

# Brain Facts

## AGING

**NEUROSCIENTISTS BELIEVE** that the brain can remain relatively healthy and fully functioning as it ages and that diseases cause the most severe decline in memory, intelligence, verbal fluency, and other tasks. Researchers are investigating both the abnormal and normal changes that occur over time and their effect on reasoning and other intellectual activities.

The effects of age on brain function are subtle and very selective. Almost everyone gets a bit forgetful in old age, particularly in forming memories of recent events. For example, once you reach your 70s, you may start to forget names, phone numbers, or where you parked your car, or you might respond more slowly to conflicting information. This is not disease. Some individuals, however, develop *senile dementia*, the progressive and severe impairment in mental function that interferes with daily living. The senile dementias include Alzheimer's and cerebrovascular diseases and affect about 1 percent of people younger than age 65, with the incidence possibly increasing to nearly 50 percent in those older than 85. In a small, third group, mental functioning seems relatively unaffected by age. Many people do well throughout life and continue to do well even when old, at least until shortly before death. The wisdom and experience of older people often make up for deficits in performance. The oldest human, Jeanne Calment, kept her wits throughout her 122-year life span.

The belief that pronounced and progressive mental decline is inevitable was and still is popular for several reasons. For one, until the 20th century, few people lived past 65. In 1900, when average life expectancy was about 47 years, 3 million people, or 4 percent of the population, were older than age 65 and typically were ill. In 2003, when life expectancy was more than 77 years, nearly 36 million people, or more than 12 percent of the population, were older than age 65. A generation ago, frailty was seen among people in their 60s; today it is more typical among those in their 80s. Moreover, few people challenged the notion that aging meant inevitable brain decline because scientists knew little about the brain or the aging process. Today's understanding of how the normal brain ages comes from studies of the nervous system that began decades ago and are just now bearing results. Modern technologies now make it possible to explore the structure and function of the brain in more depth than ever before and to ask questions about what actually happens in its aging cells.

Thus, neuroscientists are increasingly able to distinguish between the processes of normal aging and disease. Although some changes do occur in normal aging, they are not as severe as scientists once thought and certainly do not include widespread cell loss.

All human behavior is determined by how well the brain's communication systems work. Often a failure in the cascade of one of these systems results in a disturbance of normal function. Such a failure may be caused by an abnormal biochemical process or a loss of connections between neurons.

The cause of normal brain aging remains a mystery. Dozens of theories abound. One says that specific "aging genes" are switched on at a certain time of life. Another points to genetic mutations or deletions. Other theories implicate hormonal influences, an immune system gone awry, and the accumulation of damage caused by free radicals, cell byproducts that destroy fats and proteins vital to normal cell function.

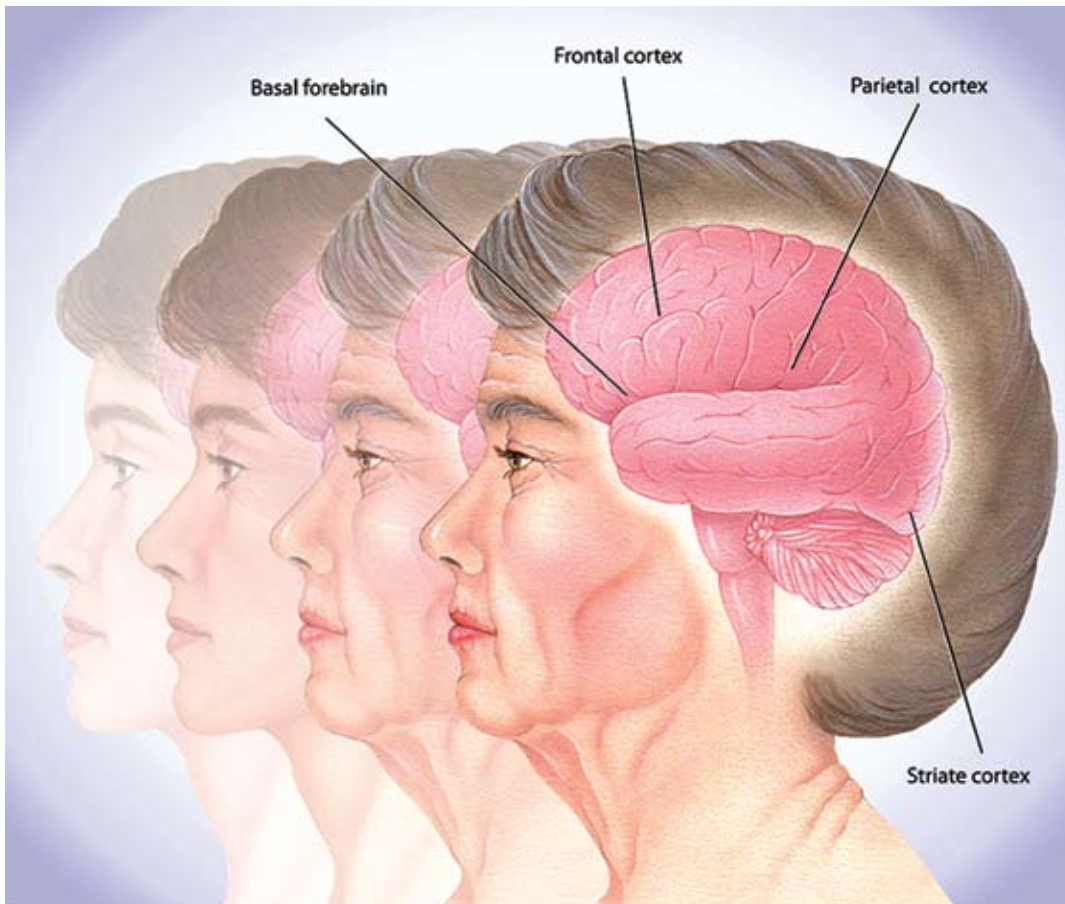
### Aging neurons

The brain reaches its maximum weight near age 20; subtle changes in the chemistry and structure of the brain begin at midlife for most people. During a lifetime, the brain is at risk for losing some of its neurons, but normal aging does not result in widespread neuron loss as occurs in Alzheimer's disease or after a stroke. Brain tissue can respond to damage or loss of neurons by expanding dendrites and fine-tuning connections between neurons. A damaged brain neuron can readjust to damage only if its cell body remains intact. If it does, regrowth can occur in dendrites and axons. When neurons are destroyed, nearby surviving neurons can compensate, in part, by growing new dendrites and connections. Physical exercise also can improve neuronal functions at later ages.

### Intellectual capacity

From the first large studies to monitor the same group of healthy humans for many years, scientists have uncovered unexpected results. They report declines in some mental functions and improvements in others. In several studies, the speed of carrying out certain tasks becomes slower, but vocabulary improves. Other findings demonstrate less severe declines in the type of intelligence relying on learned or stored information compared with the type that uses the ability to deal with new information.

This research is supported by animal studies in which scientists find that changes in mental function are subtle. For example, in rodents and primates in which only minor brain abnormalities can be detected, certain spatial tasks, such as navigating to find food, tend to become more difficult with age.



## THE AGING BRAIN.

Studies of people who have died contradict the popular belief that adults lose an enormous number of neurons every day. In fact, many areas of the brain, primarily in the cortex, maintain most of their neurons. Examples include the parietal cortex, which plays a role in sensory processes and language, and the striate cortex, which processes visual information. The connectivity between neurons changes with aging, so that the brain is constantly capable of being modified or improved.

The aging brain is only as resilient as its circuitry. Scientists debate whether this circuitry is changed only by neuron atrophy or whether some neuron loss over time also is inevitable. In any event, when the circuitry begins to break down, remaining neurons can adapt by expanding their roles, and larger portions of the brain can be recruited in older people to accomplish performance levels similar to those of younger adults.

Learning conditions may dictate what happens to brain cells. Studies of rats shed light on some of the changes that occur in brain cells when the animals live in challenging and stimulating environments. Middle-aged rats exposed to such environments formed more and longer dendrite branches in the cerebral cortex than did rats housed in isolated conditions. In response to enriched environments, older rats tend to form new dendrite outgrowths and synapses, just as younger animals do. But the response is more sluggish and not as large. Compared with younger rats, older rats have less growth of the new blood vessels that nourish neurons.

Another study showed that brain cells in rats given acrobatic training had more synapses per cell than rats given only physical exercise or rats that were inactive. The scientists concluded that

motor learning generates new synapses. Physical exercise, however, improved blood circulation in the brain. Aerobic exercise can also improve cognitive performance in humans.

Although much has been learned about the aging brain, many questions remain. For instance, does the production of proteins decline with age in all brain neurons? In a given neuron, does atrophy lead to a higher likelihood of death? How does aging affect gene expression in the brain — the organ with the greatest number of active genes? Do hormonal changes at menopause contribute to gender differences in brain aging?

Neuroscientists speculate that certain genes may be linked to events leading to cell death in the nervous system. By understanding the biology of the proteins produced by genes, scientists hope to be able to influence the survival and function of neurons.