Système Rolando Toro Araneda

NEUROPLASTICITY AND BIODANZA

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INTRODUCTION

I went looking for Biodanza, I didn't just stumble upon it. I had been working successfully with clients integrating of a number of seemingly disparate modalities in body mind work which focused on alleviation of pain, postural realignment, reestablishing the body mind connection and learning how to harness it in daily life, re-balancing and regaining equilibrium of body, mind and spirit, developing skills to become an active participant in one's own health and wellbeing, and general strengthening and fitness. These modalities included awareness based physical training in the form of Pilates and Shiatsu meridian exercises, somatic awareness based meditation techniques, Reiki energy healing and spiritual coaching. At some point I studied Group Therapy and started designing a group process which would include the principles of what I had learnt and my own work. This is when I found Biodanza.

I was already convinced that the key to transformation, growth and well-being lay in mindful physical activity which enhances balance, flow, fluidity, strength, flexibility and voluntary motor coordination. I had experienced my own miracle of neuroplasticity in a personal triumph over a severe back injury and multiple surgeries, not that I was familiar with the concept back then. I had also been experimenting with music and dance in my groups and was eager to find a system which approached dance not as a performance medium, neither as a method of expression or emotional release, but rather as a medium for personal exploration and development.

Biodanza synthesized and organized my intuitive, yet apparently disconnected methods. My response and excitement to the system, its theoretical underpinning, its approach, its integration of body-mind-spirit and the genius concept of the Vivencia was immediate. I felt I had come home. Biodanza incorporated all the principles and paradigms I had been developing in my own work and I was fascinated. It spurred me on to look even harder for reasons as to why Biodanza was so effective so I was not surprised to find when reading about neuroplasticity how many of the conditions required for enhancing neuroplastic growth and change were to be found in the Biodanza system. The more I read the more I understood that this cutting edge medical scientific concept and its related research was on many levels and in numerous ways able to explain not only the overall effectiveness of the Biodanza system, but the scientific basis for the effectivity of many of its essential features.

This paper seeks to show how recent research on neuroplasticity offers physiological explanations as to why many particular aspects of the Biodanza system promotes transformation and growth, and how as a whole it is an ingenious paradigm for the general promotion of neuroplasticity, which is ultimately the realization of our human potentials just as Rolando Toro thought.

1. NEUROPLASTICITY: WHAT IS IT?

For 400 years it's been generally thought that the brain is a physiologically static organ that after about the age of 5 was incapable of change or healing if injured. It was thought that the brain, unlike all other body organs, lacked the facility of repairing itself or restoring lost function. Today we understand that this is not true. In one of the most important breakthroughs in understanding the brain and its relationship to the mind since the beginning of modern science, it has been discovered that the brain is neuroplastic. Neuro - for neurons, and plastic – for its ability to reform and remold itself. "It has a property called neuroplasticity which enables it to change its own structure and functioning in response to activity and mental experience." (N.Doidge, M.D.) Neuroplasticity is an umbrella term that refers to changes in neural pathways and synapses due to changes in behavior, environment, neural processes, thinking, and emotions, as well as from bodily injury.

Another aspect of the now defunct understanding of the human brain was of the brain as imperial master of the body. It was a long held view that the brain was solely responsible for initiation and performance of all human functions, and that the body was a mere appendage to it. The brain was considered isolated from the body and confined to the head. This view has been thwarted by neuroplasticity which shows that not only does the brain send signals to the body to influence it; the body sends signals to the brain to affect it as well, and there is a constant two-way communication between body and brain. The brain is always linked to the body and through the senses, to the outside world. Of course the Buddha knew this, and all Eastern medicine modalities are predicated on this concept.

History of Development of Neuroplasticity

1890 first mentioned by Willian James in *The Principles of Psychology* where he wrote that "organic matter, especially nervous tissue, seems endowed with a very extraordinary degree of plasticity."

1923 Karl Lashley conducted experiments demonstrating changes in neural pathways and claiming this was due to plasticity.

1949 Donald Hebb at McGill University in Canada demonstrated in experiments that if the axon of one cell was close enough to another cell it could excite it, and furthermore that with repetition there would be some kind of structural or chemical change in one or both cells which would greatly increase the efficacy of the first cell. more efficient in stimulating the other. Later, it was demonstrated that environmental stimulation induces changes in the connections established by the neurons that can lead to the creation of the new synapses, which means we can enrich neural activity providing plasticity to the cerebral functioning. Variations in the biochemical parameters, arborization, gliogenesis, neurogenesis, memory and enhanced learning have been demonstrated.

By the 1960's neuroplasticity was a popular and exciting field of research which drew notable scientists such as Paul Bach-y-Rita, Michael Merzinich and Jon Kaas. Bach-y-Rita's work proved the physiology of a long witnessed phenomenon that when one of a person's senses is damaged or lost, others will develop extraordinary powers to compensate for the loss, by expansion and development of the healthy areas of brain function. So blind people will have extremely well developed hearing and touch, and deaf people will have phenomenal sight and reception of vibrational stimulus.

How does it work?

The brain actually changes is structure with each different activity it performs. Neuroscientific research shows that experience can actually change both the brain's physical structure (anatomy) and functional organization (physiology). Moreover with repetition and practice the brain perfects its circuits so it

becomes better and better at the given task, until it becomes automatic and requires less focused attention to achieve. If parts of the brain fail for any reason, other parts of the brain can sometimes take over that part's function, and with repetition perfect it. That dead brain cells can even sometimes be replaced, that many circuits and basic reflexes that we thought were hardwired are simply not. It's even been established that thinking, learning and acting can turn our genes on or off, thus shaping our brain anatomy and our behavior. (N.Doidge, M.D. *The Brain that Changes Itself)*

Eric Kandel got the Nobel Prize in Physiology or Medicine in 2000 for showing that the brain changes as it works, that as learning occurs, the connections among nerve cells increase. Kandel also proved that learning can "switch on" genes that change neural structure. It has since been demonstrated in many scientific studies that mental activity is not only a product of the brain but also a shaper of it. The brain has a unique and exquisite capacity to heal itself by continuously forming and re-forming new neural connections in the here and now, moment by moment in response to outside and inside stimuli.

Gopnick et al. describe neurons as growing telephone wires that communicate with one another. Following birth, the brain of a newborn is flooded with information from the baby's sense organs. This sensory information must somehow make it back to the brain where it can be processed. To do so, nerve cells must make connections with one another, transmitting the impulses to the brain. Continuing with the telephone wire analogy, like the basic telephone trunk lines strung between cities, the newborn's genes instruct the "pathway" to the correct area of the brain from a particular nerve cell. The basic trunk lines have been established, but the specific connections from one house to another require additional signals. Over the first few years of life, the brain grows rapidly. As each neuron matures, it sends out multiple branches (axons, which send information out, and dendrites, which take in information), increasing the number of synaptic contacts and laying the specific connections from house to house, or in the case of the brain, from neuron to neuron. At birth, each neuron in the cerebral cortex has approximately 2,500 synapses. By the time an infant is two or three years old, the number of synapses is approximately 15,000 synapses

per neuron (Gopnick, et al., 1999). This amount is about twice that of the average adult brain. As we age, old connections are deleted through a process called synaptic pruning. Synaptic pruning eliminates weaker synaptic contacts while stronger connections are kept and strengthened. Experience determines which connections will be strengthened and which will be pruned; connections that have been activated most frequently are preserved. Neurons must have a purpose to survive. Without a purpose, neurons die through a process called apoptosis in which neurons that do not receive or transmit information become damaged and die. Ineffective or weak connections are "pruned" in much the same way a gardener would prune a tree or bush, giving the plant the desired shape. It is plasticity that enables the process of developing and pruning connections, allowing the brain to adapt itself to its environment. This was Hebb's contribution. His concept is captured in the aphorism, "neurons that fire together, wire together"/"neurons that fire apart, wire apart," summarizing Hebbian theory. So rewiring involves the changes that occur at the synapse, increasing and strengthening, or decreasing and weakening the number of connections between the neurons.

Learning, as defined by Tortora and Grabowski, is the ability to acquire new knowledge or skills through instruction or experience. Memory is the process by which that knowledge is retained over time. So how does the brain change with learning?

According to Durbach (2000), there appear to be at least two types of modifications that occur in the brain with learning:

1. A change in the internal structure of the neurons, the most notable being in the area of synapses.
2. An increase in the number of synapses between neurons.

Initially, newly learned data are "stored" in short-term memory, which is a temporary ability to recall a few pieces of information. Some evidence supports the concept that short-term memory depends upon electrical and chemical events in the brain as opposed to structural changes such as the formation of new synapses. After a period of time, information may be moved into a more permanent type of memory, long-term memory, which is the result of anatomical or biochemical changes that occur in the brain (ibid, Tortora and Grabowski,1996).

In studies involving rats in which one area of the brain was damaged, brain cells surrounding the damaged area underwent changes in their function and shape that allowed them to take on the functions of the damaged cells. Although this phenomenon has not been widely studied in humans, data indicate that similar (though less effective) changes occur in human brains following injury.

2. THE IMPLICATIONS OF NEUROPLASTICITY

The implications are nothing short of revolutionary. It means that the architecture of each person's brain is entirely unique, and that each of our brains change continually within the course of our lives until our deaths. It also means that what we do, think, experience and feel in our daily lives has a physiological effect on our brains and therefore our minds and psyches, and that this effect can be quantified and qualified with scientific observation and diagnostic tools. It is important to understand that neuroplasticity has an upside and a downside. It works in both directions. While learning, training, positive loving experiences and enriched environments can have a positive effect on our brains by promoting expansion and proliferation of neural circuits, negative experiences, lack of activity and deprived environments can cause the opposite effect, of shutting down and reduction of established neural pathways and functioning. Neuroplasticity means our brains are vulnerable to all outside influences, negative and positive. Our brains respond to one with expanded and increased flexibility, and to the other with rigid behaviors. N. Doidge calls this the "plastic paradox" saying "ironically some of our most stubborn habits and disorders are products of our plasticity." (ibid, The Brain that Changes Itself) Once a plastic change occurs in the brain and becomes well established, it can actually prevent other changes from happening. Rolando Toro's concept of positive and negative eco-factors and his application of them to activate the person's own healing/ self-regulation capabilities fit perfectly within the neuroplasticity paradigm and as I will show, offer creative, innovative and ahead of his time solutions to common human conditions and the quest for personal growth and healing.

It also means that a bridge has been formed between humanity's two great opposing medical traditions, east and west. Interventions in western medicine spawned by neuroplastic principles include using energy, in the form of light, sound, vibration, electricity, touch, awareness and motion to effect brain function. "These forms of energy provide natural noninvasive avenues into the brain that pass through our senses and our bodies to awaken the brain's own healing capacities. Each of the senses translates one of the many forms

of energy around us into the electrical signals that the brain uses to operate. It is recognized that these techniques stimulate and reawaken dormant brain circuits. Among the most effective ways to do so is by using thought itself to stimulate brain circuits, which is why most of the interventions pair mental awareness and activity with the use of energy." (ibid, Doidge *The Brain's Way of Healing*) This coupling and use of energy and the mind to heal has long been central to traditional Eastern medicine, while relatively new to Western medicine. It challenges yet another entrenched yet erroneous view of the west that places the patient in a passive role of recipient of medical care, with no ability to understand or contribute to their healing process, silent by-stander to the battle being fought between the doctor and their disease. Interventions spawned by neuroplasticity require the active involvement of the patient in his or her own care; body, mind and brain. It takes western medicine back to its Hippocratic roots whereby the body was viewed as a supreme healer, and the doctor and patient working together with nature to activate the body's own healing capacities. Neuroplasticity encourages the physician not to focus only on the patient's deficits/diseases, but to actively search for healthy but dormant brain areas, and for existing capacities that may aid recovery. Rolando Toro's theoretical Biodanza framework is predicated on this same notion.

3. NEUROPLASTICITY AND THE VIVENCIA

Cellular problems that are based on too much inflammation or toxins or maybe some genetically induced cellular abnormalities, give rise to wiring problems. And when the brain has wiring difficulties, the circuits don't work and they go dormant. It's not just the case that the brain cells are dead or that they are not firing at all, often the problem is that they are firing but at irregular rates or at the wrong rate. And when that is happening they can't perform their function and they go dormant. This is called the noisy brain. Some kind of stimulation is needed to pull them out of that dormancy. Effective stimulation includes walking and exercise generally, music, vibrations, sensory somatic sensations, interaction and the other energetic principles mentioned in the section one. All of which, quite incredibly, are to be found in the experience of the Vivencia.

And if the stimulation works properly, then the brain gets modulated. This is called neuro-modulation, and lots of systems that weren't working well suddenly start to work together, and there's a balance of excitation and inhibition. An example might be think of people with traumatic brain injury. There are certain things they can't do anymore, and that's because circuits are dormant, but there are other circuits that seem to be hyperactive. So they are very, very sensitive to sounds and light and so on. That all has to be rebalanced. And then the brain goes through a period of rest and then it goes through learning. N. Doidge (interview with ABC Radio: All in the Mind). As the effects become permanent brain maps contract in size and neural networks become more efficient.

Neuro-modulation appears to find its theoretical parallel in the traditional vivencial curve, of activation-regression-activation. The horizontal axis of the theoretical model of development in Biodanza postulates that homeostasis on the physical and emotional levels are achieved through a pulsation from activated to regressive states of being. Integration, or learning comes after, outside the vivencia and in the sharing the next week. What is important in

fostering neuroplastic growth is the pulsation between action and rest, as the flow of neuroplastic changes in the brain involves learning, resting and then integrating new skills and concepts.

It is known that neuroplastic states can be deliberately and carefully directed. Conditions for neuroplasticity occurring include attention, intensity, duration, constraint and immersion, imitation and visualization. We have seen that neurons that fire together wire together so being aware of what you are thinking and feeling is the first step. Then conscious and focused attention creates structural change. Furthermore the more intense the experience, the greater its ability to readjust the neural network. This is very significant for Biodanza. The Vivencia, the central operating framework of Biodanza, is defined by Rolando Toro as "an experience lived with great intensity in the here and now, the intense sensation of being alive." He believed that when people are intensely present in the moment and exposed to positive eco-facors and opportunities to express and expand their innate human potentials, they can achieve true transformation. Here he has scientific, physiological proof for his paradigm.

For lasting structural changes to occur the experience must also be repeated for several months. The old adage "practice makes perfect" can now be understood as the mechanism by which the brain achieves neuroplastic change and growth. This repetition is built into the Biodanza process with exercises being repeated many times in weekly classes and in workshops to reinforce their rehabilitative effect.

The Generative Postures are a perfect example of how Biodanza combines all the conditions necessary for neuroplastic change to occur. The physical posture with its archetypal force, evokes in our beings the experience of the posture's purport. Furthermore we are getting into the posture with focused attention and intention. Reinforcing this posture is a cognitive explanation which gives context, meaning and clear goals. The Generative Postures are danced vivencially, just holding the posture and also taken into creative dances of exploration and self-expression. It is clear how just one exercise includes all the necessary conditions for neuroplastic growth and change.

Neuroplasticity and specifically “rewiring” occurs through some struggle – where the weaker circuits in the brain must be used instead of the stronger ones – this is termed "Constraint". This means that to create new circuits is to immerse yourself in new and unfamiliar cognitive or motor patterns, known as "Immersion". This dissonance is at the heart of neuroplasticity. The Biodanza process as a progressively deepening process, involves continually adding increased challenges through the exercises, so that dancers are always being challenged to broaden their range and quality of movement and their ability to establish intimate, open communication with others, through non-verbal means. Dancers are also being challenged to grow and develop emotionally and spiritually through dances in the lines of Affectivity and Transcendence.

Visualizing an activity is known to actually activate the same areas of the brain as actually doing the activity. Skills can improve and strengthen only through visualization. Paralyzed stroke patients have restored movement through visualization of the paralyzed limb moving. If we were to sit and watch dancers, our brain would send messages to our muscles as if we were dancing (even if we never move – like a mental audition). As we dance in Biodanza our brains are in active stimulation mode – fully activated by the music, sending neural messages to our muscles to respond to make the simple move, testing/playing with mobility, and, perhaps even processing visual clues from other dancers on potential ways to explore the use of our own body. We also play with imitation of other's movements in mirror games, and often exercises will require pairs to watch each other dance.

Factors that enhance neuroplasticity and learning are all present in the Vivencia. Attentional mindset, being present and attentive is an essential part of the vivencial experience and the first skill taught in the Biodanza environment. Low to moderate stress, enough for there to be challenge but not too much so that the stress factor cancels out the positive effects of the learning. The bottom line is that the person must perceive some choice or control over the task and the surrounding conditions. This condition is echoed in the concept of self-regulation which is a fundamental part of the Biodanza paradigm and an essential part of the process for every dancer. Tasks need

to be coherent and meaningful. This is also an essential aspect of the Vivencial paradigm in which each exercise is introduced with an explanation as to how, why and for what purpose we do it. Moreover each vivencia is created within a thematic framework which is explained and discussed with the group prior to the vivencia, further enhancing coherency and meaning for the participant. The demonstration of the dance/exercise by the facilitator is also another important factor in Biodanza which covers the condition of "imitation" in neuroplastic change. The fact that just by watching others dance our brains are firing as if we were dancing ourselves. The brain will create new connections when there's new learning, but these connections must be reinforced and strengthened or they deteriorate. Repetition and practice is the key.

Csikszentmihalyi's (1990) neuroplastic flow of ten discernable qualities includes the ones mentioned above and another three, which are: a loss of the feeling of self-consciousness, the merging of action and awareness, distorted sense of time and direct and immediate feedback. The first three describe the desired state of vivencia which Rolando Toro sought to achieve within the vivencial process. This is exactly what he meant by "an experience lived intensely in the here and now", it is exactly this liberation from self-consciousness and total integration of awareness and somatic sensation which leads to a release of cognitive control which he saw as being such a potentially healing experience. He was right. Toro also seemed to understand the importance of direct and immediate feedback as these concepts are woven into the very fabric of the Biodanza model and find expression in almost every aspect of its practice. In fact Biodanza encourages us to develop and acquire skills which help us communicate our feedback to others, and perceive, receive and integrate their feedback to us. Participants are encouraged to develop non-verbal skills in communicating their needs and desires, putting limits, initiating action and interaction, expressing emotion etc. The uniqueness of the vivencia is that it operates entirely on principles of direct and immediate feedback and in fact seeks to provide a safe, secure space in which all aspects and elements of feedback can be explored, expressed and experienced.

ENRICHED ENVIRONMENTS

The concept of the Enriched Environment and its role in brain development is very prominent in the neuroplasticity paradigm. In a plethora of research initiated by Donald Hebb's discovery that rats raised roaming free in his house as pets performed better on problem-solving tests than rats raised in cages, it has been established that enriched environments, especially but not only in the early childhood years, lead to neuroplastic change.

Adult brain architecture is the result of a complex interaction between genetic developmental programs and experience-driven plasticity processes. A large number of studies demonstrated the existence of time windows in early postnatal life, named critical periods (CPs), during which neural circuits display a heightened sensitivity to acquire instructive and adaptive signals from the external environment. Although there is a decline in intensity with age it has been established that plastic change in the brain as a result of exposure to enriched environments continues throughout our lives.

Progress in understanding the influence of environmental experience on the development, refinement and maintenance of appropriate neural connections has been made possible by paradigms specifically devoted to increasing the quality and intensity of environmental stimulation, such as environmental enrichment (EE). EE is defined as ‘a combination of complex inanimate and social stimulation’. It combines multi-sensory/cognitive stimulation, increased physical activity, enhanced social interactions and encourages natural explorative behaviors.

Environmental enrichment exerts profound effects on the adult central nervous system (CNS). A large number of studies highlighted the fact that EE modifies the behaviour of animals, leading to a sensitive improvement in complex cognitive functions, particularly learning and memory, and positively affecting the animal's emotional and stress reactivity. Rodents living in EE conditions display increased levels of hippocampal long-term potentiation (LTP), a physiological model of synaptic plasticity related to learning and memory. This functional improvement is accompanied by prominent changes

at the anatomical level, with robust increments in cortical thickness and weight and modifications of neuronal morphology, in terms of increased dendritic arborization, number of dendritic spines, synaptic density and post-synaptic thickening, occurring in several regions of the brain, particularly in the occipital cortex and hippocampus. Moreover, exposure to EE increases hippocampal neurogenesis and the integration of newly born cells into functional circuits. At the molecular level, EE causes a significant change in the expression of a large set of genes involved in neuronal structure, excitability, synaptic transmission and plasticity, modulating the synthesis and secretion of neurotrophic factors throughout the brain and affecting the cholinergic, serotoninergic and noradrenergic systems. K.A. Knight

Experiments have been carried out on rodents and other mammals including jerbils, squirrels, rabbits and primates. Despite the large body of evidence with regard to the effects of EE on the adult brain, until recently, the influence of EE on the developmental physiology and plasticity of the CNS has remained only scarcely investigated. In the past few years, this gap has been considerably filled with a series of studies focusing on the visual system as a paradigmatic model.

The most relevant result was the demonstration that EE from birth induces a marked acceleration in the maturation of visual ability. Rearing animals in EE during their early phases of life leads to a functional differentiation showing increased levels of BDNF in the forebrain. Mice raised in EE show increased levels of the BDNF protein in their visual cortex revealing the fact that neurotrophin BDNF is one of the crucial factors that underlie EE effects on neuro-visual maturation. Retina development is also affected by high levels of environmental stimulation. It has been recently reported that DR induces alterations in both the anatomical stratifications of retinal ganglion cells (RGCs) and the visual responsiveness of inner retinal neurons.

Strikingly, the maturation of the nervous system is sensitive to environmental stimulation during prenatal life as well. Research has demonstrated that exposing pregnant female mice to EE (maternal enrichment) profoundly affects the development of the retina in embryos, leading to an acceleration of

structural processes critical for retinal maturation, such as the migration of neural progenitors and the time course of naturally occurring cell death in the Retinal Ganglion Cell layer. The influence of increased maternal stimulation during pregnancy is not only restricted to the visual system. Voluntary wheel running of pregnant mice leads to a twofold increase in hippocampal precursor-cell proliferation in their pups. Maternal physical activity in the form of swimming during pregnancy has also been shown to increase hippocampal BDNF mRNA expression in the offspring leading to improved short-term memory abilities.

Rolando Toro understood that he was creating an Enriched Environment that promoted neuroplasticity when he invented the Vivencia. The combination of music, dance and movement, social interaction, touch and caress and the intensity of the here and now experience of the vivencial paradigm provides all the ingredients necessary to activate neuroplastic change in our brains. The creation of an enriched environment with play (vitality games as an obvious example, but arguably all Biodanza exercises are a type of game) to facilitate the use of all the potentials contained in the space, is pure genius. It provides a non-stressful and structured medium in which people are encouraged to engage in activity which stimulates neuroplastic growth, and thereby transformation and change, almost without them being aware of this happening, and definitely without focused, difficult, anguish producing process oriented work.

4. NEUROPLASTICITY AND MUSIC

> *"Every disease is a musical problem, every cure is a musical solution"*
> ~ Novalis

Links between music and brain structure and function have been postulated for centuries. For example, post mortem examinations of the brains of prominent musicians from the 19th and early 20th centuries revealed purported "abnormalities" that were thought to underlie their extraordinary musical abilities. More recently, researchers have noted that musicians, who acquire complex skills over many years of practice, provide ideal models of brain plasticity. Yet Ramón Y Cajal (1904), a father of modern neuroscience and one of the first to write about neuroplasticity, noticed this same idea over 100 years ago! This idea has now stood the test of time and with the advent of modern neuroimaging techniques, the study of music and brain plasticity has become an established and popular area of research.

Music stimulates multiple parts of your brain at once, both listening to it and even more so playing it. It does a phenomenal job (just on its own) to assist in multi-modal neuroplasticity, which is called meta-plasticity.

Some of the prerequisites for inducing neuroplasticity include repetition, intensity, and complexity of training. Most professional adult musicians have engaged in an enormous amount of practice over many years that is both repetitive and intense to reach a high level of expertise. Producing music is a complex task, requiring finely-tuned motor movements, highly developed sensory abilities (in auditory, visual, tactile, and kinaesthetic modalities), and the integration of motor and sensory information to monitor and correct performance. Even just the exposure to different types of music and the ability to enjoy and relate to a variety of musical genres, move to its rhythm, be moved by its melody, is a complex, metaplastic task requiring extensive neural networks, allowing the integration of information from all sensory domains.

In our brains each sensory modality is processed in specialised primary and secondary areas of the cortex. The motor system also has primary and secondary regions. Additional areas called association cortex play a role in integrating information from different senses and between the senses and the motor system. These cortical regions are connected via a number of white matter tracts, including the superior and inferior longitudinal fasciculi (anterior-posterior connections), the corpus callosum (cross-hemispheric connections), and the corticospinal tract (which carries in formation from the motor region to the spinal cord). Although these connections between regions are not specific to music, they are used extensively to connect the networks for music perception and production. The corpus callosum is of particular importance as it allows communication between the two hemispheres. This is crucial given the brain's contralateral organization, such that the left hemisphere controls motor output for the right side of the body and vice versa. The somatosensory and visual systems, and to a certain extent the auditory system, are also contra laterally organized, with sensory inputs processed on the opposite side of the brain. The processing of sound is fundamental to music processing and occurs first within the ear and the brainstem, and then within the auditory cortex, which is located in the temporal lobes. Sensorimotor functions are essential to music processing and production. The frontal lobes make a diverse contribution to music perception and production. In short, music processing is widely distributed throughout the brain.

Moreover the huge amount of research being done on neuroplasticity and music is showing that structural and functional differences have been found in the brains of musicians and non-musicians that are repetitively exposed to either playing, moving to or listening to music. Neuroplasticity in response to music training has been demonstrated in children, adults, and patients with neurological disorders. The research shows that these brains are better at integrating a whole host of sensory perceptions simultaneously - emotional, sensory, kinesthetic, tactile, auditory and visual. This enhances brain plasticity and learning capacity.

Doidge in *The Brain's Way of Healing* (ibid) writes that sometimes just the rhythm of music is enough to initiate movement in a Parkinson's patient at a

standstill. (experiencing "freezing"). The stimulation the music provides is enough to overcome the inability to initiate responses experienced by Parkinson's sufferers. When people who are listening to music were studied they found that their neurons were firing at the dominant frequency of the music that they were listening to. In an experiment with two Jazz musicians put in a room and hooked up to an EEG, it was found that their brain waves started to synchronize

Biodanza incorporates all these sensory perceptions within the vivencia, encouraging integration through the music, dance and the group, and most importantly achieving this with emphasis on being intensely in the here and now. It is this last point which is so fundamental to the vivencia and also in acquiring neuroplastic benefits. Focusing the mind is the first step to facilitating the neuroplastic state. The vivencia is an immersion in a bath of neuro-plastic positive eco-factors, fostering deep and widespread neural integration by encouraging participants to enter the vivencial state of enhanced attention to sensation and feeling in the here and now.

5. NEUROPLASTICITY AND DANCE

Glial Derived Neurotrophic Growth Factor (GDNF) is a brain growth factor which functions as growth-promoting fertilizer in the brain. GDNF is produced by glial cells, which far outnumber neurons—there are between 10 and 50 times more glia than neurons in the central nervous system of vertebrates. Fifteen percent of our brain cells are neurons the other 85 percent are glial cells. Glial cells are constantly communicating with each other, interacting with neurons and modifying their electrical signals. They also protect the neurons and help them to wire and rewire the brain.

The neuroplastic brain evolved in ambulatory beings who roamed the world always exploring new territories. Our brain evolved to learn. As people have become more immobile and less active they see less, process less new information, and their brains begin to atrophy from lack of stimulation.. Neuroplastic systems require physical movement to generate new cells and nerve growth factor.

As a transformative experience, dance has been linked to health and healing throughout history and across cultures. Shamans use dance and trancelike states to promote healing and recovery. Ancient Greek physicians recognized the importance of dance for improving physical health, promoting academic achievement, and encouraging social interaction. Only recently has science tried to analyze how dance benefits the brain and brings such joy. One theory holds that, like most exercise, dance releases a cascade of feel-good chemicals in the brain. Dancing induces the release of endorphins, the body's natural pain killers that increase pain tolerance and boost mood. Endorphins are responsible for the euphoria experienced during a "runner's high" and have a similar effect on the body during dancing. Dancing also increases the brain levels of serotonin and norepinephrine, two neurotransmitters that smooth out negative emotions. Norepinephrine also helps increase attention and mental focus. In addition, moving to music while we dance activates the

brain’s pleasure circuits. Dancing can even induce the production of GDNF proteins that promote the growth of new neurons in the brain. Dancing also helps lay down new synapses, or connections, between neurons, called re-wiring. Both processes can increase neuroplasticity, or the ability of the brain to change and adapt to new environments, behaviors, and even recover from injury.

Dancing activates both sides of the brain, a process that promotes brain integration and improves learning. Many regions of the brain are required to remember, plan, and produce the coordinated movements that enable us to dance to music and rhythm. The cerebral cortex, the largest area of the brain, makes us human: it enables us to experience emotions, plan our movements and behavior, and engage in complex thinking. A region of the cerebral cortex called the motor cortex plays a major role in planning, control, and execution of voluntary movement. The motor cortex has at least five areas that are important for dancers. The posterior parietal cortex interprets and helps plan movements in response to multiple sensory inputs, like vision and hearing. The premotor cortex integrates sensory and spatial input to plan and guide movement. The supplementary motor area plans complex movements, especially sequential movement and coordination of both sides of the body. The premotor and supplementary motor cortex communicate with the primary motor cortex, which in turn produces nerve signals that travel down the spinal cord and tell the muscles how to execute movement.

The basal ganglia are two areas that lie below the motor cortex in the brain and play important roles in regulation and relay of information necessary for voluntary movement. In 1957 Arvid Carlsson (Nobel laureate) discovered that dopamine was one of the brain chemicals used to send signals between neurons. He then discovered that about 80 percent of our brain's dopamine is concentrated in the part of the brain that contains the substantia nigra, the basal ganglia. Dopamine among others things helps to consolidate neuroplastic change. Low dopamine levels can give rise to diseases such as Parkinsons and Huntington's.

The basal ganglia also play a role in cognitive and emotional functions. The basal ganglia are also part of the limbic system, which contains the brain's pleasure center. An area of the basal ganglia called the thalamus is a somatosensory relay center that contains neurons directly connected to the hippocampus, which can turn on the brain's pleasure center. The hippocampus also plays an important role in memory and spatial navigation. Two other areas of the basal ganglia called the caudate and putamen are important for learning, memory, and regulating movements.

Studies have found that dance develops areas of the brain involved in motor control, spatial imagery processing, sensory integration, memory, mental focus, and cognition. Dancing gives the brain a workout and boosts brain power. Your brain and body need variability for optimal learning, and normal exercise tends to limit movements to the conventional ways of "getting strong." When you're mindlessly repeating a movement or series of movements in one way only (think a bicep curls, running, gym exercises), once you've mastered it, it no longer challenges new learning nor contributes to neurplastic change. In order to move, our neurons relay messages via our neural circuits that control movements. The signals the brain sends for muscular movement must be re-drawn when we break out of the routine way of doing things (In Biodanza dancers are encouraged to continue exploring new types, qualities and greater range of movement all the time. Emphasis on conscious liberation of movement which involves becoming aware of entrenched patterns of movement and choosing to break out of them and experiment with new ways of moving is perfect neuroplastic inducing practice stimulating re-wiring of new neural pathways and structural change. So too is the experimentation with different qualities of movement as this encourages the formation of a connection between sensation and voluntary movement, again using attention and mindfulness in combination with movement which promotes neuroplastic change.

6. NEUROPLACITICITY AND WALKING

In The Brain's Way of Healing, (ibid) Doidge describes interventions that are non-invasive and use the senses or movement of the body to access the brain.

Doidge tells the story of John Pepper, who has Parkinson's. The disease is a result of damage to the dopamine-producing cells in the brain that help us make automatic movements. This damage leads to difficulties with movement, balance and walking.

Pepper wasn't responding to conventional medication, but began to pay very close attention to the individual movements involved in walking when he joined his wife in a get-fit walking program.

'What he found was that he could do movements with that level of awareness, by breaking it down, because that's not broken in the Parkinson's brain,' says Doidge. 'He was actually using another part of his brain, in the frontal lobes, to work around the Parkinson's.' He was actually using activity, thought and movement to stimulate the dormant circuitry in the brain by stimulating the glial cells, which again provide infrastructure and support for the neurons which are the nerve cells which carry electrical and chemical signals in the brain. It was also to some degree addressing normal cellular and neuronal health.

Pepper was conscientious with his walking exercises and saw remarkable improvement in his Parkinson's symptoms.

He was using activity, thought and movement to stimulate dormant circuitry in his brain, which found other ways to overcome the problem.

'The thing that is so beautiful about this is it's something that anyone has access to,' says Doidge.

It also highlights how valuable movement—even the very simple act of walking—can be for the body and the brain.

What Pepper's story highlights is that when we walk with attention to our movement we are unmasking old automated neural sequences learned in childhood, by activating the prefrontal and other subcortical circuits, as a child would when first learning to walk. In the Parkinson's patient this simple exercise produces extraordinary results in motoric competence and overcoming many of the Parkinsonian motor symptoms. It has been proven scientifically that when we walk, regardless of our age, we produce new cells in the hippocampus, the area of the brain that plays a key role in turning short-term memory into long.

In Biodanza we learn to pay attention to synergy, to releasing the hips and shoulders in physiological walking and importantly, to the sensation of pleasure and joy in walking. This practice stimulates integration of neural impulses across the corpus callossum which is known to have a beneficial effect on motoric co-ordination and integration. It is also stimulating the unmasking of old automated neural pathways which then become exposed and available for use and adaption, expanding and enhancing brain function. Most importantly it is a practice which give us the ability to access healthy parts of our brains to compensate for damaged or even just dormant parts.

7. NEUROPLASTICITY AND PLAY

As adults we're often loathe to play. We take ourselves far too seriously, most often limited by a concern of what others might think of us. Biodanza incorporates many different types of play: locomotor, social, creative, imaginary and pretend. By introducing the voluntary option to move in a way that is unique and different to our usual ways of moving, we are doing just that in Biodanza– playing. It's fun. It's creative. Scientists have proven that play is important and critical for learning. All young mammals and especially children learn through various forms of play, alone, in parallel and in interaction with others. Open-mindedly exploring one's potential has been shown to promote positive neuroplastic changes including structural, thickening of grey matter (literally) and re-wiring of new neural connections. Of course as we have discussed, on the flip-side, if neglected, neural connections can weaken and disappear.(Peter K. Smith, Phd Anthony Pellegrini, PhD)

Biodanza exercises in the lines of Vitality and Creativity often invoke games and playful interactions to learn new skills and break automated patterning. Since the Facilitator's 'consignment' explains the purpose and goal of each exercise the conditions of attention and challenge necessary for neuroplastic growth are present. This means that each time a dancer engages in such an exercise they are expanding and enhancing their cognitive, motor and emotion-integrating neural pathways, and probably also effecting structural changes in the grey matter of their brains.

Furthermore it has been discovered that due to mirror neurons in our brain the brain cells that are active when we do something, like dance, are also active when we watch someone else doing something. Therefore just observing

other dancer's movements, and especially the facilitator demonstrating an exercise, activates these mirror neurons and builds new neural pathways.

7. NEUROPLASTICITY AND TOUCH AND CARESS

Numerous studies with mice demonstrate that, far from being rigidly determined by genetic programs, Central Nervous System development is already responsive to the environment at very early stages. The first two weeks of rodent life are characterized by the prevalent absence of a direct interaction between the pup and the external environment, with newborns spending their whole time in the nest, where the mother is the most important source of sensory experience. The similarity with the human newborn experience is obvious. It was soon realized that differences in maternal behavior between EE and non-EE conditions could be a fundamental factor triggering the earliest effects of EE on visual system development. It was demonstrated that EE pups receive higher levels of maternal care compared with standard-reared pups. More specifically, EE animals experience a continuous physical contact because of the presence of adult females in the nest and are also provided with increased levels of licking and grooming. The amount of maternal care received by the developing pup influences hippocampal structure and function, affects molecular factors crucial for plasticity such as BDNF and NMDA receptors and leaves long-lasting epigenetic marks in the offspring's physiology and behavior.

Very recently, a protocol of daily artificial tactile stimulation has been used in the rat as a strategy to promote visual system development. The authors reported that a combination of gently stroking and massaging is highly effective in accelerating the maturation of physiological visual functions. Tactile stimulation also compensates for inadequate maternal care: the negative effects produced by repeated episodes of maternal separation or by prenatal stress on pup growth, hormone secretion, hypothalamus–pituitary–adrenal axis and BDNF expression are all rescued by artificial massage applied to pups in order to mimic maternal behavior. Guzzetta *et*

al demonstrated that massage therapy also accelerates brain development in healthy preterm infants (gestational age between 30 and 33 weeks). This article underlines the role of environmental stimulation as a crucial factor for early postnatal development in humans.

Altogether, these results provide a remarkable example of cross-modal plasticity by which an increased input in a single modality reverberates as a driving force for the whole brain. Enriched Environment is a complex paradigm, as increased stimulation is provided at multiple sensory, motor, cognitive and social levels. Although most humans do experience a high degree of environmental complexity and novelty, levels of cognitive, social and physical stimulation vary greatly among individuals and in different periods of life. Strong correlative and epidemiological evidence shows that lifestyle, including occupation, leisure activities and physical exercise, have a direct effect on the risk of cognitive decline. Results indicate that a higher level and variety of mental and physical activity is associated with a lower cognitive decline and a reduced risk for dementia.

Doidge argues that touch is essential in promoting re-wiring and maintaining balance between excitation and inhibition in the brain. He argues that the "cuddle party" concept has enormous benefit for the participants both in that it offers them much needed contact and touch to generate this re-wiring and in that it offers them experiential opportunities to learn how to say no to unwelcome touch. The latter he argues, is an essential learned survival response.

Considered in light of the Biodanza paradigm these findings are remarkable. Rolando Toro argued vehemently that touch and caress have the effect of reinstating homeostasis, that they are essential and beneficial to individual development and balance, and that the vivencia offers both the opportunity to enjoy giving and receiving human touch and containment in a safe, controlled environment. He also very much emphasized the re-learning of the ability to put limits, to protect ourselves, to say no and to initiate getting what we do want. All these things are incorporated into many of the exercises and are an integral part of the learning process in Biodanza. Rolando Toro also

recognized the fundamental importance of the maternal bonding experience in the early stages of life and developed exercises that seek to re-wire the neural pathways predicated on lack of or deficiency in maternal care through experience of positive maternal-like experiences. What is truly unique in the Biodanza paradigm is that it offers a very secure, safe environment for people to immerse themselves in a bath of innocent, caring, undifferentiated human touch. In doing this it opens itself up to all sorts of ridicule and derision as a free sex cult. The research mentioned above and the understanding of the correlation between human touch and neuroplasticity might help to allay these accusations and spur more modalities on to harnessing the innocent, available and essentially healing quality of touch and caress.

CONCLUSION

Based on current research into the physiological mechanisms of neuroplastic re-wiring and the conditions needed for it to occur, there is no doubt that the practice of Biodanza offers a unique and ingenious paradigm for transformation. The Vivencia is a perfect tool for immersion in positive experiences in a safe, self-regulated environment. It could be argued that the vivencia is the perfect Enriched Environment for the development of our full neuroplastic potentials.

The inclusion of movement and dance, music, touch and caress, play, sensory and somatic awareness, direct and immediate feedback, coherent and meaningful activities, and a stress-free space in which to challenge ourselves to break with old, automated patterns of response, emotional and motor, only bolster the Vivencia's already rich fertile ground. All these factors have been proven to be essential in the attainment and maintenance of neuroplastic growth. Moreover studies show that the best effects are with regular repeated practice, which reinforces the need for weekly Biodanza classes, if not even more frequent regular classes.

Finally both because neuroplasticity is quicker and easier in the formative years and slows down with age, it is important for both children and adults to dance Biodanza. The former because they can easily establish healthy neural pathways at an early age, and the latter because they can always establish new neural pathways, even if the process takes longer and more practice. The regular practice of Biodanza enhances re-wiring of new neural pathways and probably effects structural changes in the brains' grey matter.

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