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The brain's journey from early Internet to modern-day fiber optics -- all in one lifetime

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The brain's inner network becomes increasingly more efficient as humans mature. Now, for the first time without invasive measures, a joint study from the Ecole Polytechnique Federale de Lausanne (EPFL) and the University of Lausanne (UNIL), in collaboration with Harvard Medical School, has verified these gains with a powerful new computer program. Reported in the *PNAS* early online edition last week, the soon-to-be-released software allows for individualized maps of vital brain connectivity that could aide in epilepsy and schizophrenia research.

"The computer program brings together a series of processes in a 'pipeline' beginning with individual MRIs and ending with a personalized map of the fiber optics-like network in the brain. It takes a whole team of engineers, mathematicians, physicists, and medical doctors to come up with this type of neurobiological understanding," explains Jean-Philippe Thiran, an EPFL professor and head of the Signal Processing Laboratory 5.

A young child's brain is similar to the early Internet with isolated, poorly linked hubs and inefficient connections, say the researchers from EPFL and UNIL. An adult brain, on the other hand, is more like a modern day, fully integrated fiber optic network. The scientists hypothesized that while the brain does not undergo significant topographical changes in childhood, its white matter—the bundles of nerve cells connecting different parts of the brain—transitions from weak and inefficient connections to powerful neuronal highways. To test their idea, the team worked with colleagues at Harvard Medical School and Indiana

University to map the brains of 30 children between the ages of two and 18.

With MRI, they tracked the diffusion of water in the brain and, in turn, the fibers that carry this water. Thiran and UNIL professor Patric Hagmann, in the Department of Radiology, then created a database of the various fiber cross-sections and graphed the results. In the end, they had a 3D model of each brain showing the thousands of strands that connect different regions.

These individual models provide insight not only into how a child's brain develops but also into the structural differences in the brain between left-handed and right-handed people, for example, or between a control and someone with schizophrenia or epilepsy. The models may also help inform brain surgeons of where, or where not, to cut to relieve epilepsy symptoms. Thiran and Hagmann plan to make the tool available early next year free of charge to hospitals around the world.

Provided by Ecole Polytechnique Fédérale de Lausanne

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