Prenatal Exposure to Drugs of Abuse May Affect Later Behavior and Learning

By Robert Mathias, NIDA NOTES Staff Writer

NIDA-funded studies are beginning to show that children who have been prenatally exposed to illicit drugs may be at risk of later behavioral and learning difficulties. Long-term studies using sophisticated assessment techniques indicate that prenatally exposed children may have subtle but significant impairments in their ability to regulate emotions and focus and sustain attention on a task. These neurobehavioral deficits may place these children on a developmental pathway that leads to poor school performance and other adverse consequences over time, researchers say.

"The evidence that prenatal exposure to drugs may contribute to later behavioral and learning problems has important public health implications," says NIDA Director Dr. Alan I. Leshner. "Although these effects are subtle and may not be universal, the rising tide of data from ongoing studies indicates that we need to be alert to the fact that children who have been exposed to drugs before birth may need special attention." However, because the long-term effects of prenatal drug exposure are still unclear, "we need more answers from research about the full extent of drug-induced impairments in children and what we ought to be doing to best address this problem," he says.

NIDA's 1992 National Pregnancy and Health Survey indicated that more than 5 percent of women use an illicit drug, most often marijuana or cocaine, during pregnancy. NIDA-supported researchers have been studying the effects of this prenatal drug exposure on infant and child development for a number of years. Most of these long-term studies have been assessing the clinical status of cocaine-exposed children since birth. Other long-term studies have been focusing on the status of children who have been prenatally exposed to opiates or marijuana and cocaine.

With some groups of cocaine-exposed children entering school and children in the marijuana-and-opiate-exposure studies well into their school years, the time was right to assess the status of developmental followup research with school-age, drug-exposed children. Therefore, NIDA convened more than 30 researchers conducting long-term studies with these children at a meeting in Bethesda, Maryland, in April. Representatives from the National Institute of Child Health and Human Development, the Substance Abuse and Mental Health Services Administration, and the Administration on Children, Youth, and Families also participated in the meeting. Meeting participants assessed current knowledge about the effects of prenatal drug exposure on school-age children, examined the biological and environmental mechanisms underlying these consequences, and discussed the "nuts and bolts" of conducting research to determine what happens to drug-exposed children as they progress through school and enter adolescence.
The ability to focus and sustain attention is a critical component of learning. NIDA-funded studies show that children prenatally exposed to drugs may have more difficulties in this area than nonexposed children.

Generally, most studies of physical and neurobehavioral outcomes in newborn infants have shown that prenatal exposure to marijuana, cocaine, and/or opiates increases the risk that exposed infants will be born prematurely, weigh less, have smaller heads, and be shorter than unexposed infants. However, assessing the full consequences of prenatal drug exposure for these children as they get older is a more complex task. The timing and amount of prenatal exposure, the mother's abuse of multiple drugs, poverty, poor nutrition, and inadequate prenatal and postnatal care are just some of the factors that can cloud the effects of prenatal maternal drug abuse on infants and children.

Because animal studies can exclude complicating variables, such research has provided valuable clues for researchers studying the consequences of prenatal drug exposure in children. Some important findings from animal research were presented at a conference in Washington, D.C., in September 1997, sponsored by the New York Academy of Sciences with support from NIDA. The conference brought together a number of leading basic scientists and clinical investigators to discuss what both lines of research were showing about the effects of cocaine on the developing brain. Several researchers presented data indicating that rabbits and mice prenatally exposed to cocaine develop specific and permanent brain changes. Dr. Pat Levitt, a NIDA-funded scientist from the University of Pittsburgh School of Medicine in Pennsylvania, reported finding abnormalities among rabbits prenatally exposed to cocaine in areas of the brain that are involved in attention and learning. Dr. Levitt's work buttresses other findings from animal research. For example, a NIDA-funded study at the University of Massachusetts in Amherst, Massachusetts, has shown that cocaine can enter the fetal brain of prenatally exposed rats and directly modify neurotransmitter activity in areas that play a role in learning, memory, motivation, motor control, and sensory processing.

The brain alterations found in prenatally exposed animals may provide a biological explanation for subtle impairments in emotional control and behavior that clinical researchers are uncovering in drug-exposed children whom they have been studying since the children were born. Although they remain cautious about drawing conclusions, researchers at the NIDA developmental followup meeting revealed a common thread of findings indicating that children who have been prenatally exposed to drugs may have early and persistent difficulties in regulating arousal appropriately, delaying gratification, tolerating frustration, and handling stress.

Dr. Margaret Bendersky of the Institute for the Study of Child Development at the University of Medicine and Dentistry of New Jersey in New Brunswick noted that her NIDA-funded study with Dr. Michael Lewis showed that a significantly greater number of 4-month-old cocaine-exposed infants had negative emotional reactions than nonexposed infants when play with their mothers was interrupted. These infants also responded more strongly to the stress of inoculation and took longer to calm down than nonexposed infants, she said.
Prenatal exposure to drugs may predict later difficulties in emotional regulation and social interactions and behaviors in the classroom.

Further analyses of the children at 2 years of age showed that, compared to nonexposed children, they were less able to control impulses and delay gratification and showed more frustration by kicking and screaming when restrained momentarily by their mothers. These findings were particularly true for children who were heavily exposed to cocaine. While the interaction of biological effects of early drug exposure on the brain and many other environmental factors is difficult to work out, "prenatal exposure may predict later difficulties in emotional regulation and social interactions and behaviors in the classroom," Dr. Bendersky noted.

The difficulty that some drug-exposed infants have in achieving a quiet, alert state may also affect their intellectual development because it can affect their ability to respond to new stimuli, focus and sustain attention, and process information. These abilities are critical components of learning. Cocaine-exposed children appear to be more impulsive than nonexposed children and have more difficulty screening out distractions and focusing their attention appropriately, reported Dr. Linda Mayes of the Yale University Child Study Center in New Haven, Connecticut.

Dr. Mayes' NIDA-funded study has been looking at emotional arousal and attention in a group of 475 children since they were born. Slightly more than half of these children were exposed to cocaine before birth. Followup assessments at 24 months showed cocaine-exposed children were more impulsive and language-delayed than noncocaine-exposed children, Dr. Mayes said. When both groups were tested again between ages 4 and 5, the cocaine-exposed children continued to be more impulsive, responding more quickly than nonexposed children when asked to press a button whenever they saw a picture that was repeatedly flashed on a computer screen. When the researchers added more pictures and asked the children to respond only when the designated picture appeared, the cocaine-exposed children still responded more quickly. However, they were unable to screen out the distracting pictures and made more errors than the nonexposed children did, Dr. Mayes said. "Their motor response is there, and it is fast, but it is separated from their processing of the difficulty of the task," she explained.

As children enter their school years, assessing the long-term consequences of drug exposure becomes even more difficult as school, teacher, peer, and neighborhood factors are added to the maternal, family, caregiver, and other home influences that continue to shape children's development. However, after sorting through the effects of these burgeoning variables, some studies are discovering differences in school performance between exposed and nonexposed children. For example, a NIDA-supported study with one of the oldest groups of cocaine-exposed children has completed an initial analysis of data on the first 22 cocaine-exposed and 24 nonexposed children in the study to complete the first grade. "The analysis showed that cocaine-exposed children were much more likely to be held back a grade and require special education classes than their peers in the control group," said Dr. Hallam Hurt of the Albert Einstein Medical Center in Philadelphia, Pennsylvania, who is conducting the study. Dr. Hurt cautions that these early findings are based on a relatively small number of children in the initial group. However, "if they are true, they are extremely important," she says. Dr. Hurt is continuing followup analyses with a second group of 55 children in the study who have just completed the first grade.

The subtle neurobehavioral impairments in arousal, emotional regulation, and the ability to focus and maintain attention shown in these studies may constitute a biological vulnerability that interacts with other developmental influences, such as a chaotic home environment or poor maternal care, says Dr. Vincent Smeriglio of NIDA's Center on AIDS and Other Medical Consequences of Drug Abuse. The interaction of these influences may produce a snowball effect on development and learning over time, he says. For this reason, researchers now are focusing more on understanding how the early neurobehavioral effects of prenatal drug exposure interact with
environmental factors that change over time to produce different outcomes for different drug-exposed children, Dr. Smeriglio says. "Such analyses are necessary to understand more clearly what is going on with drug-exposed children," he concludes.

**For more information**

A summary of the NIDA meeting on the developmental consequences of prenatal drug exposure in school-age children will be available on NIDA's home page on the World Wide Web at http://www.nida.nih.gov/ in early January 1998. (Also, see the special section of the Infant, Child and Adolescent Workgroup). The document summarizes workshops and lists recommendations in these areas of research:

- data analysis issues;
- the effects of drug exposure on children's cognitive and problem-solving abilities and emotional and social development;
- planning research on long-term outcomes for prenatally exposed children;
- approaches to investigating the amount and timing of prenatal drug exposure;
- methodological, legal, human subject, and social issues involved in followup research on children and their families; and
- practical issues involved in data collection and keeping participants in the studies as they enter school years and adolescence.

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http://www.drugabuse.gov/NIDA_Notes/NNVol13N4/Prenatal.html