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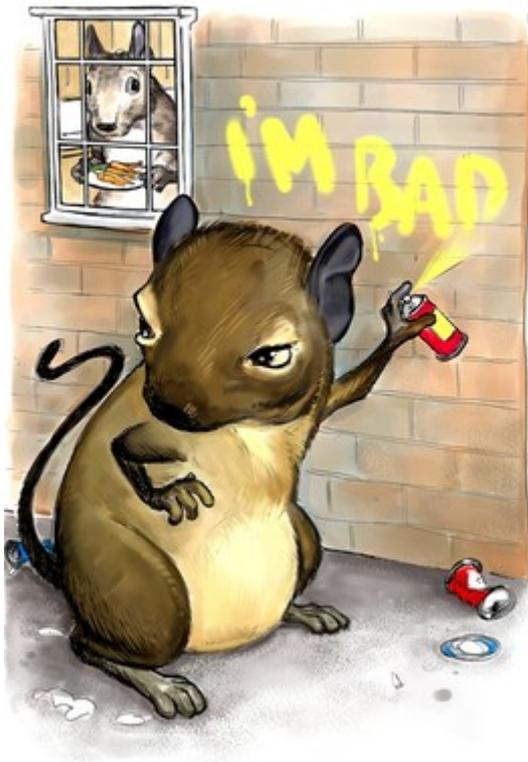
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This Is Your Brain Without Dad

By **SHIRLEY S. WANG**

Conventional wisdom holds that two parents are better than one. Scientists are now finding that growing up without a father actually changes the way your brain develops.

German biologist Anna Katharina Braun and others are conducting research on animals that are typically raised by two parents, in the hopes of better understanding the impact on humans of being raised by a single parent. Dr. Braun's work focuses on degus, small rodents related to guinea pigs and chinchillas, because mother and father degus naturally raise their babies together.



Matt Collins

When deprived of their father, the degu pups exhibit both short- and long-term changes in nerve-cell growth in different regions of the brain. Dr. Braun, director of the Institute of Biology at Otto von Guericke University in Magdeburg, and her colleagues are also looking at how these physical changes affect offspring behavior.

Their preliminary analysis indicates that fatherless degu pups exhibit more aggressive and impulsive behavior than pups raised by two parents.

In a study the researchers presented at the Society for Neuroscience meeting in Chicago earlier this month and recently published in the journal *Neuroscience*, half the degus were

raised with two parents, while the others were raised by a single mother, the father having been removed from the cage one day after the birth of his offspring.

Dr. Braun and her colleagues found that in the two-parent families, the degu mothers and fathers cared for their pups in similar ways, including sleeping next to or crouching over them, licking and grooming them, and playing with them. The fathers even exhibited a "nursing-type" position.

When the mother was a single parent, the frequency of her interactions with her pups didn't change much, which means that those pups experienced significantly less touching and interaction than those with two parents.

The researchers then looked at the neurons—cells that send and receive messages between the brain and the body—of some pups at day 21, around the time they were weaned from their mothers, and others at day 90, which is considered adulthood for the species.

Neurons have branches, known as dendrites, that conduct electrical signals received from other nerve cells to the body, or trunk, of the neuron. The leaves of the dendrites are protrusions called dendritic spines that receive messages and serve as the contact between neurons.

Dr. Braun's group found that at 21 days, the fatherless animals had less dense dendritic spines compared to animals raised by both parents, though they "caught up" by day 90. However, the length of some types of dendrites was significantly shorter in some parts of the brain, even in adulthood, in fatherless animals.

"It just shows that parents are leaving footprints on the brain of their kids," says Dr. Braun, 54 years old.

The neuronal differences were observed in a part of the brain called the amygdala, which is related to emotional responses and fear, and the orbitofrontal cortex, or OFC, the brain's decision-making center.

'A Horse Without a Rider'

The balance between these two brain parts is critical to normal emotional and cognitive functioning, according to Dr. Braun. If the OFC isn't active, the amygdala "goes crazy, like a horse without a rider," she says. In the case of the fatherless pups, there were fewer dendritic spines in the OFC, while the dendrite trees in the amygdala grew more and longer branches.

A preliminary analysis of the degus' behavior showed that fatherless animals seemed to have a lack of impulse control, Dr. Braun says. And, when they played with siblings, they engaged in more play-fighting or aggressive behavior.

In a separate study in Dr. Braun's lab conducted by post-doctoral researcher Joerg Bock, degu pups were removed from their caregivers for one hour a day. Just this small amount of stress leads the pups to exhibit more hyperactive behaviors and less focused attention, compared to those who aren't separated, Dr. Braun says. They also exhibit changes in their brain.

The basic wiring between the brain regions in the degu is the same as in humans, and the nerve cells are identical in their function. "So on that level we can assume that what happens

in the animal's brain when it's raised in an impoverished environment ... should be very similar to what happens in our children's brain," Dr. Braun says.

Other researchers, such as Xia Zhang, a senior scientist at the University of Ottawa Institute of Mental Health Research, and his colleagues in China, have observed different consequences using voles, mouselike rodents that also naturally co-parent. (Fewer than 10% of species raise their offspring with two parents.)

Voles deprived of their fathers—either from birth or later on in childhood—exhibited more anxious behaviors and were less social, spending less time engaging with stranger voles that were placed in their cage, according to a study by Dr. Zhang and his colleagues that was published in July in the journal *Behavioral Processes*.

Of course, the frontal cortex—where thinking and decision-making take place—is more complex in humans than it is in other animals. Thus, says Dr. Braun, it is important to be "really careful" about extrapolating the recent findings to human populations.

"The minute you get into stuff with extensive social and environmental components, the social differences between humans and animals are massive," says Simon Chapple, a senior economist in the social policy division of the Organization for Economic Cooperation and Development, the 30-country grouping of the world's largest economies.

It remains an "open verdict" whether single parenthood causes these bad outcomes, or is merely associated with them, says Dr. Chapple.

Risk of Delinquency

Still, the prevalence of single-parent households has researchers looking at possible consequences for children. An OECD report found that just 57% of children in the U.S. live with both parents, among the lowest percentages of the world's richest nations.

The report, which sparked some controversy when it was released in September, found that children in single-parent households have an increased risk of delinquency and attention deficit hyperactivity disorder, or ADHD, as well as poorer scholastic performance.

The OECD also analyzed data from 122 separate studies and found that there was variability in the negative effects on children of living in a single-parent home; on average, the OECD found, the magnitude of the impact was relatively small. On a standardized intelligence test with a median score of 100 points, for example, a child in a single-parent family would be about 3.5 points worse off than a similar child in a two-parent family, according to Dr. Chapple, who co-wrote the report.

Dr. Braun's goal for future research is to figure out whether degu pups' brains can be rewired by introducing a substitute caregiver, such as a grandmother, or whether other social and emotional enrichment can help "repair" the fatherless pups, she says. Human children may be sent to day care, for instance, which can help them form stable friendships with their peers and other adults.

The bottom line, says Dr. Braun, is that parents need to fuel their children's brains with talk, touch and sensitive stimulation that involves give and take.

Parents, she says, "are the sculptors of their children's brains."

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