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Competing Interests

Well before a newborn baby opens its eyes for the first time, its brain is already primed to see and understand the world. This priming occurs as a result of the finely tuned wiring of neural networks within the brain's visual system, say researchers at the Howard Hughes Medical Institute at the University of California, Berkeley.

In the March 28 issue of the journal *Science,* a research team led by Hughes investigator Carla Shatz proposes a model for brain development that confirms the old adage, "use it or lose it."

Even before birth, the brain is abuzz with activity as it begins to wire itself. Shatz's lab was among the first to demonstrate that early spontaneous neural activity promotes the organization of billions of nerve cells within animal and human brains. Their latest research shows that if that spontaneous neural activity is blocked, correct neural circuits in the visual system are not established and vision cannot occur. "This shows that early brain activity generated spontaneously is necessary to help organize detailed connections between the eyes and brain," Shatz says. "This is a lifelong process. Experience helps change connections in the brain."

The research has implications for understanding fetal development, says coauthor Anna Penn, a neurobiologist at the University of California, Berkeley. "There is growing recognition that the pattern of spontaneous neural activity could affect fetal development in humans," says Penn. "Some illicit drugs, and even nicotine, can interfere with necessary synaptic transmission."

To help explain her team's findings, Shatz likens the prenatal wiring of the visual system to the workings of a telephone system that connects Boston (the brain), Manhattan (the left eye) and the Bronx (the right eye). Since much of the developing brain grows in a predetermined way, major nerve connections between parts of the brain are established early. In other words, the "trunk line" between the New York area and Boston develops as a matter of course, Shatz says.

Once the trunk line is established, detailed connections between the brain and the eyes must be made specific buildings in Manhattan and the Bronx must be wired for telephone service. Shatz discovered earlier that this "wiring of individual buildings" occurs in the visual system when spontaneous waves of activity sweep across the retinas. This is like autodialing, Shatz says. The

neighborhood in the eye places phone calls to the brain. The spontaneous nerve activity is routed through the thalamus, in an area called the lateral geniculate nucleus, and a connection is made. "This allows millions of nerve fibers that go from each eye to the brain to be organized into layers of incredibly precise conductivity," says Shatz.

It is clear, Shatz says, that if the neural activity that organizes connections is blocked, different sections of the brain never "wire up" properly. Another important point of the research, she says, is that it shows that the eyes compete with each other for neural connectivity. "If Manhattan is blocked, the Bronx makes more phone calls and receives more connections. This shows that the fetal brain is not just a miniature version of an adult brain, but that it is a synaptic structure with changing connections."

Neuroscientist Larry Katz , a Hughes investigator at Duke University Medical Center, agrees: "This work shows definitively that an endogenous pattern of spontaneous activity is a crucial organizing force for neural circuitry in the developing nervous system," he said. "It's probably the clearest demonstration yet of competitive interactions giving rise to specific patterns of neural connections."