

Learning Disabilities, Behavioral/Emotional Disorders, and Other Brain Disorders: What We Know

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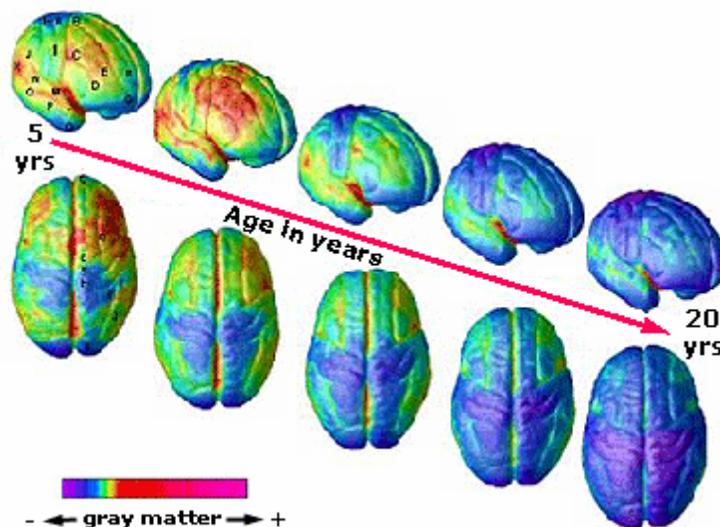
There are many ways that something can go awry in the brain, which can impair our ability to learn, think, move, feel, perceive and/or behave appropriately.

A **learning disability** is a neurological condition that interferes with a person's ability to store, process, or produce information. There are many types of learning disabilities. For example, **dyslexia** (a language-based disability), **dyscalculia** (a mathematical disability), and **dysgraphia** (a writing disability) are common learning disabilities.

Learning disabilities affect 5-10% of children in U.S. public schools. People with learning disabilities may have a more difficult time keeping a job or progressing in school. Learning problems that result from mental retardation, emotional disturbance, or visual/hearing impairments are not considered learning disabilities.

The developing brain is extraordinarily sensitive to environmental agents—exposure levels that have no lasting effect on an adult's brain can have dramatic effects on the developing brain before birth or during childhood.

The brain starts developing early in embryonic life and continues developing into adolescence.



Time-lapse images of the brain showing how it matures between ages 5 and 20 and the different amounts of grey matter (blues and purples mean less grey matter, red indicates more grey matter). From Gogtay et al. 2004.

Behavioral/Emotional disorders are characterized by:

- an inability to learn which cannot be explained by intellectual, sensory or health factors
- an inability to build satisfactory relationship with peers and teachers
- inappropriate types of behavior or feelings under normal circumstances
- a general pervasive mood of unhappiness or depression, or
- a tendency to develop physical symptoms or fear associated with personal or school problems

Autism involves life-long difficulties in communication, social interaction, and restrictive or repetitive interests and behaviors. Children with autism or related disorders may not interact and may avoid eye contact.

About 2 out of every 1,000 children have autism—an estimate much higher than a generation ago. Autism appears to be increasing, although it is not known how much of the increase might be due to better reporting or changes in diagnosis. Autism is much more common amongst boys than girls.

Attention disorders such as attention deficit hyperactivity disorder (ADHD) are the most commonly diagnosed behavioral disorders in children, affecting 3-6% of children. Children with ADHD have “a persistent pattern of inattention and/or hyperactivity-impulsivity that is more frequent and severe than is typically observed in individuals at a comparable level of development.”

ADHD and learning disabilities often occur together. ADHD is much more common in boys than girls, with lower-income boys are at especially high risk . Some studies have demonstrated increases in substance abuse, risk-taking, and criminal behaviors among adolescents and adults with ADHD.

Schizophrenia is a serious emotional disorder affecting between 0.5% and 1% of people. Hallucinations and delusions, disorganized speech, or catatonic behavior are common symptoms, which frequently manifest in young adulthood. The symptoms may also occur in younger children. There are a number of subtypes of schizophrenia.

Cerebral palsy, epilepsy, Creutzfeldt-Jakob Disease (CJD), and degenerative illnesses such as Parkinson’s disease and **Alzheimer’s** are other conditions where something in the brain has gone awry.

What Causes Learning Disabilities, Emotional/Behavioral Disorders, and Other Brain Disorders?

Genetics, environmental, and social factors interact in complex ways to determine how the brain develops and functions. They may be inherited, or caused by factors that impact brain development before, during, or after birth (such as drugs or poor nutrition before or after birth,

German measles before birth, or oxygen deprivation during birth. Or, they can be related to brain trauma or brain tumors.

How can environmental agents affect the brain?

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One way that environmental agents disrupt brain development is by interfering with the processes that control gene activity. New research is finding, for example, that the compound bisphenol A affects when genes important for controlling brain development are turned on.

By altering gene expression, environmental agents can interfere with any one of many steps of brain development, as brain cells divide, differentiate into specialized cell types, establish connections with other brain cells, and die. Environmental agents can also interfere with chemical messengers in the brain that help transmit nerve impulses.

Interfering with any one step may impact later steps of brain development. The timing can be as important as the amount of exposure. Thus, even a brief exposure to an environmental agent at an important step in brain development can have significant consequences later in life.

Lead, alcohol, and nicotine are known to interfere at several points in brain development. Both lead and alcohol interfere with the differentiation of nerve cells, as well as the transmission of nerve impulses, for example.

What role do environmental agents play in learning disabilities, behavioral/emotional disorders, and other brain disorders?

A few chemicals have been studied intensively for their impacts on the brain. However, the vast majority of chemicals to which people are commonly exposed have never been examined at all for their impacts on the developing brain. Among those that have been studied incompletely, evidence coming from a wide array of experiments in the lab point to possible impacts on people. There are many scientific steps between what we understand today and reaching scientific certainty, but we already can make some targeted recommendations about ways that exposure reduction might reduce risks.

Below are some examples of environmental agents that affect the brain and can play a role in brain disorders:

- **Lead** exposures during infancy and childhood can cause attention problems, hyperactivity, impulsive behavior, reduced IQ, poor school performance, aggression, and delinquent behavior. Lead paint and lead-contaminated water and soil are the major

sources of lead exposure to children. The more lead is studied, the more evidence we have showing that levels previously thought “safe” actually cause harm to the developing brain.

- **Mercury** easily crosses the placenta and disrupts many steps in brain development. Even exposures at relatively low levels to a pregnant woman can impair the IQ, language development, visual-spatial skills, memory, and attention of her child. Like with lead, the “safe” level of mercury keeps dropping the more mercury is studied.
- **Manganese** is essential to health at low levels in the diet, but elevated levels of manganese in hair are associated with ADHD, and laboratory experiments in animals link manganese with hyperactivity. It is also associated with Parkinsons.
- **PCBs** (polychlorinated biphenyls), industrial chemicals now banned but which persist in the environment, especially in fatty tissue, can impair reflexes and IQ, delay mental development and the development of motor skills, and cause hyperactivity. These effects have been demonstrated in children born to women who consumed fish contaminated with PCBs, as well as in laboratory animals.
- **Tobacco smoke and nicotine** are among the best studied agents for their effects on the developing brain. Children born to women who smoke during pregnancy are at risk for IQ deficits, learning disorders, and attention deficits. Children born to women who are passively exposed to cigarette smoke are also at risk for impaired speech, language skills, and intelligence. Children exposed to tobacco smoke after birth also are at risk for various behavioral problems.
- **Alcohol** crosses the placenta and disrupts many steps in brain development. Depending on the timing and amount of exposure to a pregnant woman, the exposed fetus may develop into a child with hyperactivity, learning problems, lowered IQ, or in more serious cases, mental retardation.
- **Bisphenol A** alters the expression of genes that are important for long-term memory formation and for early brain development. Exposing fetal mice to extremely low doses of bisphenol causes changes in their adult behavior.
- **Perchlorate**, a rocket fuel that now contaminates drinking water in many communities in the US west, interferes with thyroid hormone control of brain development in mice.
- **Solvents** like toluene cause learning, speech, and motor skill problems in children. These effects were discovered in studies of children borne to mothers who sniffed glue during pregnancy. The impacts on the developing brain of other solvents have not been studied in humans, but studies in animals indicate that they can also impair normal brain development.
- **Prions**, an infectious form of a type of protein, are believed to be the agents that cause a rare brain disorder called variant Creutzfeldt-Jakob Disease (CJD) in humans, as well as mad cow disease in cattle, chronic wasting syndrome in deer and elk, scrapie in sheep, and other similar brain diseases in other species. People can be exposed to prions by eating contaminated food or other products made from animals with diseases such as mad cow disease.

Why isn't more known?

There are a number of reasons, including:

- The brain is complex and can be affected in many ways.

- Interactions between multiple factors (environmental, social, genetic) make it hard to pinpoint the contribution of one factor
- Lag time between exposure and effects makes it difficult to measure or estimate exposure.
- It is difficult to use experimental animals to study how environmental agents affect higher mental abilities involving learning and behavior since these are often unique to humans.

Where does that leave us now?

- Learning disabilities, behavioral disorders such as autism and ADHD, and some other brain disorders appear to be on the increase but for the most part, hard numbers are lacking.
- The largest study of children in history, the National Children's Study, will track more than 100,000 children from before birth until age 21, examining how inheritance and a variety of environment, social, cultural, dietary, and biological factors influence health and development. Behavioral disorders like ADHD and autism are high on the study's research agenda.
- New scientific results on the impact of lead, mercury, microwave radiation, bisphenol A, flame retardants, PAHs (polycyclic aromatic hydrocarbons) and other agents provide intriguing clues that need follow-up.
- Few of the chemicals in widespread use today--even those regularly found in human tissue, including umbilical cord blood and amniotic fluid--have been submitted to any testing to determine their possible impact on neurological development.
- A "better safe than sorry" approach based on the precautionary principle should be taken when dealing with chemicals that may impact the developing brain. While such an approach is most effective when it is taken by government and industry, there fortunately are many common sense steps that individuals and families can take as well.