ARE THERE REALLY NEW BRAIN CELLS FOR OLD BRAINS?

The common view is that if your brain cells die or you're a victim of brain injury, you're out of luck. There'll be no new cells to replace your loss which is why we are so fearful of head accidents and brain disease.

Most cells, like those in the intestine or the skin, are continually dividing, repairing and replenishing organs and other systems—the cells are alive! In the developing fetus, brain cells have a terrific capacity to duplicate, so where did this belief in irreplaceable brain cells came from? Because of the extremely complex and highly unique function of various brain cells, many scientists came to believe that replication and cell-differentiation was unlikely or even impossible. What this meant was that if one cluster of neurons processes signals from the right eye, and another cluster of neurons moves the fingers of the right hand, then they will do nothing else, come hell or high water.[1]

Ramon y Cajal, a Nobel prize winner, declared in 1913 that, "In the adult centers the nerve paths are something fixed, ended and immutable." Following Cajal and many others, the conventional wisdom held that no new neurons—no brain cells--were born in adult mammals, and that the behaviors of neurons are fixed and unchangeable. Cajal's ideas took hold. Belatedly, the rejection of neurogenesis—the generation of neurons in adults--was still being propounded by the prestigious journal *Science* in 1999.

Chipping away at the dogma

In 1965 the scientists Joseph Altman and Gopal Das of the MIT labs provided solid evidence for neurogenesis in adult rats.[2] A couple years later they searched for and found neurogenesis in adult guinea pigs. Using guinea pigs was a strategic choice because, unlike mice and rats, they are born with relatively mature brains that undergo very little structural change after birth.

Although such early studies were chipping away at what was known as the "non-living adult brain cell" edifice, critics were quick to challenge these ideas. They argued that since rodents don't belong to the elite "higher" animals club (read, "humans"), analogy was not possible.

Old dogma dies hard, whether religious, political or scientific. Once a concept is deeply embedded, a superstructure of assumptions and ideas grows around it. If dogma is rejected, then many ideas become questionable, more research could be invalid, and the reputation and contribution of many scientists might be questioned. As you can guess, old dogma rarely gets challenged.

But in 1998, Elizabeth Gould and colleagues at Princeton and Rutgers made the research jump to primates.[3] Their research showed that adult marmosets, those small South American monkeys that live in the upper canopy of forest trees, can generate new brain cells in the dentate gyrus (the front of the brain). Once again, the critics refused to accept the implications of the research, sticking to the "no higher primate neurogenesis" line. The theory and the critics argued that evolution has favored a stable brain that prohibits tampering with its wiring.

Administering the coup de grace

Finally, in 1998 Fred Gage and his brilliant colleagues at the Salk Institute in La Jolla dropped the guillotine on the old dogma.[4]

When utilized with tissues, bromodeoxyurdine, a unique chemical compound, has the ability to incorporate itself into newly developing DNA of dividing cells. In other words, the compound can identify new neurons in the human dentate gyrus. It's a dangerous compound, but it is occasionally used to assess tumor cell growth in cancer patients.

Gage and his colleagues hypothesized that because of the unique characteristics of the compound (regularly abbreviated to *BrdU*) it could also be used to identify non-cancerous neurogenesis in the brains of patients. By studying the brain tissue of five cancer patients post-mortem, they found signs of normal human neurogenesis. The patients each received an infusion of BrdU prior to their deaths. They also examined the tissues of patients whose death pre-dated their research from 16 to 781 days. Their research confirmed the existence of new cells and that these new cells were neurons.

What do the new neurons in old brains mean pragmatically?

We now know that cell genesis occurs in human brains and thus the human brain can change throughout life. The hardware of the brain is not fixed, and we are not stuck with what we are born with. So, how do you go about changing and building your brainpower? Today, studies are beginning to dissect and answer that question, but it is clear that the old conventional beliefs about intelligence won't hold water. We now have an understanding of how and why expertise develops—a terrifically important issue for any business person in the highly competitive 21st century.

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[1] Begley, Sharon (2007) Train Your Mind, Change Your Brain. (New York: Ballantine Books). Begley, a well-known science writer is masterful at popularizing neuroscience.

[2] Altman, Joseph and Gopal Das (1965) Autoradiographic and Histological Evidence of Postnatal Hippocampal Neurogenesis in Rats. *Journal of Comparative Neurology.* **124**, 3: 319-35.

[3] Gould, Elizabeth, et al (1998) Proliferation of Granule Cell Precursors in the Dentate Gyrus of Adult Monkeys is Diminished by Stress. *Proceedings of the National Academy of Sciences.* **95**, 6: 3168 – 3171.

[4] Gage, Fred, et al (1998) Neurogenesis in the Adult Human Hippocampus. Nature Medicine. **4**, 11: 1313-1317.