SCIENCE BRIEF

The Environment and Experiences of Pregnant Mothers Affect Fetal Brain Development

A review of a recent study that shows the environmental experience of a pregnant mother will influence the production of naturally occurring chemicals that control fetal brain development.

Each Science Brief summarizes the findings and implications of a recent study in basic science or clinical research. Studies are selected for review based on their scientific merit and contributions to understanding early development. No single study is definitive, of course. Understanding of early development is based on many studies that, taken together, permit broad conclusions and human applications. Generalizing to human children the results of studies with animals, for example, must be done cautiously and confirmed by research with children and their families. The National Scientific Council rests its work on a rigorous discussion of the validity of many studies like these conducted over many years and using different methodologies and samples. For more information, go to www.developingchild.net

Suggested citation: National Scientific Council on the Developing Child, Science Briefs: *The Environment and Experiences of Pregnant Mothers Affect Fetal Brain Development.* (2008). http://www.developingchild.net

Why was the study done?

The disruption of healthy maternal experiences because of illness, poor nutrition, or lack of prenatal care is known to be a key risk factor influencing the development of children. The neuroscientific basis for the influence of maternal environments has focused on deprivation by exposing pregnant animals to periods of stress, comparing outcomes to standard laboratory cage environments. This standard environment, however, can itself be considered deprivation for rodents because of the lack of opportunities to engage in exploratory behavior that is typical for this species. Here, the authors examined how a more species-relevant, complex cage environment affects the growth and development of the retina, as compared to being housed in a standard laboratory environment deprived of toys and exploratory opportunities. The retina was studied because of its well-defined structure, the characteristic patterns in which different cell types in the retina mature, and previous identification of biochemicals that influence the developmental process.

What did the study find?

There was more rapid production and maturation of neurons that relay visual information to the brain—ganglion cells—in the retinas of fetal rats from mothers housed in the more complex environment, compared to those whose mothers received the typical laboratory housing experience. The development of other types of cells in the retina was unchanged. To determine *how* the maternal environment speeded up development, the authors measured levels of a hormone that is known to positively enhance neuron maturation. They measured higher levels of this hormone in the maternal brain and the milk from pregnant mothers housed in the complex environment, as well as parallel increases in the fetal retina, and even the cerebellum. In order to determine whether the maternal

increases in this hormone were in fact the source of the more rapid maturation of retina and cerebellum, they gave the pregnant mother antibodies that neutralize it, and the rapid development of the retina was prevented in the offspring. Finally, the authors provided a source of the hormone to pregnant rats living under the deprived, standard laboratory cage conditions, and found that it replicated the impact of the complex environment by speeding up retinal ganglion cell development.

How was the study conducted?

The entire pregnancy of the laboratory rats occurred in either a standard laboratory environment without items in the cage, or a complex cage environment, which contained toys, stairs, tunnels, and other items that provide opportunities for exploration. Fetuses were examined at two days, at the initial emergence of retina architecture and at a later time when most of the neurons have been produced. The development of the retina was monitored and compared in fetuses from the mothers in the complex and standard laboratory cage environments. To manipulate the hormone that enhances neuron maturation, insulin-like growth factor (IGF)-1, antibodies against IGF-1 or the IGF-1 protein were infused under the skin of pregnant rats, starting at mid-gestation.

What do the findings mean?

The results of this study have implications for understanding how experiences during pregnancy can change maternal chemistry in ways that ultimately lead to very specific effects on the development of the fetal nervous system. The authors showed that certain developing cells are more responsive to the chemical changes caused by the different experiences of the pregnant mother. Because rodents used in basic research are housed under conditions that are not typical for how the species lives in the wild, the study cannot address issues of how enriched, more positive experiences influence brain architecture compared to a typical healthy environment. Rather, the study shows that "normal" behavior during pregnancy is an important element in influencing the rates and patterns of fetal brain development. These findings have significant implications ensuring sound, healthy experiences for women during pregnancy. Moreover, the study may stimulate clinical research to examine the possibility of fetal therapy under situations in which levels of growth factors such as IGF-1 are disrupted.

Study Title and Authors

Sale, A., Cenni, M.C., Putignano, E., Chierzi, S. & Maffei, L. (2007). Maternal enrichment during pregnancy accelerates retinal development of the fetus. *Public Library of Science One (PLoS One),* 11:e1160.