March 30, 2006

Scans Show Different Growth for Intelligent Brains

By NICHOLAS WADE

The brains of highly intelligent children develop in a different pattern from those with more average abilities, researchers have found after analyzing a series of imaging scans collected over 17 years.

The discovery, some experts expect, will help scientists understand intelligence in terms of the genes that foster it and the childhood experiences that can promote it.

"This is the first time that anyone has shown that the brain grows differently in extremely intelligent children," said Paul M. Thompson, a brain-imaging expert at the University of California, Los Angeles.

The finding is based on 307 children in Bethesda, Md., an affluent suburb of Washington. Starting in 1989, they were given regular brain scans using magnetic resonance imaging, a project initiated by Dr. Judith Rapoport of the National Institute of Mental Health.

This set of scans has been analyzed by Philip Shaw, Dr. Jay Giedd and others at the institute and at McGill University in Montreal. They looked at changes in the thickness of the cerebral cortex, the thin sheet of neurons that clads the outer surface of the brain and is the seat of many higher mental processes.

The general pattern of maturation, they report in Nature today, is that the cortex grows thicker as the child ages and then thins out. The cause of the changes is unknown, because the imaging process cannot see down to the level of individual neurons.

But basically the brain seems to be rewiring itself as it matures, with the thinning of the cortex reflecting a pruning of redundant connections.

The analysis was started to check out a finding by Dr. Thompson: that parts of the frontal lobe of the cortex are larger in people with high I.Q.'s. Looking at highly intelligent 7-year-olds, the researchers said they were surprised to find that the cortex was thinner than in a comparison group of children of average intelligence.

It was only in following the scans as the children grew older that the dynamism of the developing brain became evident. The researchers found that average children (I.Q. scores 83 to 108) reached a peak of cortical thickness at age 7 or 8. Highly intelligent children (121 to 149 in I.Q.) reached a peak thickness much later, at 13, followed by a more dynamic pruning process.

One interpretation, Dr. Rapoport said, is that the brains of highly intelligent children are more plastic or changeable, swinging through a higher trajectory of cortical thickening and thinning than occurs in average children. The scans show the "sculpturing or fine tuning of parts of the cortex which support higher level thought, and maybe this is happening more efficiently in the most intelligent children," Dr. Shaw said.

The I.Q. was tested when the children entered the program. Further tests were not needed because I.Q.'s are
so stable, Dr. Rapoport said.

Dr. Thompson said the new study opened huge possibilities because researchers should be able to identify the factors that influence the brain by looking at the scan patterns identified by the researchers.

The Bethesda children have had genetic samples taken from their cells, so genes that have even the mildest influence on the brain should be detectable, Dr. Thompson said. The pattern of development may also be affected by factors like diet, hours spent in school or the number of siblings, and these may come to light by asking parents how they raised their children.

"There are many enigmas of intelligence that they can now solve," he said.

I.Q. scores and measuring intelligence have long been controversial. Brain-imaging studies by Dr. Thompson and the study group have advanced the field by identifying physical features of the brain that correlate with I.Q.

In 2001, Dr. Thompson reported that based on imaging twins' brains the volume of gray matter in the frontal lobes and other areas correlated with I.Q. and was heavily influenced by genetics. Despite the great importance of genes in brain function, Dr. Thompson said experience could also change the brain.

"Unless you have strong natural potential, you won't become a world-class marathon runner," he said. "But that disillusionment is rapidly replaced by the notion that you can improve your own performance."

The institute's team has many genetic studies in progress. The analysis reported today was not intended to look at the relationship between genes and intelligence.

"A lot of research in intelligence has not been that great," Dr. Shaw said. "I would hope by this modest descriptive study to put things on an empirical footing."

One goal of the study was to establish normal development patterns, to diagnose what goes awry in children with schizophrenia or attention deficits. Dr. Shaw said his team did not have the full answers as to how the brain differed in those cases.