Sight Requires Exact Pattern of Neural Activity to be Wired in the Womb

Yale UniversityYale University

New Haven, Conn. — The precise wiring of our visual system depends upon the pattern of spontaneous activity within the brain that occurs well before birth, a new study by Yale researchers shows.

"It isn't just the genes. What happens within the womb is crucial," said Michael Crair [1], the William Ziegler III Associate Professor of Vision Research at Yale School of Medicine and senior author of the study published in the June 23 issue of Neuron.

The extent of the roles of nature and nurture in the development of neural circuitry has long been debated. Scientists know genes provide the basic plan for brain development initially, and connections between brain cells are fine-tuned later in development.

But how does experience influence the wiring of the visual system in mammals, which have relatively long gestation periods during which the fetus is never visually stimulated? The answer apparently lies in the spontaneous pattern of neural activity generated by the brain itself.

Crair and his team genetically manipulated the retina of mice early in their development in ways that affected the pattern, but not the overall levels, of neural activity. They found that the visual system in these mice never developed properly.

"If experience plays a role in neural development, it is hard to explain how vision would be affected before birth because we do not see anything in the womb," Crair said. "But we found that it is actually the pattern of ongoing spontaneous activity in the developing retina, not genes alone, that play a crucial in the development of the visual system."

That means environmental disruption of these neural patterns during development could be damaging to the formation of these neural circuits. Crair notes that the team managed to alter these patterns by manipulating nicotinic acetylcholine receptors - the same receptors that are targeted by nicotine.

"It is possible that nicotine exposure would have a negative influence on neuronal connectivity of a child's brain, even in the womb," he said.

Lead author of the paper is Hong-ping Xu, of Yale. Other authors from Yale are Moran Furman, Yann S. Mineur, Hui Chen, Sarah L. King, David Zenisek, Z.Jimmy Zhou, Ning Tian and Marina R. Picciotto.

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