

The Adolescent Brain

Making a Difference Today

Adolescence is often a time when teens seek more independence, knowledge and discovery. It also is a time when changes to their brain can cause them to take greater risks, to become more vulnerable to addiction, or increase their chance of developing a mental illness.

Many teens experiment with drugs and alcohol during adolescence. A 2004 study found that 70 percent of high school seniors used alcohol in the previous year. Furthermore, the adolescent brain may be especially vulnerable to the negative effects of drugs, including a greater chance of becoming addicted later in life compared with teens who don't use drugs.

Unusual brain changes and behaviors often appear in adolescence. A 2005 report found that an estimated 2.7 million children and adolescents are suffering from severe emotional or behavioral difficulties. These difficulties may persist into adulthood and lead to lifelong disability, including more serious forms of mental illnesses.

To reduce the incidence and impact of mental disorders and emotional problems, it is essential to continue research on both the normal and abnormal brain changes that occur during adolescence.

Research Advances Understanding

Scientists once thought that a critical period of brain development occurred only during the first few years of childhood. However, current findings suggest that certain brain regions undergo refinement throughout adolescence.

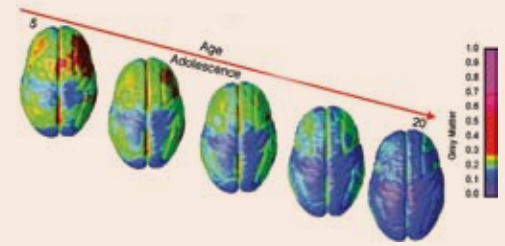
For example, new research supported by the National Institutes of Health (NIH) examined changes in the brain for clues to explain normal and abnormal adolescent behavior. Scientists found that nerve connections and pathways in the brain change over time to meet the needs of the environment during adolescence. Overall, gray matter volume increases at earlier ages, but by puberty it begins to decrease and thin, which correlates with advancing cognitive, or reasoning, abilities. Scientists suspect this process may reflect more efficient organization of the brain as it prunes redundant connections and speeds signal transmission through increased myelin formation.

Other evidence of adolescent brain refinement comes from imaging studies showing that parts of the brain associated with more basic functions, such as motor and sensory areas, mature early; regions showing delayed maturation include ones involved in planning and decision-making, such as the prefrontal cortex—the area of the brain important for controlling impulses and emotions—which doesn't attain adult characteristics until the early 20s. Research also has revealed that the brain's reward center, the ventral striatum, is more active during adolescence than in adulthood, and that the adolescent brain may still be strengthening connections between its reasoning- and emotion-related regions.

With their brain's emotion-related areas and connections still maturing, adolescents may be more vulnerable to psychological disorders, such as depression or bipolar disorder. A recent study supported by the NIH suggests that bipolar disorder is as common among youths as it is among adults. However, adult therapies may not be as effective, or as safe, for adolescents. Scientists are currently studying the effectiveness of adult psychotherapies, including medications and cognitive-behavioral therapy, when prescribed for teens.

Better Understanding Leads to Treatments

Knowing more about the changing adolescent brain has spurred treatment studies on teen disorders. For example, a recent NIH clinical trial found that combining the medication fluoxetine with cognitive behavioral therapy was more effective in treating depression in adolescents than either the drug or therapy alone. Another similar study found that the combination of therapy and the drug sertraline was effective in treating Obsessive Compulsive Disorder in adolescents.



These composite brain models derived from magnetic resonance images show the sequence of gray matter maturation over the top surface of the brain. Scientists found that, overall, gray matter volume increased at earlier ages, followed by sustained loss and thinning starting around puberty, which correlates with advancing cognitive abilities. Scientists suspect this process reflects more efficient organization of the brain as it prunes redundant connections, and increased myelin forming, which enhances neuron's ability to transmit impulses.

Continued funding for research could lead to:

- Improved understanding of the growing adolescent brain, both in normal and abnormal development.
- Earlier and more reliable detection of abnormal brain changes that may serve as markers for diseases or disorders later in life.
- Improved and targeted interventions that can be administered early enough to delay or halt the development of more serious illness, such as depression.

For more information please email brss@sfn.org.

The Adolescent Brain

Making a Difference Tomorrow

Although research has advanced our understanding of typical adolescent brain development, many questions remain. Continued funding for research is needed to aid our understanding of both typical and atypical brain development and behaviors, so that better and earlier interventions and treatments can be developed.

Did you know that:

- Different parts of the brain mature at different rates.
- The adolescent's brain may be particularly vulnerable to the negative effects of drugs.
- Some brain changes associated with psychological disorders, including those that may not manifest until adulthood, are present during adolescence.
- An estimated 2.7 million children and adolescents suffer from serious emotional or behavioral difficulties.

Hope for Early Intervention and Prevention

New discoveries often arise from technological advances. For example, advances in brain imaging methods enable scientists to re-scan subjects at regular intervals to map brain tissue growth spurts and losses. This allows researchers to compare brain growth in both health and disease and to pinpoint where brain changes are most prominent in disease. This research may lead to targeted interventions to better treat or prevent ensuing disorders. Scientists also are exploring the use of low doses of the medication lithium to prevent the atrophy and loss of brain cells in bipolar disorder.

Research Brings Hope for the Future

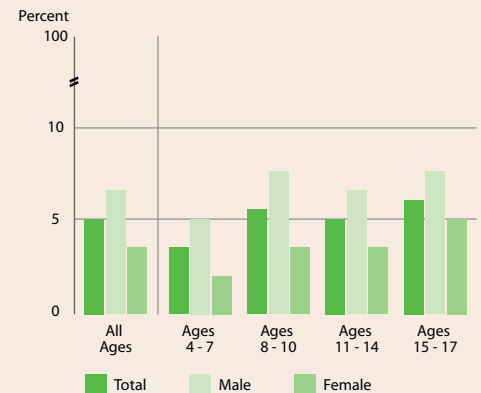
Advances in our understanding of typical adolescent brain development have aided scientists in learning more about what is different or atypical in the brain as it grows.

For example, findings that normal changes occur in the volume of brain structures implicated in emotional experience, learning, and memory have led to the discovery that these changes differ between men and women beginning at puberty. These results may have relevance to the higher incidence of depression in women that emerges during adolescence.

Recent research is also investigating the manifestations of other psychological disorders in adolescents, particularly schizophrenia. Large brain-imaging studies supported by the NIH have shown that brain changes associated with schizophrenia typically begin when the brain is undergoing the normal childhood sequence of growth spurts followed by a loss of gray matter. Scientists have discovered a larger and more severe wave of gray matter loss in the brains of adolescents developing schizophrenia, which eventually affects much of the cortex after a period of five years. Overall, the loss corresponds with impairments in neuromotor, auditory, visual search, and planning and decision-making functions that characterize schizophrenia. Scientists believe that a teen's natural loss of gray matter may be accelerated or otherwise altered in schizophrenia and in other neurodevelopmental disorders.

Increased funding for both typical and atypical adolescent brain research is essential to keeping teens' brains healthy into adulthood and for developing better therapies for disorders that emerge during the teen years.

Percentage of children ages 4 through 17 reported by a parent to have definite or severe emotional or behavioral difficulties, by age and gender



A 2005 report found that an estimated 5 percent, or 2.7 million, children and adolescents are reported by their parents to suffer from severe emotional or behavioral difficulties. These difficulties may persist throughout development and lead to lifelong disability, including more serious mental illnesses. With advanced brain imaging techniques, scientists now can see some of the atypical brain changes that may occur in adolescence.

Already research has led to:

- Discovering that the brain's key development is not complete by the first few years of life, but continues through adolescence and into a person's twenties.
- Increased understanding of the gray matter loss that begins in adolescence, which correlates with advancing cognitive abilities.
- Better understanding of the brain regions that are still maturing during adolescence, like the prefrontal cortex, which may help explain why teens are more apt to engage in risky behaviors.
- Improved treatments for disorders that typically arise in adolescence.

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