WHAT CAN WE LEARN ABOUT HUMAN BRAINPOWER FROM RATS?

Most neuroscience research comes from the study of rats and mice. But what can that teach us about human beings? This is an intriguing question for those of us who are not biologists.

The facts

Mice and rats are strikingly similar to humans in their anatomy, physiology and genetics. In fact, over 95% of the mouse genome—the hereditary information found in the mouse DNA—is similar to our human genome. In addition, they have a short generation time, and a very accelerated lifespan. One mouse year, for example, equals about thirty human years.

Thus, we can accelerate our understanding of human disease and behavior by studying mice and rats. Furthermore, their brains are strikingly similar to the human brain. Extensive research in diseases of the brain, such as Alzheimer's, is usually conducted by means of mice. One of my daughters manages a university animal laboratory, and recently took my wife and me on a tour. She explained in colorful detail how mice genetics can be modified to display human disease, providing an opportunity for research. "Ever see a golden mouse, Dad?" she asked. Holding it up by the tail, she explained that it was a genetically modified mouse for the study of Alzheimer's. (One of the primary investigators using her lab resources is an internationally famous Alzheimer's expert.)

Though mice are the most widely used lab animal, in a personal note to me, Marian Diamond of UC Berkeley stated that she *used rats instead of mice because they had a bigger yet "similar cerebral cortical structure."* With a larger brain to study, changes are easier to identify.

So how can you learn about humans by studying rats?

Simply put, researchers take information they've learned as a result of rat research and invent ways to perform similar research on humans.

In the early 1960s, research by Diamond demonstrated that enriching the environment—providing five or six objects for the animals to explore and climb upon in their cage, and changing these objects two to three times a week to provide novelty and challenge—changes both the chemistry and the anatomy of the cerebral cortex.[1] The cerebral cortex is associated with higher cognitive processing, thus impacting learning and memory. This was a controlled experiment using three groups of animals in differing environments: enriched, standard, and impoverished. Later research studied different ages, gender, and duration of environments.

After thirty days, the animals were anesthetized, and their brains examined. The scientists found dramatic brain differences. Animals from enriched settings showed more and longer dendrites with flowering spines. These spines—or branches--function as bushy projections of the dendrite tree, representing sites through which a brain cell instantaneously receives messages from other cells. Neuroscientists agree that this provides more opportunities for learning and memory. And the better connected these dendrites and spines, the better the mind can engage with new and old facts, retrieve memories and see patterns—the foundation for creativity and enhanced intelligence.

Numerous enrichment experiments, including exposure to social interaction were carried out over the years confirming those same results. This leads to the big question: how do we check brain alterations with humans? Not to worry. Scientists will discover a way.

In 1993, Bob Jacobs at UCLA and others were able to obtain tissue from the Veteran's Hospital in West LA from deceased individuals. What they found corroborated their research with rats.[2] They were able to isolate tissue from veterans who had a college education and those who had a high school education—a classic example of enrichment differences. They demonstrated that the nerve cells in the college-educated showed significantly more dendrites than those with only a high school education. They concluded that the brain changes—multiplying connections--in response to complex environments.[3]

Further experiments on human tissue support the data obtained from these animal studies. As Marion Diamond puts it, *we can now safely say that the basic concept of brain changes in response to enrichment hold true for a wide variety of animals and for humans*.[4]

So what?

If you want to build your brainpower, it's quite possible. The notion of intelligence as static, innate and hard-wired is a bankrupt ideology. The next question, of course, is how do you build your brainpower? That's a question for another chapter.

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[1] Diamond, MC, Krech D and Rosenzweig, MR (1964) The Effects of An Enriched Environment on the Rat Cerebral Cortex. *Journal of Comparative Neurology*, **123**, 111-119. Marian Diamond, Professor of Integrative Biology at University of California, Berkeley, is a well-known leader in the field of brain plasticity, focusing on brain enrichment and impoverishment.

[2] Jacobs, Bob, et al (1993) A Quantitative Dendritic Analysis of Wernicke's Area in Human, II: Gender, Hemispheric, and Environmental Factors. *Journal of Comparative Neurology*, **327**, 1, 97-111.

[3] Jacobs, Bob, et al (1993)

[4] Diamond, Marian (2001) Response of the Brain to Enrichment. *Annals of the Brazilian Academy of Sciences*. **73,** 61.

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