Medical Xpress

Development of the brain's visual cortex depends on experience with light

September 8 2011

Tiny molecular signals that govern how the connections between brain cells mature when the eyes first see light have now been identified by a research team in MIT's Picower Institute for Learning and Memory and the Department of Brain and Cognitive Sciences.

Working with the brains of mice, the researchers identified small RNA molecules whose presence helped develop the connections between cells responsible for perceiving and processing signals from light. When the brain matures normally, these micro-RNAs allow visual brain regions to preferentially strengthen certain connections in response to the light they experience from their surroundings, a process known as synaptic plasticity. However, when one or both eyes are deprived of light, levels of these micro-RNAs are reduced and the connections don't develop properly.

"Our study is the first to demonstrate the existence of numerous experience-dependent micro-RNAs in the visual cortex, and to demonstrate that inhibition of one of these small RNAs causes a profound loss in the ability of neurons to adjust to changes in their input," says postdoc Nikolaos Mellios, the lead author of a research report appearing in the current issue of the scientific journal *Nature Neuroscience*.

Such research is important because neuroscientists see increasing evidence that abnormalities during the development of the brain's basic wiring play some role in brain disorders. Too-high or too-low levels of

micro-RNA molecules could contribute to these abnormalities.

The report's 12 authors did their work in the laboratory of Mriganka Sur, the Paul E. Newton (1965) Professor of Neuroscience at MIT, and at several research centers overseas.

Their studies focused on a micro-RNA molecule called miR-132, which was shown to steadily increase in abundance as the brain region responsible for vision, primary visual cortex, matured. Conversely, levels of miR-132 were reduced when animals were reared in darkness.

To study how miR-132 could impact the ability of this brain region to adapt to changing conditions, the scientists temporarily stitched closed one eyelid in mice, to stop the nerve signals from that eye from reaching neurons in the visual cortex. Because the other eye remained open, transmitting information to cortex normally, the scientists could study how the visual cortex responded to the mixed signals, offering clues about the brain's capacity to adapt to changes in input. Using an innovative technique to measure real-time activity in the brains of live mice, conducted by co-first author Hiroki Sugihara, the authors demonstrated that reducing miR-132 in neurons delayed their maturation and made them unable to respond to the changes in signals from the two eyes.

Scientists are aware that micro-RNAs orchestrate gene expression and coding proteins in cells, but little has been known about how these molecules contribute to processes of brain development that are dependent on experience and external surroundings. This research shows that they do, in fact, play an important role in synaptic plasticity, especially during sensitive periods of early maturation.

Micro-RNA was discovered only a dozen years ago, yet studying these molecules has led to a whole new understanding of how genes and

genetic systems communicate with each other inside living organisms. There is, of course, much yet to be learned.

Provided by Massachusetts Institute of Technology