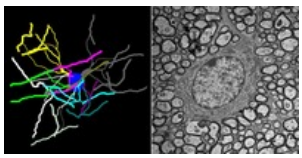
Science NOW UP TO THE MINUTE NEWS FROM SCIENCE

Early Isolation Impairs Brain Connections

by Emily Underwood on 13 September 2012, 5:17 PM | 5 Comments

During the 1980s, thousands of infants in Romanian orphanages spent up to 20 hours a day lying untouched in their cribs, deprived of human contact. As they grew up, neurological and psychological tests confirmed a haunting phenomenon observed in other species, such as mice and rhesus monkeys: Early isolation and neglect can produce lasting cognitive damage, ranging from severe emotional instability to mental retardation. Now, researchers say they have discovered a possible explanation for why early neglect wreaks such havoc—isolation may stunt the growth of the brain cells that insulate neurons, resulting in slower communication between different areas of the brain.

ENLARGE IMAGE



Swaddling cells. The growth of these neuron-supporting cells (*shown left* in a three-dimensional representation, and *right* in cross-section) can be stunted by early neglect.

Credit: Gabriel Corfas

Scientists have known for 50 years that the strength and arrangement of connections between neurons changes as we learn and experience new things, says Gabriel Corfas, senior author of the paper published online today in *Science* and a neuroscientist at Harvard Medical School in Boston and Boston Children's Hospital. But the role of the brain's non-neuronal cells in creating, strengthening, and shaping these neural circuits is more mysterious. The brain's "white matter"—as opposed to its gray matter, which is composed of neurons—consists mostly of glial cells, which produce the fat and protein myelin sheaths that insulate a neuron's branching axons, the slender fibers that conduct electrical impulses to other cells. One purpose of myelin, scientists think, is to reduce "leakage" of electric current as electrochemical signals zip to and fro. When the myelin is thin or damaged, the signals can't travel as fast; that slowdown can impair many different brain functions, including motor control, language, and memory.

Children who've experienced early neglect show reductions in their white matter—particularly in the prefrontal cortex, an area of the brain linked to decision making, working memory, and social function, Corfas says. To track how isolation might affect the development of the myelin-producing glial cells, called oligodendrocytes, the researchers bred mice in which those cells would glow: They added green fluorescent protein to the creatures' oligodendrocytes.

After the mice were weaned from their mothers at 21 days old, the researchers reared them in three different environments for 1 month. One group was raised alone, with one mouse per cage. In the second, "normal" group, four mice occupied a cage. The third group grew up in an "enriched" environment: A large cage contained eight mice as well as an assortment of toys.

After 4 weeks, the team introduced the mice in each group to one another and observed how they interacted—including how interested the mice were in exploring each other versus checking out objects in the cages. The difference was clear: Mice raised with four or more companions spent roughly 80% of their time mingling. Mice raised in isolation, however, were indifferent to the other mice; they were just as content to inspect inanimate objects.

The team also gave the mice a cognitive test, in which the rodents had to remember whether to turn right or left when swimming in a pool of water. With training, mice raised under "normal" conditions and enriched conditions

ScienceNOW. ISSN 1947-8062

learned to swim in the right direction in about 5 days. But the mice raised in isolation paddled confusedly around the pool, even after 7 days. "It was the same as if they had not been trained," Corfas says.

There was also a striking difference in the rodents' brain tissue, highlighted by the glowing green glial cells. Compared to the complex branched cells of the mice raised in "normal" or enriched conditions, oligodendrocytes in the isolated mice looked oddly stunted: They had fewer and shorter branches, with thinner myelin sheaths around the neuronal axons. In another trial, the team found that isolating the mice after they were 5 weeks old did not stunt oligodendrocytes, suggesting that the susceptible period for the mice lasted only between weaning and 5 weeks of age.

Finally, the team ran a series of experiments to better understand how mature glial cells develop, using mice genetically engineered to block the production or function of molecules involved in the growth and maintenance of oligodendrocytes. By process of elimination, they found that mice who were isolated when they were between 3 and 5 weeks old produce significantly less of a protein called neuregulin-1, or NRG1. NRG1 plays a role in fostering an oligodendrocyte's full development of long, complex branches that reach out to neurons and wrap neuronal axons in thick, protective myelin sheaths.

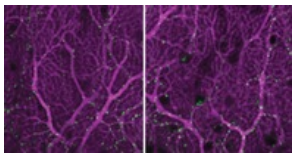
Together, Corfas says, the experiments show that oligodendrocytes require social interaction to develop properly, and that failure to receive that stimulation results in defective brain function. He hopes that the molecular insights that the team has gleaned from this study could also be applied to developing drug therapies to treat the effects of early neglect, as well as other neurodegenerative diseases associated with loss of the myelin sheath, such as multiple sclerosis.

The team's findings have "important implications" for how isolation affects the brain on a molecular level, with a mechanism that is likely to be the same across different species, says John Cacioppo, a social neuroscientist at the University of Chicago. Although this study focuses only on the effects of isolation in early life, he notes that for humans, even the perception of being alone can seriously affect long-term health. Loneliness isn't just angst, he says—it's an emotional signal we've evolved that motivates us to repair and maintain relationships, which are vital not only to our health and well-being, but to "the survival of our genes."

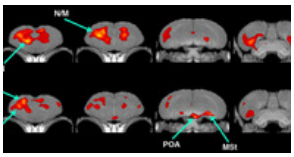
Follow ***Science*****NOW** *on Facebook and Twitter*

Posted in Neuroscience

Related Articles



SEPTEMBER 13, 2012
Rewiring the Autistic Brain



SEPTEMBER 10, 2012
***Science*Shot: Bird Brains Show Their Fear of Faces**

AUGUST 28, 2012
Chimps' Answer to Einstein

5 comments • 7 reactions

0 Stars

Leave a message...

Discussion | Community | My Disqus 100

Doug Fenner • 2 days ago

My memory is that the name of the cells that wrap around axons is "Schawann cells."
They may be a type of oligodendrocyte, but the classic name is Schwann cell.
It says scientists "think" that mylin speeds up conduction on axons. This is typical journalist cautionary talk which under-emphasizes the role of evidence. "Scientists conclude from extensive direct evidence that mylin sheaths speed up conduction" would be more accurate. This kind of talk plays into the hands of those who are anti-scientific and claim that evolution is not real, for instance. When a journalist writes "scientists believe evolution is real" then the religious people think that means that scientists are basing their views on faith, just like they themselves are. When in fact, the scientists are basing their views on piles of hard evidence. Statements in popular articles on science should state clearly when scientific views are based on evidence without saying "think" or "believe" as though the evidence was weak or lacking. That gives an opportunity for the public to interpret it as "scientists have their own opinion that is no more based on evidence than my opinion, all opinions are equal" which is just plain not true.

3 • Reply • Share ›

Gene Jockey • 9 hours ago • parent

Schwann cells are responsible for myelination in the peripheral nervous system. In the central nervous system, myelination of axons is undertaken by oligodendrocytes. These are the cells most altered in this study.

0 • Reply • Share ›

Cindy Kuhn • 2 days ago

Great research BUT it does not emulate what happened to Romanian infants as set up in the article. The period of time that animals were isolated (PN 21-PN 31) is more like late childhood-early adolescence, when animals learn their social skills (hence the interesting findigs about social interactions). They had a perfectly normal chidlhood with mom

4 • 1 • Reply • Share ›

Ying Chen • 2 days ago

interesting!

0 • Reply • Share ›

Ishtiyaque Ahmad • 2 days ago

Very interesting peice of reserach

1 • 1 • Reply • Share ›

ALSO ON SCIENCENOW What's this? ✕

Live Chat: Figuring Out What DNA Does

0 • 13 comments • 6 days ago

Chris Day — Is it really accurate to say that DNA is 'functional' just because it is transcribed. Couldn't this...

Harvard Psychology Researcher Committed Fraud, U.S. Investigation Concludes

1 • 4 comments • 10 days ago

Tom Davidson — Scientists are trained to respect empirically verifiable evidence above all else, and when their sta...

Plight of the Bumblebee

0 • 1 comment • 2 days ago

Ivan Meeus — I would like to point out that the other European bumblebee in Argentina isn't B. pascuorum but B....