

Developing Brains- Ideas for Parenting and Education From the New Brain Science

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Lead Exposure and the Developing Brain

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"We must make protection of the young brain a paramount goal of public health protection. You have only one chance to develop a brain."

-Phillippe Grandjean

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(Terradaily, Nov. 13, 2006)

What is the problem with lead exposure?

The development of a child's brain occurs in an environment, and that environment can either support or hinder the processes of development as directed by genetics. Toxic substances, such as lead, can disrupt the development and structure or architecture of the brain.

"The nature and severity of that disruption depend upon:

- the type of substance,
 - the level and duration of exposure,
 - and most important, on the timing during the developmental process."
- (NSCDC) 2006, 1)

How does lead disrupt development of the brain?

Lead (Pb), which is classified as a heavy metal, can disrupt several aspects of brain development. Among these are:

- "the formation and sculpting of neural circuits" (NSCDC 2006, 3), and
- The process of myelination (the formation of fatty insulation along the axon).

This disruption is due, in part, to "interference with the normal function of several important neurotransmitters, including dopamine, glutamate, and acetylcholine." (NSCDC 2006, 3)

Lead exposure also “reduces the birth and survival of new neurons (neurogenesis) in the brain,” particularly in the hippocampus, which is involved in learning and memory. (News-Medical.Net 2007) Lead also interferes with cell differentiation, the formation of synapses, and cell pruning through programmed cell death. (Schettler, et. al. May 2000)

Thomás Guilarte (of Johns Hopkins Bloomberg School of Public Health) states: “now that we know that lead decreases neurogenesis in the hippocampus and alters the ability of these new neurons to communicate, in future studies we hope to determine if environmental enrichment can reverse the long-term learning deficits caused by lead poisoning.” (News-Medical.Net 2007) At the same time, of course, we should be working to reduce or eliminate exposure to lead at any point in the life span. No one is immune to the effects of lead exposure.

Fetal exposure

“The fetal brain may be particularly sensitive [to lead exposure] not only because unique organizational processes are underway but also because of an immature blood-brain barrier¹.” (Schettler, et. al. May 2000)

“Lead tends to be stored in bones, and during pregnancy, accelerated maternal bone turnover results in mobilization of lead, leading to increased blood lead levels.... Lead easily crosses the placenta and enters the fetal brain where it interferes with normal development. One study found greater uptake of lead in [the] fetal brain during gestation than after birth in rats.” (Schettler, et. al. May 2000)

The protective blood-brain barrier is not present in the fetus and “only reaches maturity in the first year after birth. Thus, the time of greatest brain growth and most intensive construction of brain architecture is also the period that is most vulnerable to the relatively free passage of toxins into its cells.” (NSCDC 2006, 2) Women who are of child bearing age should be alert to reducing their exposure to lead as much as possible; and, women who are pregnant should wash their hands frequently, in addition to avoiding exposure to lead.

¹ The blood-brain barrier is made of “cells that restrict the entry of chemicals from the bloodstream into brain tissue.” (NSCDC 2006, 2)

What are the effects of lead exposure?

The findings of research indicate that toxins such as lead, even at low levels, can have "subclinical effects, such as decreases in intelligence or changes in behavior." (Terradaily Nov. 13, 2006) When children are exposed to low levels of lead, they may display behavior that is inattentive, hyperactive, and irritable. At higher levels of exposure, children may have trouble learning, reading, and may have delayed growth and suffer hearing loss. "At high levels, lead can cause permanent brain damage and death." (Facts for Families 2004)

Two studies that were published in 2008 were described in Science News by Rachel Ehrenberg. These studies were both looking at the long term impact of childhood lead exposure. One study, which used MRI scans of the brains of young adults, "revealed that the more lead the participants were exposed to as children, the smaller their adult brains were..." (8) The part of the brain that was especially affected was the anterior cingulate cortex. This is "a brain region associated with mood regulation, decision making and impulse control..." (Ehrenberg, 2008, 8)

In the second study, the researchers compared the subjects' arrest records (current) with their childhood levels of lead in their blood. They found that as the childhood blood lead levels increased, so did the total arrests they had as well as the total arrests for *violent* crimes. (Ehrenberg, 2008, 8)

Some of the harmful consequences of exposure may create problems for the person in school and work life, such as having a shortened attention span and heightened aggression. In the long term, exposure to lead in childhood may increase the risk of developing Parkinson's disease. (Terradaily Nov. 13, 2006)

Lead Exposure and Academic Performance

Thinking and feeling are the functions that are most likely to be disrupted by toxic exposures. (NSCDC 2006, 3) The cognitive problems include:

- Mild decrease in I.Q.
- Slower response time
- Central auditory processing problems
- Word finding difficulties
- Sequencing difficulties

- Perceptual integration problems

Academic behavior problems include such things as:

- Problems in organization
- Inability to show persistence
- Problems following instructions
- Overall poor academic functioning (Naylor 2005)

Lead levels in children are related to high school graduation - the higher the lead levels, the lower the graduation rate. High lead levels are also associated with increased juvenile delinquency. In terms of mental illness, one study found that for babies born to mothers with high lead levels during the 2nd trimester, the risk of developing "schizophrenia later in life is doubled." (Naylor 2005) Lead harms people at any age, but children are at greatest risk for serious harm.

What are the sources of lead exposure?

"Since lead was removed from most of the nation's gasoline supply, most current environmental exposures in the U.S. come from lead paint, lead contaminated dust, and drinking water." (Schettler, et. al. May 2000)

Lead-based paint is most frequently found in housing built before 1950, but houses built before 1978 are likely to have some lead-based paint in them. Levels of lead in the blood have gone down since the early 1980s. (Facts for Families, 2004; CDC, "Tips to Prevent Lead Exposure" 2007; and Ehrenberg 2008, 8)

Household dust is a major source of lead, according to the Centers for Disease Control and Prevention (CDC), so frequent hand-washing, washing of toys, and "wet" cleaning of floors and window sills are recommended as some ways to prevent contamination. (Links to CDC articles are in the References section below.)

In their article, "Toys and Childhood Lead Exposure," the CDC explains how lead is used in the manufacture of toys.

"Paint: Lead may be found in the paint on toys. It was banned in house paint, on products marketed to children, and in dishes or cookware in

the United States in 1978; however, it is still widely used in other countries and therefore can still be found on imported toys. It may also be found on older toys made in the United States before the ban.

"Plastic: The use of lead in plastics has not been banned. It softens the plastic and makes it more flexible so that it can go back to its original shape. It may also be used in plastic toys to stabilize molecules from heat. When the plastic is exposed to substances such as sunlight, air, and detergents the chemical bond between the lead and plastics breaks down and forms a dust." (CDC, "Toys and Lead Exposure" (8/31/2007)

The CDC has a list of "Tips to Prevent Lead Exposure". The basic idea in prevention of lead poisoning is to keep children from coming into contact with lead. If a child or adult has been poisoned by lead, identifying this and seeking treatment as soon as possible is recommended. For more information on prevention and recalls, see the CDC's site on Lead Poisoning Prevention Program at <http://www.cdc.gov/nceh/lead/default.htm>.

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