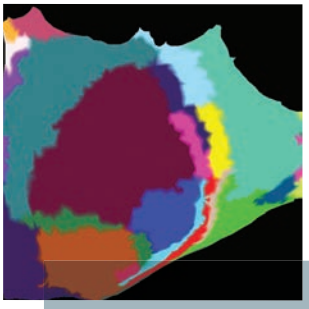

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Where cures begin.

Charles Stevens

Professor
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The Problem

In many ways, the brain is like a computer: It stores information for future access, compresses memories and pulls up those files when needed. Virtually all of the neural pathways in the brain are able to increase their computational power by simply growing in size while conforming to a single basic design. Understanding this evolution and how brains are able to vary in size without any major changes in organization could not only answer questions about brain development and function, but also help computer engineers build better computers that mimic the human brain.

The Approach

Charles Stevens is one of the only researchers in the world trying to formulate a complete list of the principles that govern organization in brains both large and small. His research encompasses an area called scalable architecture—the idea that something can gain more properties simply by making it bigger. Stevens wants to know how scalable architecture is enforced in the brain and if there are always constant ratios between the size of cells and structures.

To answer these basic questions, Stevens has begun to pinpoint these scaling laws that dictate how brains grow and develop. He observes how organisms develop from an embryo to an adult and, in particular, has started with the goldfish as a model organism. Unlike mammals, goldfish have brains that continue to grow throughout their adult lives. Stevens has already unearthed some design rules of the goldfish brain, such as set relationships between certain brain areas and laws on how neurons leading from the eyes to the brain are organized. He continues to chart how those rules are enforced during development and growth.

The Innovations and Discoveries

- Stevens recreated classic experiments—using modern techniques—to verify that the number of neurons found in one square millimeter of the brain's cortex is a constant number. Like the older experiments had shown, Stevens found that the neuron density is the same across species and throughout the whole cortex.
- Stevens showed that the ratio of neurons in the cortex that produce the neurotransmitter GABA—now called GABAergic neurons—remains the same throughout development. The observation hints at how the balance of different neuron types is established in an embryo.
- He examined goldfish eyes to determine how eyes improve as they grow. He found that the fish gain more photosensitive cells as well as bigger cells. The fundamental principle of how size mediates eye structure likely holds true for other organisms, including humans.

For more information, please visit:
www.salk.edu/scientist/charles-f-stevens

Cellular Biology, Evolution, Neurological Disease, Neurobiology, Systems Biology, Vision