

Brain Development and Experience: The Involuntary Legacy of Our Children

May 20, 2008

The brain is dynamic and has a remarkable ability to change. This is not a new idea as Jean-Jacques Rousseau, a Swiss philosopher, in 1762 proposed that the brain was affected by our experiences, and "that children must exercise their "senses" as well as their "limbs."

These early ideas on the malleability of the human mind inspired educators the likes of the Maria Montessori to develop school programs with enriched sensory and motor experiences designed to enhance learning and memory skills of children. Modern brain research in animal experiments has now confirmed these early ideas.

The dogma was that no new neurons (nerve cells) were formed in the adult nervous system, and it has now been shown that new neurons are formed throughout the life-span of an animal, including humans. Neurogenesis (formation of new neurons) occurs in limited regions of the mature brain, one of which is the hippocampus which has a major role in learning and memory. Interestingly, animals given enriched sensory and extensive motor experiences have more neurons formed and incorporated into their nerve networks in the hippocampus; correlatively, these animals also have higher performances on learning and memory tasks. This phenomenon has been observed throughout the life-span of the animals, although it is less robust with aging. Most importantly, animals whose mothers were stressed prenatally or who were stressed or deprived early postnatally have learning deficits associated with this neurogenesis in the hippocampus. More generally, during the development of the nervous system, there is a critical time when the genetics (nature) requires sensory (nurture) input in order to establish the fine and precise circuitry of the brain. The best characterized example of this is the visual system. If light to an eye is blocked during this critical period, this eye will be permanently blind. This same general phenomenon has been observed in most systems studied. It is like "sloppy in and sloppy out." If the system is given more precise sensory input, the system will develop more precise processing circuits.

These types of empirical data in animal experiments certainly give us pause when we think about how we might prioritize and support prenatal, postnatal, and parenting programs in our society. It provides strong evidence that the experiences we provide for our children can have a permanent positive or negative imprint on the structure and function of

their brains and can impact the potential quality of their lives and our lives.

This reality is revealed in several studies that show that impoverished early experiences lead to a trajectory of school failure and behavioral problems. Lower child neonatal health status is a strong indicator of lower cognitive abilities and behavioral competence. There is a causal link between nutrition and cognitive and behavioral outcomes.

A North Carolina study of 531 students in 16 different schools showed that there was a range of 2-10 year cognitive levels (literary and social skills) when children started kindergarten, and this difference continued into the next grades and even became more exaggerated as they progressed in school. It appears that cognitive abilities are set into a trajectory of a certain level before children start school. Early brain development is so important that risk factors in first grade predict dropout nearly as well as risk factors in high school. Nobel Award Economist James Heckman put it this way: "the most effective college preparatory program is enriching the lives of infants and toddlers."

A Gates Foundation Study reports of a "high school dropout epidemic in America." Each year, almost one-third of all public high school students and nearly 1/2 of all Black, Hispanics, and Native Americans fail to graduate from public high schools with their class. Forty-four percent of the persons in California prisons have not finished high school. A recent Pew Foundation study reported that for the first time in America there are more than 1 in 100 persons in jails and prisons. This includes 1 in 30 men between ages 20-34, and 1 in 10 black men.

The Denver Post recently reported that there are fewer students going to Colorado colleges, despite burgeoning growth in K-12 (increased 45 percent since 1997), and administrators are wondering what is going on!

This is the 25th Anniversary of the ground breaking report on the status of the U.S. education system called a "Nation at Risk." Twenty-five years since its release, many of the problems noted in the report have gotten worse.

We continue to demand more rigorous and consistent standards, i.e. "No Child Left Behind", and put more money and resources into assessment. It is our sense that it is too late to think about these problems at this late stage. We continue to blame the schools, but, perhaps the blame

should rather be placed on the national agenda and political will to care for our infants and toddlers. We need to get our heads out of the sand, and realize that the time cognitive development can be most improved is during the prenatal, neonatal, and early childhood.

The Head Start Program was a step in the right direction, however, they started with 4 year olds, which may be too late.

There are abundant studies that show that the most proven crime prevention programs is childhood education. In a longitudinal study of high-risk preschool children, it was shown that 40-year-old persons who attended a quality pre-school program in early years are 20 percent more likely to have graduated from high school, have higher earnings, are more likely to hold a job, and have committed fewer crimes. In this same study they reported that there was a \$17 return for each \$1 invested.

Rousseau and Montessori intuitively understood the plasticity and malleability of the human mind. Modern neuroscience and educational research provides us with strong direction/guidance on risk factors and how to improve/optimize the development of cognitive and emotional levels of our children. Overwhelming data shows us that we get the most "bang for our buck" in pre/postnatal and early childhood education. The time is right for us to put our best minds and resources to this project and make a commitment on the order of the "Go to the Moon" project of the Kennedy years. This could be a step towards the reality of our human potential.

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