SURVIVING THE TEENAGE BRAIN

One of the ways that scientists have searched for the causes of mental illness is by studying the development of the brain from birth to adulthood. Powerful new technologies have enabled them to track the growth of the brain and to investigate the connections between brain function, development, and behavior.

The research has turned up some surprises, among them the discovery of striking changes taking place during the teen years. These findings have altered long-held assumptions about the timing of brain maturation. In key ways, the brain doesn't look like that of an adult until the early 20s.

An understanding of how the brain of an adolescent is changing may help explain a puzzling contradiction of adolescence: young people at this age are close to a lifelong peak of physical health, strength, and mental capacity, and yet, for some, this can be a hazardous age. Mortality rates jump between early and late adolescence. Rates of death by injury between ages 15 to 19 are about six times that of the rate between ages 10 and 14. Crime rates are highest among young males and rates of alcohol abuse are high relative to other ages. Even though most adolescents come through this transitional age well, it's important to understand the risk factors for behavior that can have serious consequences. Genes, childhood experience, and the environment in which a young person reaches adolescence all shape behavior. Adding to this complex picture, research is revealing how all these factors act in the context of a brain that is changing, with its own impact on behavior.

The more we learn, the better we may be able to understand the abilities and vulnerabilities of teens, and the significance of this stage for life-long mental health.

The fact that so much change is taking place beneath the surface may be something for parents to keep in mind during the ups and downs of adolescence.

The scans also suggest that different parts of the cortex mature at different rates. Areas involved in more basic functions mature first: those involved, for example, in the processing of information from the senses, and in controlling movement. The parts of the brain responsible for more "top-down" control, controlling impulses, and planning ahead—the hallmarks of adult behavior—are among the last to mature.

A Spectrum of Change

Research using many different approaches is showing that more than gray matter is changing:

- Connections between different parts of the brain increase throughout childhood and well into adulthood. As the brain develops, the fibers connecting nerve cells are wrapped in a protein that greatly increases the speed with which they can transmit impulses from cell to cell. The resulting increase in connectivity—a little like providing a growing city with a fast, integrated communication system—shapes how well different parts of the brain work in tandem. Research is finding that the extent of connectivity is related to growth in intellectual capacities such as memory and reading ability.

- Several lines of evidence suggest that the brain circuitry involved in emotional responses is changing during the teen years. Functional brain imaging studies, for example, suggest that the responses of teens to emotionally loaded images and situations are heightened relative to younger children and adults. The brain changes underlying these patterns involve brain centers and signaling molecules that are part of the reward system with which the brain motivates behavior. These age-related changes shape how much different parts of the brain are activated in response to experience, and in terms of behavior, the urgency and intensity of emotional reactions.

- Enormous hormonal changes take place during adolescence. Reproductive hormones shape not only sex-related growth and behavior, but overall social behavior. Hormone systems involved in the brain's response to stress are also changing during the teens. As with reproductive hormones, stress hormones can have complex effects on the brain, and as a result, behavior.

- In terms of sheer intellectual power, the brain of an adolescent is a match for an adult's. The capacity of a person to learn will never be greater than during adolescence. At the same time, behavioral tests, sometimes combined with functional brain imaging, suggest differences in how adolescents and adults carry out mental tasks. Adolescents and adults seem to engage different parts of the brain to different extents during tests requiring calculation and impulse control, or in reaction to emotional content.

- Research suggests that adolescence brings with it brain-based changes in the regulation of sleep that may contribute to teens' tendency to stay up late at night. Along with the obvious effects of sleep deprivation, such as fatigue and difficulty maintaining attention, inadequate sleep is a powerful contributor to irritability and depression. Studies of children and adolescents have found that sleep deprivation can increase impulsive behavior; some researchers report finding that it is a factor in delinquency. Adequate sleep is central to physical and emotional health.

The Changing Brain and Behavior in Teens

One interpretation of all these findings is that in teens, the parts of the brain involved in emotional responses are fully online, or even more active than in adults, while the parts of the brain involved in keeping emotional, impulsive responses in check are still reaching maturity. Such a changing balance might provide clues to a youthful appetite for novelty, and a tendency to act on impulse—without regard for risk.

While much is being learned about the teen brain, it is not yet possible to know to what extent a particular behavior or ability is the result of a feature of brain structure—or a change in brain structure. Changes in the brain take place in the context of many other factors, among them, inborn traits, personal history, family, friends, community, and culture.

The Adolescent and Adult Brain

It is not surprising that the behavior of adolescents would be a study in change, since the brain itself is changing in such striking ways. Scientists emphasize that the fact that the teen brain is in transition doesn't mean it is somehow not up to par. It is different from both a child's and an adult's in ways that may equip youth to make the transition from dependence to independence. The capacity for learning at this age, an expanding social life, and a taste for exploration and limit testing may all, to some extent, be reflections of age-related biology.

Understanding the changes taking place in the brain at this age presents an opportunity to intervene early in mental illnesses that have their onset at this age. Research findings on the brain may also serve to help adults understand the importance of creating an environment in which teens can explore and experiment while helping them avoid behavior that is destructive to themselves and others.

QUESTIONS TO PONDER AND DISCUSS