NATIONAL SCIENTIFIC COUNCIL ON THE DEVELOPING CHILD
SCIENCE BRIEFS

NEUROSCIENCE

Enriched Environments in Adolescence Prevent Long-Term Effects of Early Impoverished Environments

A review of a recent study examining the potential for interventions to mitigate the effects of early adversity later in life.

Why was the study done? The effects of early toxic stress on infants and toddlers can alter the brain architecture and neurochemistry of circuits involved in cognitive performance and emotional control. Early stress can also impact the physical well-being of individuals well into adult life. Scientists would like to determine whether children exposed to early severe stress will respond to later interventions that may lessen the impact or even eliminate the negative effects of these early experiences. In addition, the timing of when the intervention needs to occur is a key issue for scientists to determine. This study used an animal model, in which the precise type and timing of early stress and the timing of the intervention could be well-controlled. The scientists were able to use standard behavioral and physiological measures to determine the impact of a well-defined intervention, exposing the animals to an enriched environment in large cages after the period of early stress.

What did the study find? The negative effects of early stress were mitigated by exposure to positive environments. By exposing rats to enriched environments just after weaning through the onset of puberty, the negative effects of early exposure to impoverished environments – as measured by physical development (weight gain), impaired learning and memory performance, and depressive-like behavior -- were prevented. In contrast, experiencing an enriched environment for control rats that were raised in a normal environment before weaning had no impact on overall behavioral performance, though both experimental and control groups exposed to an enriched environment did exhibit some positive changes in nerve cell communication at the level of the connections—the synapse.

How was the study conducted? For the impoverished environment, newborn rats were raised for the first 21 days after birth with their mother in a standard cage, but they were provided only with a single, small nesting with which to play and interact. After weaning, from postnatal day 22-52, the rats were placed either in a standard cage or in a larger cage that had

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SCIENCE BRIEFS summarize the findings and implications of a recent study in basic science or clinical resesarch. 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.

extensive materials, including a running wheel, toys, ramps, ropes and other constructions for climbing. The control group of rats was raised in a more standard early environment, in which the cage contained full nesting and other materials with which to play. These control animals were then exposed to the enriched or normal cage environment. On postnatal days 53-57, all animals were assessed for learning and memory in a standard maze task, in which they need to remember certain visual cues to find their way around the maze. In addition, the animals were tested for depressive-like behavior using a task that measures swimming in a small water pool. Here, the scientists measured the length of time the animals are willing to swim before giving up, a measure of depressive-like behavior. Finally, electrophysiology in the hippocampus, the part of the brain used in memory and learning, determined whether there was improved functioning of nerve connections (synapses), measured as an increase in the activity of the synapse. This improvement is called long-term potentiation by neuroscientists and is the physiological correlate of memory.

What do the findings mean? The authors note that both cognitive deficits and disrupted emotional behavior in rats that have experienced impoverished environments in early life can be prevented by exposing the animals to enriching life experiences right after the stressful experience. This study shows that impoverished environments, which are an early stressor, may elicit long-term physical and mental changes, but do not necessarily cause permanent deficits if interventions are implemented. It also shows that for animals raised in a typical environment with opportunities for stimulation, exposing them later to an enriching environment beyond acceptable, nurturing norms does not further improve behavioral functions such as learning and memory. The findings show that the systems of the brain involved in cognitive and emotional tasks remain plastic before and during adolescent development. This basic research study is exciting because it suggests that in the animal model, the so-called window of opportunity for effective interventions does not close immediately but remains available for some time, open to remediating stimuli. However, it must be emphasized that because rats develop far faster than children, it is not a simple exercise to make accurate predictions of the most appropriate timing and duration of using enriching environments in children exposed to toxic stress during early development.

Title and Authors: Cui, M., Yang, Y., Zhang, J., Han, H., Ma, W., Li, H., Mao, R., Xu, L., Hao, W., Cao, J. (2007) Enriched environment experience overcomes the memory deficits and depressive-like behavior induced by early life stress. Neuroscience Letters 404:208-212.