

The Neurobiology of People-Plant Relationships: An Evolutionary Brain Inquiry

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Abstract

People-Plant research studies the effects of our relationship with plants. Understanding how relationship has contributed to our brain's evolution may further illuminate our therapeutic interventions and research findings. The triune brain theory posits a model of brain functioning from three separate evolutionary centers (MacLean, 1973). The reptilian brain is the oldest and operates on a fight or flight paradigm. The mammalian brain is associated with our capacity to nurture life. The neocortex, developed most recently, represents our capacity for reasoning and long range planning. Each center contributes to our response to threat, injury, illness or trauma.

Charles Darwin, usually associated with an evolutionary emphasis on survival of the fittest, observed that the emergence of mammals in the progression of species placed nurturance as central to evolutionary fitness. Current attachment and neurobiology of relationship theory suggests the extended time spent in caring for the immature mammal fostered the development of a nervous system that can be regulated by linking with others. This paper posits this linkage extends to our relationship with plants.

Over the past decade, significant research has focused on the brain's release of the neuropeptide, oxytocin, as an antidote to the stress inducing neuropeptide cortisol. Oxytocin evokes the experience of trust and well-being, and is stimulated by a range of mammalian behaviors including touching, grooming, and nursing. Since mammalian behavior includes husbandry, people-plant research may show that gardening and caring for plants and animals stimulates the release of Oxytocin.

Our health models often treat humans as separate from nature. People-Plant research, viewed from the perspective of the neurobiology of relationship, suggests that our health and well-being is intricately intertwined with the health of our ecosphere.

INTRODUCTION

As a family therapist and ecotherapist, I welcome the invitation to dig deeper into our understanding of people-plant relations. I bring to this investigation a broadly defined family systems perspective that encompasses our interconnectedness with all of life. In research, good data is often disregarded because it is not located within a theory that provides sufficient explanatory power. In this paper, I will discuss material gleaned from evolutionary brain theory, the neurobiology of relationship and ecotherapy that may inform our understanding of how our relationships with plants nourish us and produce the beneficial effects our research reports.

It can be said that what sustains us in life is our relationships. Good research always links the present with the work of our predecessors. Indeed, gratitude for the wisdom of our ancestors and teachers provides grounding for the work each of us does in our lives. In 1925 Carl Jung traveled to Taos Pueblo, in the four corners regions of the United States, to meet with Hopi elders. He was hoping to better understand the European mind by viewing his culture through the eyes of an older culture. Afterwards he spoke of the importance of our relationship to the land we live on and expressed concern for the health of the American psyche. Jung, a descendent of generations of Swiss farmers, observed that most Americans were separated from the soil of their ancestors and

hence their psychological ground. He believed that our psychological health necessitated weaving our scientific and technological knowledge with the understandings of the indigenous peoples who had lived on this continent for many generations (Jung, 1962; McGuire and Hall, 1977; Sabini, 2002).

This paper was first presented at the 10th International People-Plant Symposium held at the Nova Scotia Agricultural College in Truro, Nova Scotia. My practice in presenting work in a new location is to acknowledge the ancestors of the land. The First Nations People of Nova Scotia are known to us as the Mi'kmaq. While they referred to themselves as li'nuk, "the people," the name we call them comes from the word ni'kmak, meaning my kin-friends. The Mi'kmaq lived along the coastal waters of Nova Scotia throughout the year, taking advantage of the abundant food, game and fish that dwelled here. They were story tellers whose stories could last for several days of feasting, eating, and dancing. The Mi'kmaq believed, like many earth peoples, that humans and nature speak the same language. (Mi'kmaq Spirit Home Page, N.D.) May this understanding illuminate our approach to research in Horticultural Therapy and Therapeutic Horticulture.

Seeing all of life as one's kin helps heal the artificial conceptual split our scientific understandings sometimes foster. When we think of ourselves as separate from nature, it becomes easier to develop what Martin Buber referred to as an I-It relationship, where objectification occurs (Buber, 1971). When we consider human nature as kinship with all of life, we enter what Buber called an I-Thou (or I-You) relationship, where respect, intimacy and awe emerge through our engagement. When kin come together they share news about the health of the family, offer advice, and work together for the benefit of all. Truro is located on the south side of the Salmon River flood basin close to the river's mouth at the east end of Cobiquid Bay. While it is unlikely that oil from the Deepwater Horizon, Gulf of Mexico spill that was capped in July, 2010, will reach these waters of Nova Scotia, its impact on the microorganisms living in the ocean's sediment will move up the food chain and be experienced here through global migratory patterns. According to the Ecology Action Centre, northern gannets nest in this area during the summer and winter in the Gulf. Blue fin tuna spawn during the winter in the Gulf and spend their summers in Nova Scotia's water. Piping Plovers nest on Canada's beaches during the summer and winter in Florida on the Gulf Coast. Sea turtles spend part of their lives in the Gulf and part in the Canadian maritime (EAC's Position on the Gulf Oil Spill, 2010). Kinship with life carries the recognition that we are affected deeply by the fate of others with which we share this life. We can ill afford to solely focus on how relationships with plants improve human well-being (Rice, in publication). As researchers, horticultural therapists, teachers, students, and human beings, we are called upon to link our research and horticultural therapy programs directly to sustaining our biosphere, so that we and all of our relations may continue to thrive.

It had been a goal of the people-plant movement to encourage horticultural therapists to incorporate evaluation and research in their program designs. The need for a humans-in-horticulture research focus, first articulated by Charles Lewis, Diane Relf, and others grew from the recognition that university horticultural science departments were emphasizing plant sciences at the expense of what Wendell Berry has called the soul of agriculture, the relationship between humans, plants and nature's cycles (Berry, 1977; Lewis, 1996; Relf, 1992). The experience of the gardener or farmer was subsumed beneath the rush to develop industrial farming (Berry, 1977). I believe we continue to struggle with how best to present our perceptions, observations and understanding of this remarkable human-plant bond.

Our primary processing organ in research, as in life, is our brain. Understanding how our brain functions will enable us to use it more effectively as a research tool. I am indebted in the

following discussion to *A General Theory of Love*, an extraordinary study of the psychobiology of emotions by Thomas Lewis, Fari Amini, and Richard Lannon (2000). What we call the brain is a complex system of neuron to neuron communication via electrical and chemical transmission. Paul MacLean (1973), an evolutionary neuroanatomist, observed in his triune brain theory, that the brain is comprised of three distinct brains that evolved to address different demands during the course of our evolution. Rather than being a neat, logical, and linear progression, our evolution has made leaps based upon a complex set of adaptations to the ever changing external circumstances of our planetary home. Each brain, in fact, functions with different purposes that are drawn from differing perceptions as to what we need. Some of the confusion we experience internally and externally can be understood within the context of these competing and sometimes contradictory perceptions and motivations.

In the introduction to *The Reenchantment of Science*, David Ray Griffin notes the paradigmatic shift emerging from modern, mechanistic and reductionistic science to an ecological, organismic model (1988). The word science means knowledge and in the modern view greater emphasis is placed on explicit knowing. Our predominant early education model focuses almost completely on the conveyance of facts and the testing of our retention of these facts. Rarely are we given the respect to discover and bring forward the things we learn and know directly through our experience and engagement with life. Aristotle drew a distinction between knowing something is so and knowing why (Zuzne, 1957). I believe that part of our struggle to integrate research with our horticultural therapy practices lies in the belief that we have to shift from our direct encounter with life to convey our understanding and observations in a more technical mechanistic language. It is my hope in this paper to lay the groundwork for more seamlessly utilizing what we have discovered in relationship to plants to design research that is better suited for describing and evaluating people-plant relations.

Many of my teachers stem from oral traditions where stories and songs were shared with the purpose of evoking the listener's implicit knowing while cultivating the experience of relationship. This communication process draws upon the limbic brain. As an exercise, I invite the reader to notice when the words on this page resonate with your own knowing. I invite you to note, as well, any feelings that emerge during your reading. This mode of receiving information without and within, blending explicit knowledge with intuitive or implicit understanding, is present, as well, when we enter the garden.

Our oldest brain center is the basal ganglia, what MacLean referred to as the reptilian brain, because it is believed to have emerged with the development of reptiles approximately 250 million years ago. In humans, this brain is located in a bulb on the top of our spinal chord. Our life control centers – the neurons that prompt our heart beating, breathing, and swallowing – are located here. These activities can operate completely without any conscious awareness. In addition, our capacity for survival is enhanced by the visual tracking and startle reflexes that are situated here. Many of the factors that contribute to our physiological temperament stem from this center as well. Some of these physiological differentials are: introversion-extroversion, high-low stimulation needs, impulsive-compulsive and permeable-impermeable boundaries.

While reptiles have elaborate behaviors for courting, mating, and territorial defense, their brain does not address emotions. MacLean suggests that reptiles do not raise their young and thus do not develop the emotional capacity for relatedness. In fact, reptiles are capable of eating their own young. When we become ill, experience a significant trauma or loss, or feel threatened in any way, our survival fear is evoked. Often when the reptilian brain is activated, it stimulates the release of cortisol into our system. Cortisol increases our heart rate, speeds up our breathing, causes us to

perspire and narrows our focus. We may experience an increased readiness to defend ourselves, as well as stress and anxiety. Take a moment to think of a time when you have felt yourself under the influence of your reptilian brain or have worked with someone in a similar state.

As with most models, MacLean's triune brain theory is somewhat oversimplified. Life rarely follows our desire for order. Birds, for example, are considered reptiles, yet they clearly take care of their young beyond the egg-laying stage. For our purposes, it is sufficient to establish that the reptile brain contains our earliest mechanisms for ensuring survival and is not directly connected to nurturance of relationship.

Paul Broca, a French surgeon and neuroanatomist, discovered in 1870 that there was a lobe of the brain that all mammals share in common that he called the limbic, which is Latin for edge, border, or ring (Goleman, 1995). This name derives from its location surrounding the reptilian brain and represents, as well, the separation between reptiles and mammals over 100 million years ago. The development of this limbic brain emerged with the change in reproduction and care for the young with the ascendance of mammals. When we think of Charles Darwin's evolutionary model, we often ascribe the concept of "survival of the fittest" to a reptilian sensibility that deems relationship of little consequence. Yet Darwin observed that with the development of mammals, the capacity to nurture and care for others became the dominant factor in enhancing survivability (Darwin, 1998). This shift gave rise to closer social groups, families and relationships that were mutually nurturing, exhibiting caring behaviors such as touching and grooming. Agriculture itself emerged during this era of limbic expansion in mammals.

The limbic brain is an interconnected system of brain structures that includes the septum, amygdala, hypothalamus, hippocampal complex, and cingulate cortex. This limbic system shapes and expresses our emotional life. Daniel Goldman (1995), author of *Emotional Intelligence*, describes how the limbic structures allow us to experience our emotions as well as the emotions of others. Emotional intelligence represents our ability to attune to each other. I will return to this sub-brain after introducing the youngest, and sometimes brash, sub-brain.

The neocortex developed about 100,000 years ago. It is the largest part of the brain in the more recently evolved mammals. The neocortex provides us with the capacities for abstract reasoning, planning and perception and represents our thinking mind. It is this part of our brain that enabled the Greeks to conceive of ideals that existed outside of nature. David Abrams delineates this development in *The Spell of the Sensuous* (1997). Initially, our written languages utilized alphabets whose letters were representations of figures in nature. The basis of these alphabets suggests the formulators were embedded in relationship with the natural world. The Greeks were the first to develop an alphabet with vowels, and the emphasis shifted to language as a representation of the human voice. Greek philosophers were the first to conceptualize ideal states that existed supra-nature. Yet, as Albert Einstein has written, it is important not to deify our intellect (1995). Einstein suggests intellect is a powerful muscle that can serve, but should not lead. Indeed, our scientific era has given rise to the development of numerous technologies that have disturbed our balance and relationship with our children, families and the natural world.

How then can the triune brain theory facilitate our work? A survey of people-plant research shows interactions with plants have positively influenced human behavior, cognition, and physiology. A significant amount of the data collected to date emphasizes how working with plants influences our clients' emotions and their experiences of themselves. Turning our focus to how our limbic brain functions may enhance our understanding of how our relationship with plants supports the regulation and health of our emotional life.

Mammals are generally born immature and vulnerable and require extended care to survive. This expanded time fostered the development of a complex emotional language that expressed internal physical and emotional need states. John Bowlby, the formulator of attachment theory, identified many of the innate behaviors human infants exhibit in order to stimulate the proximity of their parents and care-givers to ensure their survival (1988). Bowlby suggests that each of us develops an attachment template that we carry within that is based upon the quality of attunement we have experienced. This template influences our level of emotional trust, flexibility and adaptability to novel experiences.

Emotional attunement is not limited to humans. Barry Lopez, in his powerful first book, *Of Wolves and Men*, observes a mother wolf leaving the den for the first time in order to hunt for food (1979). She goes a short distance, just out of sight of the den, and lies down at a spot where there is a drop off in the trail and waits. A short time later the pups leave the den to begin exploring. As they come to the dip in the trail, she growls menacingly at them. They immediately retreat back into the den and await her return. This is a compelling example of limbic attunement or resonance. As the wolf mother leaves, she knows that the pups' curiosity and dependency will impel them to follow her. She knows that she will need to utilize surprise and a little fear to shape their behavior in a way that increases their chance of surviving at this vulnerable stage. She has to modulate the stimulation of this fear to achieve the required scampering back to the den.

As a parent of a young child, I quickly learned the benefits of limbic attunement. After a few very stressful experiences of trying to get my child to go to sleep, I learned that recognizing and responding to the earliest signal of an impending meltdown made this passage to sleep go much easier. I also learned that in order for him to relax and fall asleep, I needed to relax first. As I calmed my body and my voice, he would relax and fall asleep. I recall once taking my toddler to the pediatrician to get an immunization. I held him chest to chest and focused on breathing in a deep and relaxed manner. After he received his shot he turned to the doctor and said "thank you." She assured me that this was the first time a child had thanked her for a shot in all her years of practice.

Note that, in each of the above examples, fear was not addressed via our logical mind. Feelings, and in particular fears, rarely shift in response to logic and reason. Feelings are transmuted through attunement. In essence, our nervous systems are not fully contained within our bodies. Our nervous system can be linked via an empathic bridge between limbic brains (Lewis, et al 2000).

As human mammals, we have been doing this far longer than we have been thinking and explaining things. This capacity for limbic attunement draws upon our implicit knowing that reveals itself through our emotions. Human infants develop emotional communication considerably earlier than the development of their cognitive capacities. Within a few days of birth, infants are able to distinguish facial emotional expressions. The visual cliff experiment highlights how this ability is used in the service of survival for infants at the crawling stage (Lewis, et al 2000). An infant is placed upon a counter that is half solid and half clear Plexiglas. As the infant approaches the divide, what it sees is the danger of falling. At this perceived precipice the infant looks to the mother. If her face is calm, he or she will precede with crawling. If the mother looks worried or alarmed, the baby will stop and begin crying. When this exchange is unavailable the infant's survival is at risk. These infants are showing a rudimentary example of limbic resonance that grows over the course of a life time into a veritable "symphony of mutual exchange and internal adaptations whereby two mammals become attuned to each other's inner states" (Lewis, et al 2000, p. 63).

Are our relationships with plants a part of this symphony? In *The Botany of Desire*, Michael Pollen states that plants are masters of co-evolutionary development (2002). Of course, we understand that since plants are unable to move on their own, they use their remarkable capacity for

creating compounds to develop various means of attracting insects to them, so that their pollen can be disseminated, thereby, ensuring their procreation. However, our human conceit, finds it a bit more difficult to recognize that plants might do this to us as well. Could there be evidence of limbic resonance between plants and humans?

Patricia Damery answers affirmatively in *Farming Soul* (2010), an exploration of her integration of her training as a Jungian analyst with farming biodynamically on a ranch in Napa, CA. Biodynamic agriculture was developed by Rudolf Steiner, the Austrian philosopher and social critic whose writings provided inspiration for the creation of the Waldorf school model. Jung and Steiner were influenced by the 19th century German poet and philosopher, Johann Wolfgang von Goethe. Goethe is best known for his psychologically complex book-length poem, *Faust* (1990). Goethe made significant contributions to botanical science as well. His scientific method entailed intensive direct observation that produced insight and the experience of unity consciousness with nature, wherein the smallest observations produce the experience of the whole (Naydler, 1996). I was fascinated to discover this lineage linking major educational, psychological, and philosophical figures to the direct engagement with plants. Perhaps we too often look for the results of our clients' participation in horticultural therapy programs without observing closely the very essence of the relationship that is producing these outcomes. Yet most of us come to this work through our own rich relationship with plants. Is it possible that our thinking brains' (neocortex) bias towards separation and distinction has blocked our approaching people-plant research through our experience of this relationship?

Just as our reptilian brain is associated with the secretion of cortisol, researchers have discovered another neuropeptide, oxytocin that is associated with the limbic brain and the experience of well-being that accompanies limbic attunement. Oxytocin production and release is stimulated by warm affectionate touch, music, and scents. Oxytocin levels have been shown to increase during breast feeding and orgasm. Recalling an experience of attunement also stimulates oxytocin production, just as remembering a stressful experience will stimulate the release of cortisol. Oxytocin is an antidote to cortisol and stress and generates a blissful experience of contentment (Graham, 2010).

How do limbic attunement and the release of oxytocin affect lasting change in our neural pathways or nervous system? The brain's capacity for change is brought about through neuroplasticity, the ability to form new neural connections that allow the brain to reshape itself. Bruce Ecker (2010) notes that the experience of a memory or thought of a traumatic physical or emotional experience activates a neuronal script. When a new experience is introduced repeatedly, i.e. a relationship that evokes the experience of well-being, trust, and connection with an accompanying release of oxytocin, the brain is able to rewire itself.

When I researched the impact of learning to garden organically on chemically dependent San Francisco County Jail inmates many years ago, I found the majority of the program participants had traumatic family lives that produced impaired attachments (Rice, 1993; Rice, Remy, 1998). In the garden, the inmates experienced well-being and a renewed experience of hope and a positive connection to something larger than themselves. Indeed, a few inmates remarked that the garden produced a better high than the chemicals they had been ingesting! I now recognize that they may have also been experiencing the release of oxytocin. To date, blood oxytocin levels have been measured in human interactions, as well as having been shown to rise when petting a dog (Keltner, 2010). Further research may show that gardening may stimulate oxytocin levels as well. .

If our nervous systems are limbically attuned to plants and nature as a whole, the influence extends in both directions. I believe that we all have experienced the restorative calmness and

grounding that emerges when working with plants. Perhaps some of us have also experienced that we have provided healing and the experience of well-being for plants on occasion as well. In *Ecotherapy*, Linda Buzzell and Craig Chalquist suggests that our ecological crisis stems from the human psyche and is, at the core, a crisis of consciousness (2009). Perhaps this crisis can be understood as an imbalance in the functioning of our triune brain.

The neocortex can easily develop technologies that overcome natural limits. Electric lights enable us to work and stay awake when it is dark outside. Air conditioning and heating allow us to function without paying attention to natural limits. While our technological advances do have benefits, they at times enslave us to unnatural rhythms that drain us and diminish the quality of our lives. This imbalance is reflected in how we consume our natural resources as well. Remove these technological conveniences and we begin to see how the natural world shapes our activities and provides psychic balance. For example, winter provides an opportunity to lay fallow and restore ourselves by drawing inwards. In a sense, are we any different from the plant that folds its leaves up when the sun retreats and opens when the light returns? Is our natural state one of limbic attunement with the rhythms of nature?

Our reptilian brain responds to threats with fear and aggression. Indeed, in our culture, the very structure of our corporate economy and its relationship to the earth is the epitome of a functioning reptile brain. Relationships by design are not meant to get in the way of succeeding in accumulating wealth. Fear of not having enough drives our consumer economy. Does this reptilian fear cause us to grasp even tighter to a lifestyle that is strangling our ecosystem?

How might horticultural therapy function as a treatment modality to address our individual and collective imbalance? Horticultural therapy fosters the relationship between humans and nature. Evaluating oxytocin levels may show that gardening stimulates the secretion of oxytocin, catalyzes our brain's neuroplasticity, and thereby promotes our capacity to grow, change and heal.

I invite horticultural therapists and researchers to apply Goethe's model of intense observation to the relationships formed in our programs. In the participatory research paradigm (Marshall and Rossman, 1999), the researcher observes his or her own experience as one facet of the data collection. By attuning to how we are feeling when we cultivate relationships between our clients and plants, perhaps we will begin to notice the formation of limbic resonance and the emergence of a unitary oneness with the earth that brings bi-directional healing.

Our ability to articulate a more holistic and integrative paradigm in reporting our findings has relevance for advancing our efforts to validate and disseminate (broadcast) horticultural therapy and other people-plant interventions. A relational approach to people-plant research invites a reconceptualization of our treatment interventions to include simultaneously the cultivation of the health of our biosphere, for it is impossible to cultivate our wellness without attending to the health of our mother earth.

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