to describe the ability humans have to learn-

> "**Intussusception** is the grasping of the external world (suscipere) and the internalising thereof (intus), i.e. the synchronising of all the gestes that flow from nature into man, so that he can then express them. I use the term, 'gestes', but I should say 'actions' because outside of us they are only actions which take place. But within the man who receives them and re-plays them, these actions will become 'gestes'" (Jousse 2000:576).

I am only able to know what I have intussuscepted. I cannot know what someone else has intussuscepted, as each person intussuscepts differently. Furthermore, through intussusception, "our learning, understanding, memory, thinking and feeling –mind- are operations of the whole human being, rather than of the brain only" (Conolly 2001:119). Pert asserts confidently at a recorded lecture in 2000, *Your Body is Your Subconscious Mind,* that 'we think with and feel with our whole indivisible bio-psychological complexus of geste, and that we are indivisibly

resonating to the universe – whether we like it or not (Pert 2000). This 'indivisibility' of the human being, the anthropos, is a position that Jousse adopted as well from his teacher, Professor Pierre Janet who said "We think with our entire body" (Jousse 2000:83).

I understand that my movement or 'geste' is

> action executed as a bio-psychological or psycho-physiological whole in re-action to actions played into him/her by the universe. These gestes can be visible or invisible, macroscopic or microscopic, developed or only hinted at, conscious or unconscious, voluntary or involuntary. (Jousse 2000:60)

my geste, the living energy, is regarded as the 'motricity mechanism' be it visible or invisible, macroscopic or microscopic, developed or only hinted at, conscious or unconscious, voluntary or involuntary (Jousse 2000; Jousse 2004). This 'motricity mechanism' or 'motor response' is the first and foremost e-motion in man, e-merging from the depths of my beings. Jousse reminds me that "memory is only, and can only be, the replaying of macroscopic or microscopic gestes which have previously been embedded in all the diversified fibres of the human organism" (Jousse 2000:26) by the process of intussusception. Memory is thus driven by motor-e(x)motion responses into consciousness throughout "all the diversified fibres of the human organism" (Jousse 2000:26) which constitute the whole of man. Jousse thus concludes

> Memory constitutes man as a whole, and the whole of man is embedded in his Memory(Jousse 2000:258)

Conolly (2001:126) elaborates on the geste as being the "emotive-thoughts" and "thoughtfilled-feelings" of indivisible human thought and emotion. Furthermore, the geste operates both microscopically and macroscopically as a complexus of rhythmo-mimisms "received, registered and replayed" in interaction with the universe of the anthropos or whole being (Conolly 2001:126). Conolly provides an explanation of what Jousse termed the microscopic and macroscopic gestes:

> The inner and hidden gestes are referred to as **microscopic**, and the visible outer gestes are referred to as **macroscopic**. In other terms, the

> **microscopic** gestes are the inner vibrations of rhythmic motor energy - our thoughts and emotions - and the **macroscopic** gestes are the visible and audible - and other - manifestations of human expression, such as movement, dance and mime, sound, speech and song, writing, sculpting, painting and so on.(emphasis in original) (Conolly 2001:194).

Hence all my neurotransmitters inclusive of the molecules of emotion as described by Pert (1999) are microscopic gestes. The inner microscopic activity is either psycho-physiological or bio-psychological, what I have identified as the biochemical processes identified by Candace Pert (1999) and Michael Gershon (1998). The inner activity is what is *im*-pressed as reality in a child who receives it into her viscera, into her being and into her memory and then registers it, and then re-plays it. The macroscopic geste is the "observable expression of the inner activity" (Jousse 2004:36).

Jousse (2000) reminds me that the energy within each of my tissues is stored in a potential state in the form of chemical compounds. This highlights for me the particle –wave duality that exists in our human bodies. In my living body, the chemical compounds in turn transform into mechanical energy, heat, electricity in the muscles and into nervous energy in the nervous system. This transformation is occurring everywhere in my body and is ongoing which is evident as movement.

Dynamogenesis – release of energy- is the process that occurs as humans respond to internal and external stimuli. Stimuli arise continuously from the internal components of the body such as the muscles, vessels, glands, viscera as well as from the exterior through the skin, eyes, ears, noses and taste buds. As my body experiences dynamogenesis, its vital and intellectual capacity is enhanced. I experience this enhancement as pleasure. Pleasure is the consciousness of dynamogenesis. This release of energy, dynamogenesis, involves thought which is the bringing –into-consciousness, and the memory which is the re-play of consciousness. Both my thought and memory pulse and respond to the Rhythm of my Body. my body is in collective and continuous rhythm in the way that my heart-beats, rhythm in the way I breathe, rhythm in the balancing of my hands, rhythm in the footsteps I take. All this rhythm is organic and dependant upon the part of my

body that is used to express the intussuscepted, intelligised and globally re-played Cosmos.(Jousse 2000:175). Thus what I feel, act and know becomes visibly expressed and known as I interact with others and the cosmos.

According to Jousse, "In the universe everything interacts. There is universal interaction (Jousse 2000:62).

Every word I speak and every gesture that I make resonates through the universe for all time. Jousse observed that all elements of the universe interact following the Law of Interaction in ever interacting phases. The 'universal interaction' is triphasic and Jousse has formulated it as the Law of Interaction – "*an Acting one' – 'acting on' – 'an Acted upon*'" (Jousse 2000:111). An '*Acting one'* and an '*Acted upon*' are clusters of energy that are dynamically propelling gestes – streams of subtle energy. The interactions are indefinite, occurring with a degree of multiplicity as the *'Acted upon'* registers and replays the action on other 'action-beings'. The *'Acted upon'* is unconscious of the multiple, complexus interactions played by the *'Acting one*.' An '*Acting One'* and '*Acted upon'* are seen and mimed as a geste which is 'in essence' the reality itself – the *Essential* Action. The human has not only the one essential geste which has been 'expressed' within her /him, but rather many, which are considered her/his potential. The '*Acting one'* and the '*Acted upon'* act on each other through multiple *Transitory* Actions which are continuous and diverse.

Each interaction energises the following geste, in(de)finitely, in self-energising patterns of movement. As a dynamic living, breathing being, I am never motionless as all my involuntary processes move – cardiovascular, digestive – my gestes continue to move so my thought-filled feelings and my feeling-filled thoughts cannot stop.

Through intussusception, an 'Acted upon'

> *replays* the phases of each of the interactions of the universe mimically through the gestes of his[sic] whole body (…) What is created physically and

> unconsciously in the universe is psycho-physiologically and consciously re-created in and through [the Acted upon] (Jousse 2000: 91).

Furthermore, Jousse observed that humans interact with each other and the world around them in a process of interaction which he called the Law of Mimism as "a process of dynamic imitation so that "everything that is re-played through us, is within us" (Jousse 2000: 25).

These two processes of interaction and dynamic imitation in- and trans-form my human understanding of ourselves and the world in which I live, viscerally, in "intuition" which rises from within the viscera into 'intelligent consciousness'. Jousse notes that what is played into - in+pressed into - the anthropos is automatically in the memory. Even when 're-played' in 'ex-pression', it leaves its 'im-pression' in the molecules of the viscera. As the **'**mimorisation' is repeated into the 'memorisation'**,** it rises into consciousness constituting learning and understanding and our knowledge - 'what I know'.

I am fascinated how Conolly (2001) shows that Jousse is able to link memory, learning, the heart and the whole being:

> Learning in the '**memory-heart''**, viz. 'memorising' is central to Jousse's thesis of learning and understanding. 'Mimorisation is memorisation' he says, meaning that anything that has been 'mimismed' - im-pressed by the universe - is automatically embedded in the viscera, and is therefore learned, and therefore known, and therefore potentially understood. But it must be remembered that 'mimisming' implies, simultaneously the fulfilment of all the principles of the Anthropology of Geste and Rhythm, viz.: a 'mirroring of meaning' and rhythming in a balanced and formulaic format AND repeated re-impression in order that it rise into consciousness.

The mnemonic oral-style (Jousse, 2010, Sienaert, 1990; Conolly, 2001) is not 'rote learning', even though it might appear so. The distinguishing differences between oral-style mnemonic memorisation and rote-learning memorisation is that the former is (in)formed by corporeal-manual performed texts, and the latter either memorised from scribal alphabetic texts or simply imitated with little or no context, application and/or exemplification. The oral-style mnemonic text is always performed in context

and with examples to which the learner can relate because they are part of the learners' reality, while the rote-learning text is "meaningless words repeated without understanding or reference, and therefore have no potential for application, analysis, synthesis or evaluation unless the meaning can be resuscitated in some way" (Jousse 2004:145).

Jousse, using Jesus as a teacher role model says

> Jesus was in essence a teacher who wanted adults to be taught as children are taught, which is why he uttered the famous maxim that is hardly ever properly understood : *unless you become like a small child, and memorize your lessons, you cannot enter into my divine teachings* (Jousse 2004:110).

A small child is a dynamic, living being. As a small child I am able to learn as I "be myself … draw from [myself] the maximum of [myself]" (Jousse 2004:114). In becoming like a small child, I believe that I need to become aware of what I am as I engage with life, through play. A child spontaneously plays all of her experiences. She learns as she pays attention to, sees and observes things as oriented by the teacher. Her curiosity is conserved as she observes things and becomes conscious of everything that she mimes[4]. Jousse observed children to understand more about play and he concluded that:

> *Play* consists of taking in the interactions of the universe and in replaying them. *Play* is, in and of itself, thought, expression, language. Human expression is nothing more than *Play…* the human child [is] immediately i(n)mpressed by the gestes of moving things and will mime the gestes of these things, and it will do so in an *interactional* fashion (Jousse 2004:118).

Jousse reminds us that

[4] Mimism is the process of miming and the Mimeme is a "unit of selected voluntarily and involuntarily, balanced rhythmic formulaic expression synchronous with the universe" Conolly, J. 2001. An Annotated and Glossed English Translation of Memory, Memorisation and Memorisers in Ancient Galilee by Marcel Jousse: A Study of the Origin, Nature, Analysis and Recording of Mnemonic Rhythmo-stylistic Texts. PhD, University of Natal. ..

> [I] think with, and feel with, [my] whole indivisible psycho-physiological complexus of geste, which resonates indivisibly with the universe, whether [I] am aware of it or not" (Jousse 2004:154).

This awareness is expressed in our emotions, beliefs and expectations and influences how we respond to and experience our world. Pert's scientific findings also show that emotions are molecular in the body and the "body is hardwired for pleasure" (Pert 2000).

So then what is the role of the head brain in memory? Pierre Janet as cited by Jousse has the following to say:

> In no way is it the organ of action. Action does not depend on the brain; it is not performed by it. There was a time when the brain was said to secrete thought as the liver secretes bile. That is childish. A brain separated from a living being is incapable of thought or of action. The brain is one of the elements of the extremely complex circuit that we call action; when the brain is separated from the muscle, there is no longer action. Action is dependent on both brain and muscle. In reality, man thinks with his whole body; he thinks with his hands, his feet, his ears, as well as with his brain. It is absolutely ridiculous to claim that his thought depends on a part of himself: it is tantamount to saying that our manual ability depends on our fingernails.
>
> Psychological activity is an activity of the whole - it is not a localized activity. The brain is quite simply a conglomerate of switches ... It is not the brain that determines psychological activity; it only regulates it. (Jousse 2000:73)

I have come to realise that I as a human being think and feel indivisibly with my whole body and being through the "complexus of gestes" (Jousse 2000:60). My gestes can change from deep unconsciousness to full consciousness or from purely automatic reflex action to totally voluntary activity depending on the emphasis placed on them by the organs that emit them. Thus an ocular geste makes me see, whilst an auricular geste, makes me hear. There are innumerable gestes being played and re-played in me at any one time. This led Jousse to seek an answer to the question:

> How does the composite human being, situated at the very core of the universe's perpetual motion, react to this activity and manage to hold it in his memory? (Jousse 2000:60)

Jousse found the answer after years of observation of the human expression - both oralate and literate - of the whole being of people from all over the planet, from many different linguistic groups, cultures, and spiritual and religious beliefs. He formulated the psycho-physiological laws of human expression and memorisation.

What have I learnt about human expression and communication?

Jousse (2005) observed that humans ex-press (press out) their human inner reality - microscopic gestes - in different forms of external ex-pression - macroscopic gestes. He observed that human expression began in a new born infant at the level of 'whole body' which he called "corporeal-manual" (Jousse 2000) expression that involves use of the whole body and hands. Using "corporeal-manual" (ibid) expression, the human being expresses all states of consciousness, the emotional, the intellectual and motor, primarily through the movement of the body and the hands. The human being never loses this capacity. But human expression occurring through the "corporeal-manual" (ibid) only is limiting. It can only be used in daylight and other artificial sources of light, and in face-to-face interactions, and they cannot ex-press themselves corporeally-manually with something in their arms.

Hence an evolutionary and developmental drive takes place which localizes their expression in the larynx and the lips called "laryngo-buccal" (ibid) expression, not to the exclusion of the "corporeal-manual" (ibid), but to enhance it. In both evolutionary and developmental terms this takes place quickly and naturally. Babies are born expressing themselves corporeally-manually in physical and vocal movement and by the age of six to eight months they have discovered their lips to shape what is coming from their larynxes, and by the time they are one year old, they are using single words and have connected statements by the age of three. When the child goes to school - if he or she is that fortunate – the child learns the code known as scribal alphabetic writing. In evolutionary terms, the same pattern of development is evident: corporeal-manual ex-pression is enhanced by laryngo-buccal ex-pression, and scribal alphabetic writing comes much later, actually only 6000 years ago, which is recent, given the age of the human species.

These three categories of human expression – corporeal-manual, laryngo-buccal and written style – show distinct differences. The whole body is active in the first two categories, viz. the corporeal-manual and laryngo-buccal expression, and there is an immediate and direct interface with the inner geste. The law of memory states that:

> The greater the number of motor elements a psychophysiological state engages, the greater the ease with which it will be revisited and relived (Jousse 2005:62)

But the third category of mimographism which develops into scribal alphabetic writing requires mediation through an extra-biological tool of some kind.

So I understand that the written style is mediated with a tool. The living expressive geste from Corporeal-manual style man is called Mimodrama, the laryngo-buccal gestes are Oral style and the algebrised or reduced form of Oral Styles produces the written style which is Mimographic from drawing or alphabetic scribal writing (Jousse 2000). Thus learning that relies on the human expression using only scribal alphabetic writing is not as active, as learning that includes all of the corporeal-manual and the laryngo-buccal forms of human expression and scribal alphabetic mode. The longevity and success of the oral tradition using the mnemonic oral style from all over the globe furthermore indicates to us that human learning can be effective and efficient without scribal alphabetic writing. This is not to say that scribal alphabetic writing has not added significantly to human development, but written texts in and of themselves are inert and do not present the vitality and energy of the living human being unless they are “reintegrated into the living musculature” (Jousse 2000:272). Jousse used the term ‘algebrisation’ to describe the mediated form of expression such as scribal alphabetic writing. The algebrisation “removes and dislocates us from the gestually balanced, rhythmed, concrete Mimodramas of those…who remain spontaneous” (Jousse 2000:76). Scribal alphabetic writing as a form of mediated expression is a reduced means of recording the socio-cultural archive.

I have come to realise that nothing is ever written in a book which is not first recorded in living memory, but also very often because it is written in a book, I don't always try to remember. I have also come to realise that when the recording is in the form of scribal alphabetic writing then the tonal and gestual features are lost and the expression is potentially inert and dead, missing the corporeal-manual/laryngo-buccal elements of expression.

Jousse stated that

> Corporeal-manual Style man is able to embed the countless actions and interactions of the universe in *his entire* acting, sensing and knowing *being*. This he does both for himself and for others: for himself a summarised microscopic gesticulation which still allows him to grasp with full consciousness and to trace with clarity each of the phases of the Propositional Geste will suffice, while for others he lets his corporeal and manual Mimemes irradiate macroscopically with all the amplitude needed to make them easily recognizable and understood (Jousse 2000:73).

Corporeal-manual Style man, who is spontaneous, has mirrored/imitated the many balanced rhythmic formulas of the universe - that is, mimed - and has the potential to mirror them synchronously, voluntarily and involuntarily. That in me which is oralate – my residual corporeal-manual/ laryngo-bucccal oral-style self - enables me to balance the expression of rhythmic formulas by activating the bilateralising and balancing conformity of my body that exists within me - left to right, top to bottom and back to front. The balanced expressions also "play in alternating pulsations of tension and relaxation, facilitating successive and rhythmic energetic explosions" (Jousse 2000:238). My life is driven by biological rhythms that are infinitely supple.

> Our bodies pulse successively and we are therefore rhythmed. Our bodies create the universal and perpetual flow of Rhythmism. *Panta reî*, said Heraclitus. We cannot stop: that is the great ironic tragedy. We are never motionless. Around us, over us, in us, everything flows. Our hearts continue their beating and our blood flows, our breathing functions, our gestes, which have been labelled 'images', continue to flow. Everything flows within us, in spite of us. We cannot stop our thoughts, not even for one second. We try to fix our attention. 'A thought passes by', and immediately another fills the space. All things flow and we flow with them (Jousse 2000:238).

Communities engage in rituals as a significant activity to focus on a common purpose, at a common time and in a common way. Rituals are intrinsically rhythmic hence they can be aligned with natural rhythms. Thus rituals in the classroom are

powerful for preserving and enhancing harmonious rhythms. Rhythmic patterns of activity and rest, depicted in oscillation, allow for full engagement. Human capacity for full engagement is driven by the rhythmic patterns of high performance and personal renewal. Each human life moves, oscillates, vibrates and pulsates through seasonal flows or regular cycles. As the humans interact, so too do their energies oscillate, vibrate and pulsate in a wave-like manner thus either enhancing the intensity of the interaction or diminishing the intensity depending on their wavelengths and frequency of the energy-waves.

How do I relate the science of learning to what happens in the classrooms?

Thus I understand that in a learning situation where the teacher and the learner are interacting in a classroom, each of them (as particles) stay somewhat separate and maintain some of their original identities, while their energies (wave aspects) merge that gives rise to a new system that enfolds them. The teacher and the learner relate internally, they get inside each other and evolve together, with a new identity, not reducible to the sum of their parts. The interaction in the learning environment is not linear, but rather holistic in nature with lots of crosstalk, feedback and communication loops not just in one linear direction, and signals of different kinds, all of which are energised in multiple ways. The expressions of the memorization and mimorisation are visible in the macroscopic gestes of the teacher and the learner. I believe that the learning environment thus needs to be a 'safe space' where all these interactions result in active learning through a biochemical change experienced within the whole being of the learner.

From this point on in my account, I will be using *whole-being-learning* when I am referring to an understanding of learning as a biochemical process. The biochemical process is the inner microscopic activity of the neuropeptides and their receptors, molecules of emotion, as identified by Candace Pert (1999). These molecules of emotion are found throughout the whole being and not just localized in the head-brain, inclusive of the gut-brain as identified by Michael Gershon (1998). The biochemical change is inclusive of the myelin growth that occurs across the neuronal

circuits (Fields 2005; Fields 2008a; Fields 2008b). The inner microscopic activity is what is *im*-pressed as reality in a learner who receives it through her/his nine senses (Robinson and Aronica 2009), into her/his viscera, into her memory and into her/his whole being, then registers it, and then re-plays it. The macroscopic geste is the "observable expression of the inner activity" (Jousse 2004:36) in the learners.

Conclusion

In this chapter I have provided an account of the biochemistry, neuroscience, my understanding of learning as a biochemical process. In the following chapters, I will provide evidence of how the macroscopic gestes explained in this chapter can be recognized in learning teaching and assessment environments.