DR. MONTESSORI AND THE IMPLICATIONS OF CURRENT BRAIN RESEARCH (The Child's Brain/The Child's Mind)

By Shannon Helfrich

Montessorians might consider it a current trend or a novel approach to look at Dr. Maria Montessori's philosophy of child development through the lens of brain research. However, a revisit to Dr. Montessori's own writings soon reveals that we are simply picking up the study where she left off. When Dr. Maria Montessori began her professional work in 1896, she began at the Orthophrenic School in Rome. The essence of the work done through this program was a systematic study of the nature of the brain. Cranial measurements were taken reflecting changes in the brain. When we put this study into the context of the time in history, we can see the inherent limitations. There was no way to really study the living human brain without breeching the cranial cavity. Simple characteristics associated with brain density or assumptions regarding parts of the brain used for specific functions could only be viewed through the brains of the cadavers. And yet, the scientists of Dr. Montessori's day were intensely interested in the knowledge and insight that an understanding of the brain could provide for work with living humans.

Dr. Montessori soon shifted her focus from looking at cranial measurements to looking at the children who were present and could be observed functioning in their everyday lives. From these observations, she was able to arrive at many incredible interpretations of what was happening in the mind of the developing child. One common criticism laid against Dr. Montessori is that she did not clinically document her theories about the nature of the child's mind. Dr. Montessori understood that the technology required to accomplish so-called "proof" did not exist in her life-time. However, Dr. Montessori did write extensively regarding her discoveries. Her first book, "The Pedagogy of Cultural Anthropology" was dedicated exclusively to her studies of the human brain. An in-depth examination of her writings reflects that fact that she indeed wrote prolifically regarding her theories on the nature of the child development and in particular the nature of the child's developing mind.

Today, the necessary technology is in place and the ability to study the brain, in action, without invading the sanctity of the cranial cavity is possible. Of interest to Montessorians, is how Dr. Montessori's theory stands up in this light. I can tell you that from my perspective, her theories pass the "test" with flying colours. This is not a surprise to me or unexpected, however, it is validating to know that the understandings Dr. Montessori arrived at can be supported and known with greater depth in this new light.

For example, in the Absorbent Mind, we find Dr. Montessori's description of the development of the cerebellum as one of the essential physiological keys in development.

At birth and throughout the first six months of life, the cerebellum is so small as to be completely covered by other folds of the brain. Between 6-15 months of age, the cerebellum goes through a period of tremendous growth. This allows the cerebellum to now function as the command centre for the rest of the functions of the brain. Along with the reticular formation, the cerebellum controls the flow of the impulses of the brain. It controls the powers of concentration and attention. It serves to focus the energies flowing into the synaptic connections. This flow of energy is critical in fine-tuning the creation of the neural networks and to the strengthening of the synaptic connections.

The role of the cerebellum both in early childhood and in early adolescence has been well documented in our day. Dr. Joseph Chilton Pearce talks about this brain component which is

"made of extensions of all three brains in our triune system, and is involved in just about everything we do…" (***The Biology of Transcendence***, pg. 42n)

Dr. Montessori and her contemporaries were on the leading edge of this brain research.

In June 1996, a large group of neuroscientist and educators met in Chicago to correlate all the current brain research. Their findings were published in a document entitled ***"Rethinking the Brain"*** by Rema Shore in 1997. These neuroscientists acknowledged that as recently as 25 years ago, "…neuroscientists assumed that by the time babies are born, the structure of their brains is genetically determined. They did not recognize that the experiences that fill a baby's first days, months and years have such a decisive impact on the architecture of her brain, or on the nature and extent of his/her adult capacities. Nor did they appreciate the extent to which young children actively participate in their own brain development by signalling their needs to care givers and by responding selectively to different kinds of stimulation." (***Rethinking the Brain***, p.2) These same scientists go on to state that: "A strong, secure attachment to a nurturing care giver is essential and also appears to have a protective biological function, "immunizing" the infant to some degree against the adverse effects of stress and trauma." (Ibid, pg.29)

Neuroscientists have confirmed that children learn in the context of important relationships. The best way to help very young children grow into curious, confident, able learners is to give them warm, consistent care so that they can form secure attachments to those who care for them. Children who receive consistent, responsive care in the first years of life are more likely to develop strong social skills.

Dr. Pearce gives us tremendous insight into the importance of early development, especially the positive/negative impact of the early mother-child bonding. He writes regarding the development of the prefrontal cortex of the brain that "the growth of the prefrontals is determined by mother-infant interactions in the first eighteen or so months after birth." (***The Biology of Transcendence***, pg. 134) He also quotes Allan Schore, who states, "Interactions with the mother directly influence the growth and assembly of the brain's structural systems that perform self-regulatory functions in the child…and mediate the individual's inter-personal and intra-personal processes for life." (Ibid, pg. 134)

The brain is the most unique organ of the body. The brain has a unique way of developing that sets it apart from every other organ in the human body. It gradually creates and organizes billions of brain cells in a predetermined manner during early childhood. This would be an overwhelming task if all the information was to be contained in the genetic coding. The first task of the brain post-natally is the maturation and protection of the brain cells.

At birth most brain cells are in place within the structure of the brain. However the cells exist in an unprotected state. The process of myelinization is required to coat the axon of each cell. This thin coating serves to shield the chemical and electrical charges that will course through it during its life. The myelinization also assured that the charge will be directed toward the appropriate connections. This process of myelinization begins at the base of the brain and moves downward through out the central nervous system (the spine) and upward from the base of the brain toward the frontal lobe. The maturation of the cells is only the first step. The next challenge is the connecting of the cells into a usable system.

The creation of neurological networks is a massive task. It is through this process that the density of the brain increases greatly. In essence, there are not new neural cells, but an increase in the number of dendrites. The dendrites branch out in response to stimulation. The greater the stimulation, the greater the density of dendrites. The more dendrites, the greater the potential for synaptic connections. The neuroscientists quoted in ***Rethinking the Brain*** also acknowledge that, "The brain is affected by environmental conditions, including the kind of nourishment, care,

surroundings and stimulations an individual receives. The impact of the environment is dramatic and specific, not merely influencing the general direction of development, but actually affecting how the intricate circuitry of the human brain is "wired."

Here is the Absorbent Mind at work. The gathering of sensory information as it is available in the environment stimulates the brain cells. The chemicals stimulate connections of similar information. Gradually, the network becomes more complex and integrated.

"Scientists have also learned that different regions of the cortex increase in size when they are exposed to stimulating conditions and that the longer the exposure, the more they grow." (Ibid, pg.37) While learning continues throughout the life cycle, there are prime times for optimal development-periods during which the brain is particularly efficient at specific types of learning. These periods are described as "critical periods" or "plastic periods".

Harry Chugani, a contemporary neurophysicist explains, "This is an opportunity, really-one of nature's provisions for us to be able to use the environmental exposure to change the anatomy of the brain and to make it more efficient." (As quoted in ***Rethinking the Brain***, pg. 37.) Once the prime time has passed, opportunities for forging certain kinds of neural pathways appear to diminish substantially. This concept is built on the premise that development depends on the exposure of the brain to many kinds of stimulation according to a predictable timetable.
When there is a disruption of the normal developmental schedule of experience, neural connections are not made properly, and the cortical columns that result are thinner than they should be. During developmental "prime times" neurons can create synapses most easily and efficiently. As Montessorians, we recognize the context of these recent discoveries, for we call them "sensitive periods."

The neuroscientists explain further, "The brain's intricate circuitry is not formed at a steady pace; rather, it proceeds in waves, with different parts of the brain becoming active 'construction sites' at different times and with different degrees of intensity." (Ibid, pg. 39) The impact of intrinsic motivations to grow and learn is observable in the life of the child. The child learns spontaneously and effortlessly, taking from the world around those elements that provide the building blocks of intelligence. At different times and in various ways, the child is drawn to aspects of the world with intense interest and concentration. One can imagine a growing network of connections all intertwined in a massive ball. How could such a system function efficiently or effectively?

Nature solved this problem by evolving a more economical system. The developing brain produces many times more neurons and more synapses than it will ever need. In the early years each neuron forms up to 15,000 synapses. The brain development of infants and toddlers proceeds at a staggering pace. By the age of three, a child's brain has 1,000 trillion synapses (twice as many as an adult!) Brain development from here on is a process of pruning: the brain selectively eliminates excess synapses. As a child grows, an overabundance of connections gives way to a complex, powerful system of neural pathways.

The brain knows which connections to keep and which to discard according to the stimulation the synapses receive. When some kind of stimulus activates a neural pathway, all the synapses that form that pathway receive and store a chemical signal. Repeated activation increases the strength of that signal. When the signal reaches a threshold level, the synapse becomes exempt from elimination and retains its protected status into adulthood." This might lead us to conclude that the young child needs a plethora of sensory stimulation, possibly even prenatally.

Rich and varied stimulation is important but does not need to be voluminous. What many adults do not understand is the power of the Absorbent Mind to glean every nuance of information out of every possible experience. What we might perceive as a need for the volume in exposure the

child replaces with quality of perception. The child uses this plethora of perceptions within the brain to create an abstraction (the generalized notion or understanding of what is experienced.)

Let's take one straightforward example from the development of the child-the creation of an abstraction for a single animal - say "a cat". How could we postulate this creation happening? The young child perceives the cat. All of the available sensory data is stored in the brain cells - the visual images, the auditory messages, the tactile information, the smell. As the experience is repeated, the initial information is refined and strengthened. New information is added - maybe, regarding common activities or functions relative to the cat. A personal interaction adds new information. All of this knowledge is linked in the brain, each component serving to record one aspect of the whole. What does the child use to link and call forth this information? One last piece must be added to the network - the language! This piece exists as the summation of all the components. It serves the generic function of linking all the associated pieces and making them accessible to the memory.

The implications of this in all areas of the Children's House in particular are astounding: all the sensorial refining and sensory discrimination in the Sensorial area; all the refinement and coordination of movement in Practical Life; and think of the importance of enrichment of vocabulary especially beyond nouns. The orientation to exactness and precision are the preparations of the mathematical mind for arithmetic.

We are impacting the brain of the child during the most critical periods of development. We are supporting and nurturing the child through the richness of the environment in ways that go so far beyond what they might experience randomly or spontaneously in the world.
I believe that we could say unequivocally, that there is nothing totally new in the information from the neuroscientists. What is new is the picture we now have of the physiological work of the brain.

We have the advantage of going beyond speculation or assumption to actually see the activity of the brain through the technology of PET scans and MRI's. We can study the brain at work; we can see the manifestations of chemical and electrical energy coursing through different regions of the brain. The new understanding of the brain stimulates us to think more fully and more responsibility about the child and the work we do. It brings to mind the greater importance of serving the child well, providing as richly as possible for the child's developmental needs and avoiding any waste of energy through activity that just fills the time. This is the ultimate gift to the child!