[1] The newsletter title has been changed from **Aphasia Insights** to **Plasticity Insights** to encompass brain function and plasticity as the foundation of all learning as well as recovery.

November 2023
Volume 5, Issue 22
November 21, 2023

"The human brain is the most complex mass of protoplasm on earth - perhaps even in our galaxy. A product of heredity and environment, operative for many tens of millions of years, this three-pound collection of cells is still of virtually unknown potential; yet what a history of achievement and what incredible promise for the future!"

"Certainly, one significant achievement is the ability of the brain to change in response to cultural diversity – with measurable chemical and structural changes! Indeed, our brains literally add nerve cell branches in response to training and learning, no matter what our age."

Diamond, MC, Scheibel AB, Elson LM. The Human Brain Coloring Book. Barnes & Noble Books, A Division of Harper & Row, Publishers. New York, et al, 1985.

Aphasia Nation, Inc. is committed to educating the wider public about stroke and aphasia and the "*Aim High for Aphasia!"* international Aphasia Awareness campaign.

Stroke Educator, Inc.
4 Aspen Drive
Brunswick, ME 04011
207-798-1449
tbroussa@comcast.net
www.strokeeducator.com
www.aphasianation.org
FB: DrTomBroussard
FB: StrokeEducatorInc
FB: AphasiaNationInc

Plasticity Insights![1]

Marian Cleeves Diamond: Einstein's Brain, Enriched Environment & Plasticity.

By Tom Broussard, Ph.D.

This is the next in a series of articles about the science and scientists behind the brain, stroke, aphasia, plasticity, learning, recovery, and education.

Marian Cleeves Diamond (1926 – 2017)

Marian Cleeves Diamond (November 11, 1926 – July 25, 2017) was an American scientist and educator and was considered one of the founders of modern neuroscience. Her research provided the evidence that the brain changes with experience in an enriched environment and neuroplasticity (Wikipedia).

She obtained a bachelor's degree at UC Berkeley in 1948 and after graduation, spent the summer at the University of Oslo. After returning to Berkeley, she became the first female graduate student in the department of anatomy. Her doctoral dissertation thesis was entitled *Functional Interrelationships of the Hypothalamus and the Neurohypophysis,* and she received her PhD in human anatomy in 1953. She became an Assistant Professor at UC Berkeley, then a full professor, and finally Professor Emeritus, still teaching well into her eighties, until her death in 2017 (Wikipedia).

Diamond studied both non-neuronal cells (glial cells – in Greek, *glue*) and neurons, making great scientific strides with both as a result of over 60 years of her research.

Einstein's Brain

Thomas Stoltz Harvey was a pathologist at Princeton Hospital at the time of Einstein's death (4/18/1955) and removed Einstein's brain, without getting permission from Einstein's family.

He kept Einstein's brain and allowed scientists pieces of Einstein's brain to study. In early 1984, Diamond received four slices of the preserved brain of Albert Einstein (Sanders, 2017). Her research on Einstein's brain and her paper *On the Brain of a Scientist: Albert Einstein* (1985) helped the ongoing scientific revolution and controversy over the role of glial cells in the brain (Wikipedia).

Glial cells hold neurons in place, supply nutrients and oxygen to them,

insulate one neuron from another, and help remove dead neurons, but more needed to be investigated about the "glue" in the nervous system. Glial cells or neuroglia, are non-neuronal cells and do *not* produce electrical impulses in the brain. They are compared to neurons or neuronal cells that *do* produce electrical impulses and induce plasticity by growing new neural matter and the resultant learning. However, the glial cells completely surround all the neurons and make up more than half of the volume of the neural tissue in our body.

Enriched Environment & Plasticity

Next, Diamond's scientific passion addressed the enriched environment of the brains of rats which provided the first hard scientific evidence of brain plasticity and its ability to grow and learn through adulthood. At that time, the scientific community still thought that the brain was fixed, permanent, and couldn't be changed.

Several earlier scientists were starting to see the appearance of brain changes in their research. These included Spurzheim, by differential exercises (1815), Darwin, with the changed environment for wild versus tame rabbits and the resultant changes in learning ability (1874), and Ramon y Cajal, with cerebral exercises that helped create new neural collaterals connecting to other neurons (1895). All described the changes as a result of the exterior "enriched" environment with activities that affected the interior, structural changes in the brain (Bennett et al., 1964)

Diamond demonstrated that the structural components of the cerebral cortex can be changed as a result of differential experiences, either enriched or impoverished at any age, from birth to old age. In Diamond's lab, she raised the rats in different environments, some alone, with no simulation or activities, and others with playmates, toys, and activities. As a result, the enriched environment allowing "rats to interact with toys in their cages produced anatomical changes in the cerebral cortex" (Diamond, 1988).

She studied the rats' brains with various environments and discovered that the rats who were placed in small, isolated "impoverished" cages, were having a hard time finding their way through the maze to get to their cheese. The brains of the rats who had been placed in "enriched" cages, had grown to about 6 percent thicker than the solitary rats. They also found their cheese quicker (Diamond, 1988).

Diamond studied the rats' brains, but her real goal had been to "gain a better understanding of human behavior by examining its source, the brain" (Diamond, 1988). An enriched brain shows greater learning capacity than an impoverished one with less learning capacity. Learning how the brain works is the core of learning. Teaching about the brain and plasticity must be taught from the beginning starting in elementary school.

As Diamond stated in *Enriched Heredity*, "we have begun to appreciate the plasticity of our cerebral cortex, the seat of the intellectual functioning that distinguishes us as human beings, we must learn to use this knowledge. It must stimulate and guide our efforts to work toward enriching heredity through enriching the environment…for everyone …at any age" (Diamond, 1988) including recovery from people with stroke and aphasia.

Signed: *The Johnny Appleseed of Aphasia Awareness*

The author is a three-time stroke survivor and has aphasia as a result of the strokes. His language skills continue to improve.

He is Founder and President, Aphasia Nation, Inc., a non-profit organization whose mission is educating the wider public, national and international, about aphasia and plasticity, the foundation of all learning.

1. Bennett E, Diamond M, Krech D, Rosenzweig M. Chemical and Anatomical Plasticity of Brain. SCIENCE, Vol. 146, October 30, 1964, pp. 610-619.
2. Darwin, Charles. The Descent of Man (Rand, McNally,Chicago, ed. 2, 1874), p. 53.
3. Diamond, M. C.; Scheibel, A. B.; Murphy, G. M.; Harvey, T. (April 1985). "On the brain of a scientist: Albert Einstein". *Experimental Neurology*. **88** (1): 198–204. doi:10.1016/0014-4886(85)90123-2. ISSN 0014-4886. PMID 3979509.
4. Diamond, MC, Scheibel AB, Elson LM. The Human Brain Coloring Book. Barnes & Noble Books, A Division of Harper & Row, Publishers. New York, et al, 1985.
5. Diamond, Marian Cleeves. Enriching Heredity, The Impact of the Environment of the Anatomy of the Brain. The Free Press, a Division of Macmillan, Inc. New York, 1988, pg. 165.
6. Ramón y Cajal, Santiago; L. Azoulay (1894). Les nouvelles idées sur la structure du système nerveux chez l'homme et chez les vertébrés' ('New ideas on the fine anatomy of the nerve centres) (in French). C. Reinwald.
7. Sanders, Robert (July 28, 2017). "Marian Diamond, known for studies of Einstein's brain, dies at 90". *Berkeley News*. Retrieved October 21, 2018.
8. Spurzheim JG, The Physiognomical System of Drs. Gall and Spurzheim (Baldwin, Cradock, and Joy, London. Ed. 2, 1815), pp.554-555.)