# Chapter 32

# Lifelong Learning and the Aging Brain

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## SYNOPSIS



## 32-1. Introduction

The human brain is the largest muscle in the human body. At roughly three pounds, it is also easily the most impressive. The source of the Mona Lisa, the atomic bomb, and rap music, the workings of the human brain have both mystified and inspired us since the beginning of time. While its functioning is still a mystery on many levels, we have learned more about how the human brain works in the past five to 10 years than in any other period of history. Advances in brain imagery technology have allowed us to "peer inside" and observe neural circuitry in ways previously only imagined.

As our understanding of the brain has increased, many old beliefs have fallen by the wayside. A new model of the brain is emerging — one that embraces self-determination, flexibility, growth, and optimism. It is a whole new way of looking at how our brain works and what the future holds for us as we age. And it is filled with amazing hope.

## 32-2. Brain Basics

Let's begin with some basics regarding the brain. It might be helpful to define a few key terms:

- **Neurons** — These are your "brain cells." They function electrochemically to relay signals throughout your brain.
- **Synapse** — This is the gap between neurons. Synaptic firing represents one brain cell communicating with another one.
- **Brain regions** — These are the areas of the brain that we typically associate with certain types of cognitive functioning. Examples include the auditory cortex, the visual cortex, and the frontal lobe.
- **Hemispheres** — The brain is divided into left and right hemispheres, and different brain regions are located in different hemispheres.

## 32-3. The Old Paradigm

Prior to the 1990s, the conventional model of the brain can reasonably be summarized as follows:

- **The brain is fixed and finite.** You are born with a finite number of brain cells with fixed pathways and you cannot grow your brain at a cellular level.
- **Brain regions are dedicated to specific functions.** Certain parts of the brain have certain functions that can only be processed in that region. For example, visual signals must always be processed by only the visual cortex.
- **Once mature, the brain declines steadily.** Brain functioning peaks sometime in early adulthood, then begins a slow, inexorable decline.

This was the model of the brain that scientists firmly believed for decades, if not centuries. One implication of this paradigm was to focus research efforts on medical or surgical solutions for treating brain-related afflictions. Unfortunately, this focus neglected many potential avenues that have subsequently shown promise.

## 32-4. The New Paradigm

With the advent of technologies such as MRIs and CAT scans, scientists began to explore new realms of brain research and revise old theories about how the brain works. While still evolving, a new paradigm has emerged. Key components of the new understanding of the brain include:

- **The brain grows new neurons.** The old notion that growing new brain cells was impossible has been proven wrong. In a landmark study in 1998, scientists proved conclusively that the human brain grows new brain cells. Even 70-year-old (and older) brains produce new neurons and new neural pathways. Important factors in brain cell growth are exercise and mental stimulation.
- **Brain regions are flexible.** Studies have demonstrated that while regions do tend to specialize in dedicated ways, this is *not* absolute. The human brain is capable of rewiring and reallocating its "real estate" in ways that the old paradigm believed were impossible.
- **As the brain ages, functionality may decline, maintain, or even improve.** While it is true that processing speed generally slows with age, one-third of older brains in one study had functioning characteristics that closely resembled those of younger brains. Furthermore, certain types of functioning (integrated thinking, flexible problem solving) appear to improve with age.
- **We can have an impact on how our brain ages.** Perhaps the most profound conclusion in recent years is the notion that there are things we can do to maintain our brain and potentially protect it from certain types of cognitive decline.

## 32-5. The Older Brain

As our understanding of the brain has increased, it has been clear that the older brain has been underestimated on a number of dimensions.

### Cognitive Processing

- **Bilateral (or multi-region) activation.** Older brains frequently use multiple parts of the brain to perform tasks that younger brains accomplish with a single region. This may be a way of compensating for lost processing speed, but it may also be a superior approach for certain types of tasks that require more integrated or flexible thinking.
- **Expert knowledge.** Knowledge that has been accumulated over 10 years or more appears to be far more resistant to the effects of aging than previously thought.
- **Managing information.** The ability to manage information and extract meaning generally increases with age.
- **Focus and attention.** The ability of the brain to focus on a task without getting distracted by other input increases with age.

- **Vocabulary.** Verbal abilities, including vocabulary and facility with synonyms and antonyms, increase with age.

### Emotional Maturity

Studies have shown that, *on average*, older adults exhibit:

- **Less:** Impulsiveness, fear, impatience, anger, frustration, irritability, and hatred.
- **More:** Empathy, comfort with ambiguity, sense of peace, and ability to judge character.

Scientists are able to measure the frequency of these emotions in older adults by using brain imaging technology along with the knowledge of where in the brain certain types of emotions are located.

## 32-6. Neuroplasticity

One of the key shifts in our understanding of the brain has been the change from the old paradigm view that the brain is fixed and finite to the new paradigm understanding that we can rewire our brain in a wide variety of ways. The seminal study in this area was done by renowned neuroscientist Michael Merzenich in 1993 at the University of California at San Francisco. Dr. Merzenich designed an experiment in which a group of monkeys was exposed to two types of stimuli: (1) auditory (listening), and (2) somatosensory (touch). Half the monkeys were trained (through rewards) to pay attention to changes in the auditory signals, while the other half were trained to pay attention to changes in the somatosensory signals. After six weeks, the brain region dedicated to the stimuli that was being rewarded was two to three times larger than that same region for the monkeys that were not paying attention to that stimulus. This clearly established that *our very thoughts affect the physical structure of our brain.*

This ability of the brain to rewire itself is called *neuroplasticity* or *cortical remapping*. Scientists have discovered evidence of neuroplasticity in a wide variety of situations, including:

- Blind individuals have reallocated the visual brain regions to touch and hearing, resulting in the ability to read Braille (a feat beyond most sighted people) and make sense of complex auditory signals that most sighted people cannot.
- Deaf individuals have reallocated the auditory cortex to visual processing and are frequently reported to have superior peripheral vision than hearing individuals.
- Concert violinists have more space in their brains dedicated to controlling the fingers used to play the violin.
- Stroke victims have been successfully treated using a form of physical therapy that forces the brain to rebuild damaged circuitry.
- Psychiatric diseases such as depression and obsessive compulsive disorder have been successfully treated using techniques that encourage the brain to construct alternative synaptic pathways.

The implications of neuroplasticity are vast and are just beginning to be understood. Some developments to watch include:

- **Alternative brain inputs.** A new frontier is developing in which scientists may be able to artificially supply the brain with missing inputs. The best example of this is a device known as a cochlear implant. Cochlear implants allow deaf individuals to potentially "hear" by translating sound waves into electrical signals that the brain can learn to interpret in a way that substitutes for actual hearing.
- **Alternative brain outputs.** Similarly, computer chips have been successfully implanted in the brains of physically handicapped individuals which, through training (read: neuroplastic brain rewiring), can then be used to control external devices such as a computer, TV, or a robotic arm.
- **Emotional transformations.** The potential for us to rewire our brain in ways that positively affect our emotional well-being or overall happiness is an area of research that is just beginning, but seems to hold considerable promise.

**Bottom Line:** *The aging brain is not necessarily a fading brain.* As Dr. Merzenich stated, "Under optimal environmental conditions, almost every physical aspect of the brain can recover from age-related losses."

## 32-7. Lifelong Learning and Healthy Aging

Against this backdrop of new understanding of the human brain, the role of lifelong learning takes on new importance. Indeed, for a variety of reasons, most experts would agree that *lifelong learning is a key part of healthy aging*.

If one were to attempt to establish the four cornerstones of healthy aging, they would most likely be:

- Nutrition;
- Exercise;
- Social interaction; and
- Lifelong learning/purpose/meaning.

A number of recent studies have shown a positive correlation between pursuing mental stimulation and brain health. These show up in a number of areas, including:

- Global cognition;
- Working memory;
- Perceptual speed;
- Likelihood of Alzheimer's disease;
- Likelihood of dementia;
- Psychological/emotional health; and
- Physical health/mortality rates.

One study found a 33 percent lower likelihood of Alzheimer's disease among those who engaged in as little as one additional cognitive activity per week.

"Enriched environments" (more cognitive stimulation) are associated with a 5 to 9 percent increase in brain size and 25 percent more neuron branches. Many scientists believe that this represents a "cognitive reserve" that better prepares an aging brain for the potential challenges it may face as it grows older.

## 32-8. What Brain Exercise Is Best?

If your goal is to improve your brain health, the key element in selecting your form of brain exercise is *newness*. That which is new stretches your brain. Stretching your brain makes it stronger. The brain has a chemical called acetylcholine that is increased by exposure to new challenges. Acetylcholine increases our ability to pay attention, which results in the cognitive improvements we want to encourage.

Recommended activities include:

- Attending lectures and seminars;
- Doing crossword puzzles;
- Participating in discussion groups;
- Reading a book or the newspaper;
- Learning a foreign language;
- Playing a musical instrument;
- Learning to dance the tango; and
- Traveling.

Activities that have proven not to be particularly helpful for the brain include bowling, babysitting, golfing, and watching TV.

An important component to consider is the level of social interaction. While solitary activities are beneficial, social activities are even more so. Declining social interaction predicts declining cognitive function and higher mortality rates. A recent study found that chronic loneliness is associated with a twofold increase in the likelihood of developing dementia.

Recently, a whole host of software programs have hit the market designed to provide the equivalent of a gym workout for your brain. Feel free to give these a try. Many individuals have reported noticeable changes working with these programs. Unless, however, you find these programs to be highly entertaining (most are not), it probably makes sense to also seek activities that you really enjoy and can do with other people. Your best bet is to develop a variety of interests that stimulate your brain in different, enjoyable ways.

**Bottom Line:** Find activities that are new, challenging, and fun. You and your brain will thrive.

## 32-9. Resources

Below are a variety of resources for further information or programs to stimulate your brain.

### Organizations

**Active Minds**
*Courses, lectures, and seminars on a wide variety of topics.*
(303) 320-7652
info@ActiveMinds.com
www.ActiveMinds.com

**Alzheimer's Disease Education and Referral Center**
*Information and programs relating to Alzheimer's disease.*
(800) 438-4380
www.nia.nih.gov/alzheimers

**Colorado Academy for Lifelong Learning**
*Courses on a wide variety of topics.*
(303) 770-0786
info@AcademyLL.org
www.academyLL.org

**Osher Lifelong Learning Institute University of Denver**
*Courses on a wide variety of topics.*
(303) 871-3090
www.universitycollege.du.edu/olli/index.cfm

### Internet Resources

The Healthy Brain Program: www.healthybrain.org
Society for Neuroscience: www.sfn.org

### Books for Further Reading

Begley, Sharon. *Train Your Mind, Change Your Brain: How a New Science Reveals Our Extraordinary Potential to Transform Ourselves* (Ballantine Books, 2007).
Doidge, Norman, M.D. *The Brain That Changes Itself* (Viking, 2007).