

The Four Pillars of Brain Maintenance

How to live a brain-healthy lifestyle

Why a brain-healthy lifestyle is so important

The latest scientific research shows that specific lifestyles and actions can, no matter our age, improve the health and level of functioning of our brains. Such improvement can happen thanks to neuroplasticity that is, when the rate of creation and survival of new neurons in certain parts of the brain is increased, or when the rate of creation and survival of synapses (the connections between neurons) speeds up, or when a neurochemical environment is nurtured in our brains to support information processing.

The nice thing about discovering that our lifestyle can affect brain functions is that it puts our brain health largely under our own control. However there is no magic formula. Scientists are only beginning to understand how what we do can interact with our genetic makeup. As to now, it is not possible to define which actions are the best for which individuals. It is likely that there will never be one general solution that solves all the challenges inherent in maintaining one's brain health.

So what factors have an influence on brain health?

Current recommendations suggest that a brain-healthy life style should include at least balanced nutrition, stress management, physical exercise, and brain exercise. Other factors may also have an influence. Dr. Elizabeth Zelinski points out that "it is also important to maintain emotional connections. Not only with ourselves, to have self-confidence and self-esteem, but also with our family our friends." Sleep and overall health conditions are other factors that also matter.

Here we focus on the four main pillars of brain health:

Balanced Nutrition:

- Eat a variety of foods of different colors without a lot of added ingredients or processes.
- Plan your meals around your vegetables, and then add fruit, protein, dairy, and/or grains.
- Add some cold-water fish to your diet (tuna, salmon, mackerel, halibut, sardines, and herring), which contain omega-3 fatty acids.
- Go to the United States Department of Agriculture website at www.mypyramid.gov to learn what a portion-size is, so you don't overeat.
- Try to eat more foods low on the Glycemic Index (learn more at www.glycemicindex.com).
- If you can only do one thing, eat more vegetables, particularly leafy green ones.

Stress management:

- Get regular cardiovascular exercise.
- Try to get enough sleep each night (i.e. six to eight hours).
- Stay connected with friends and family.
- Practice meditation, yoga, or some other calming activity as a way to take a relaxing time-out.
- Try training with a heart rate variability sensor, like the one in the emWave® Stress Management programs.
- If you can only do one thing, set aside 5-10 minutes a day to just breathe deeply and recharge.

Physical Exercise:

- Start by talking to your doctor, especially if you are not currently physically active, have special health concerns, or are making significant changes to your current program.
- Set a goal that you can achieve. Do something you enjoy for even just 15 minutes a day; you can always add more time and variety later.
- Schedule exercise into your daily routine. It will become a habit faster if you do.
- If you can only do one thing, do something cardiovascular, i.e. something that gets your heart beating faster. This includes walking, running, skiing, swimming, biking, hiking, tennis, basketball, playing tag, ultimate Frisbee, and other similar sports/activities.

Mental Stimulation:

- Do a variety of things, including things you are not good at for novelty (if you like to sing, try painting or dancing).
- Be curious! Get to know your local library and community college, look for local organizations that offer classes and workshops, or join a book club.
- Work puzzles like crosswords and sudoku or play games like chess and bridge. However, make sure to introduce novelty and variety – doing more of the same is not what helps most.
- Try a computerized brain fitness program for a customized workout.

1. How can nutrition influence brain functions?

First of all, the brain consumes considerable amount of glucose. One of the earliest sign of dementia is a decrease in the ability of the brain to use glucose efficiently. As such a dysfunction is at the core of diabetes, some neuroscientists refer to Alzheimer's Disease as Type 3 diabetes.

The brain is also a fatty organ. Fats are present in the neurons' membranes to keep them flexible. These fats are the omega 3 and omega 6 fatty acids molecules. Our brain is dependent on dietary fat intake to get enough fatty acids. Omega-3 fatty acids can be found in cold-water fish (such as mackerel, herring, salmon, and tuna), kiwi, and walnuts. Docosahexaenoic acid, or DHA, is the most abundant omega-3 fatty acid in cell membranes in the brain.

In general, the brain is highly susceptible to oxidative damage. This is why antioxidant food has become popular for their positive effects on brain function. Antioxidants are found in a variety of food: Alpha lipoic is found in spinach, broccoli and potatoes; Vitamin E is found in vegetable oils, nuts, green leafy vegetables; Vitamin C is found in citrus fruit and several plants and vegetables. Berries are well known for their antioxidant capacity but it is not clear which of their many components has an effect on cognition.

Based on these observations, Dr. Larry McCleary (whose interview you will find at the end of this Chapter) recommend a diet containing fatty fish, vegetables and salads, non-starchy fruits (like berries) – that are high in free radical fighting compounds – and nuts.

As most people you probably have bought or thought of buying nutrition complements. Indeed it is hard to get all the good nutrients in one's diet. The most common consumer purchase is herbal and



vitamin supplements purported to improve memory. *Table 2* shows you the most recent findings associated with well-known supplements such as Ginkgo biloba.

However one has to be cautious. One negative aspect of self-medication with herbal supplements is the fact that some products have been shown to counteract the effects of prescription and over-the-counter medications. For example, in 2001, Dr. Piscitelli from the National Institute of Health (NIH) showed a significant drug interaction between St. John’s wort (*hypericum perforatum*), an herbal product sold as a dietary supplement, and Indinavir, a protease inhibitor used to treat HIV infection. The herb has also caused negative interactions with cancer chemotherapeutic drugs and with birth control drugs.

Experts usually recommend a balanced diet that is getting healthy nutrients (Omega-3, antioxidants, etc.) from the food you eat, rather than ingesting supplements. Few studies so far have shown that supplements are beneficial to brain health. More importantly the best dosage of these supplements is not known.

Supplement	Recent Evidence
<p style="text-align: center;">DHEA</p> <p>A steroid precursor to testosterone and estrogen purported to fight aging.</p>	<p>The conclusion of a two year study at the Mayo Clinic in Minnesota and University of Padua in Italy showed that DHEA did not improve strength, physical performance, or other measures of health. The study’s lead author, Dr. Nair (2006) said, “No beneficial effects on quality of life were observed. There’s no evidence based on this study that DHEA has an anti-aging effect.”</p>
<p style="text-align: center;">Ginkgo biloba</p> <p>An over-the-counter “memory-enhancing” supplement.</p>	<p>In 2002 Dr. Paul Solomon from Williams College found that “when taken following the manufacturer’s instructions, ginkgo provides no measurable benefit in memory or related cognitive function to adults with healthy cognitive function.”</p> <p>Dr. Burns (2006) from the University of Adelaide, Australia found longer-term memory improved in healthy fifty-five to seventy-nine year olds, but no other cognitive measure improved for younger participants.</p> <p>Dr. Elsabagh (2005) from King’s College London found that ginkgo initially improved attention and memory. However, there were no benefits after 6 weeks, suggesting that a tolerance develops quickly.</p> <p>A recent randomized trial (DeKosky et al., 2008), conducted in 5 academic medical centers in the United States and including 2587 volunteers aged 75 years or older with normal cognition, showed that G biloba at 120 mg twice a day was not effective in reducing the overall incidence rate of dementia.</p>
<p style="text-align: center;">Omega-3 fatty acids</p> <p>Components of neurons’ membranes.</p>	<p>Dr. Fontani’s work at the University of Siena in Italy associated omega-3 supplementation with improved attentional and physiological functions, particularly those involving complex cortical processing.</p>

Table 2. Summary of recent findings on supposedly brain-enhancing dietary supplements.

2. Stress management: exercise, relax, socialize, empower, biofeedback

Prolonged exposure to high levels of stress can damage the brain. As part of a brain-healthy life-style it is essential to manage stress efficiently.

It is clear that our society has changed more rapidly than our genes have. Today, instead of being faced with physically and immediately life-threatening crises that demand instant action, we more regularly deal with events and illnesses that gnaw away at us slowly without any stress release.

In his book, *Why Zebras don't have Ulcers*, Dr. Sapolsky points out that humans are unique in that they are the only mammals who can get stressed from their own thoughts. When humans are stressed, for any reason, they have the same kind of stress reaction that, for example, a zebra would when it tries to escape from the clutches of a lion. However, in trying to save its life by running away, the zebra essentially uses up its stress hormones to fuel its escape. Humans, on the other hand, usually just keep muddling along and let the stress build up over long periods of time.

Overall, stress limits mental flexibility and one's ability to see alternative solutions. As such, it can prevent us from adapting to, and succeeding in, new circumstances. It can also lead to various cardiac and immune problems. Although stress is an unavoidable consequence of modern life, when work stress becomes too much, it can lead to burnout.

Prolonged exposure to adrenal steroid hormones like cortisol, which is released into the blood stream when we are stressed, can damage the brain and block the formation of new neurons in the hippocampus, the key actor in encoding new memories in the brain. Chronic stress leads to cell death and hampers our ability to make changes and be creative enough to think of possible changes we could make to reduce the stress.

General Adaptation Syndrome (GAS) describes the long-term, nasty kind of stress that does not go away. This is the kind of stress that paralyzes someone into inaction. The common reaction to this type of stress is to think about a problem and worry about it without doing anything about it. This is the kind of stress that kills neurons, destroys immune and cardiovascular systems, and makes a person anxious, irritable, and unable to sleep.

What can you do once you have realized that you are stressed? As you can see in Table 3, the best defenses against chronic stress are physical exercise, relaxation, self-empowerment, and cultivating social networks. Biofeedback has also been mentioned as useful in stress reduction. As an example, in 1998, a study showed that self-management programs using techniques designed to eliminate negative thought loops and promote positive emotional states can successfully decrease cortisol levels (McCraty and colleagues, 1998).

How to manage stress?

- **Exercise:** Exercise can reduce the experience of stress, depression, and anxiety.
- **Relax:** Relaxation, whether through meditation, tai chi, yoga or taking a walk by the beach, lowers blood pressure, slows respiration and metabolism and releases muscle tension.
- **Socialize:** Cultivating social networks of friends, family and even pets can help foster trust, support and also relaxation.
- **Empower yourself:** Finding ways to empower oneself can be a defense against chronic stress since self-confidence and taking control of one's environment helps to resolve the stress response.

- **Use biofeedback programs:** Biofeedback programs that generate real-time information on stress levels can provide a unique opportunity to learn effective techniques for reducing stress levels.

Is stress always bad?

There is such thing as “positive” stress. This stress is often experienced as butterflies in the stomach or sweaty palms felt before a big athletic game, artistic performance or speech. The same stress may also surface at work before a presentation or important phone call or meeting. This “positive” stress may boost performance as cortisol usually combines with adrenaline in such circumstances. However, this kind of stress is short lived. The adrenaline is evident for a period of time and then it gets essentially used up as the goal is accomplished. And, once the goal is accomplished, there is typically time to rest and recover while basking in the glow of having completed the task.

3. Physical exercise: why aerobic exercise enhances neurogenesis and neuroplasticity

As little as three hours a week of brisk walking has been shown to halt, and even reverse, the brain atrophy (shrinkage) that starts in a person’s forties, especially in the regions responsible for memory and higher cognition. Exercise increases the brain’s volume of gray matter (actual neurons) and white matter (connections between neurons).

Through increased blood flow to the brain, physical exercise triggers biochemical changes that spur neuroplasticity – the production of new connections between neurons and even of neurons themselves. Brain exercise then protects these fledgling neurons by bathing them in a nerve growth factor and forming functional connections with neighboring neurons. Dr. Gage’s work of the Salk Institute for Biological Studies, have shown that exercise helps generate new brain cells, even in the aging brain.

Studying this topic, Dr. Smeyne of the Saint Jude Children’s Research Hospital in Memphis, found that results could be seen in two months in Parkinson patients. Parkinson patients demonstrate a progressive loss of dopamine neurons in the substantia nigra pars. After two months of exercise, the patients had more brain cells. Higher levels of exercise were shown to be significantly more beneficial than lower amounts, although any exercise was better than none. Smeyne also found that starting an exercise program early in life was an effective way to lower the risk of developing Parkinson’s disease later in life.



Numerous animal studies have shown that physical exercise has a multitude of effects on the brain beyond neurogenesis, including increases in various neurotransmitters and nerve growth factor levels, and angiogenesis (the formation of new blood vessels).

In 2003, Dr. Colcombe and Kramer, analyzed the results of 18 scientific studies published between 2000 and 2001. The results of this meta-analysis clearly showed that physical fitness training increases cognitive performance in healthy adults between the ages of 55 and 80.

Another meta-analysis published in 2004 by Dr. Heyn and colleagues shows similar beneficial effects of fitness training for people over 65 years old who had cognitive impairment or dementia.

What type of exercise is needed? According to Dr. Art Kramer, aerobic exercise, at least thirty to sixty minutes per day, three days a week, has been shown to have a positive impact on brain functions. Importantly, the exercise does not have to be strenuous, walking have been shown to have positive effects too.

4. Mental stimulation: building a Brain/ Cognitive Reserve with novelty, variety and challenge

The cognitive or brain reserve hypothesis states that it is possible to build up the brain's resilience to neuronal damage and delay the onset of Alzheimer's symptoms. The concept of brain reserve stems from the repeated observation that the relationship between clinical symptoms and actual brain pathology is not direct. For example, Katzman and colleagues (1989) described 10 cases of cognitively normal older adults who, at death, were discovered to have advanced Alzheimer's disease pathology in their brains. The researchers hypothesized that these individuals did not show symptoms of Alzheimer's because they had larger brains, that is more neurons. The idea is that having a larger "reserve" of neurons and abilities can offset the losses caused by Alzheimer's. The concept of cognitive/brain reserve is thus defined as the ability of an individual to tolerate progressive brain pathology (including Alzheimer's plaques and tangles) without demonstrating clinical cognitive symptoms.

Subsequent research has shown that frequent participation in mentally stimulating activities reduces the risk of Alzheimer's disease, possibly by increasing brain reserve. As a consequence, brain activity or exercise in general is hypothesized to help increase brain reserve.

In our view, brain training is more than the stimulation triggered by challenging daily activities. We define brain training as the structured use of cognitive exercises aimed at improving specific brain functions (see Chapter 3).

Rigorous and targeted brain training has been used in clinical practice for many years as a way of helping patients recovering from the effects of traumatic brain injury, stroke, and other neurological disorders. It can help improve memory, attention, confidence and competence, reasoning skills, and even reduce anxiety.

Past research outside the clinical domain has shown that cognitive abilities can also be trained systematically in healthy individuals. Individuals trained in a specific task usually will become better at this task (see for instance Willis et al., 2006 or Ball et al., 2002). What is even more important, such training sometimes has generalized effects improving performance on other, similar tasks.

Although it has been long thought that "you cannot teach old dogs new tricks", many studies show that cognition can be trained at all ages. In particular, many studies have shown that middle age individuals as well as older individuals can learn techniques to boost their memory (see for example Brooks et al., 1999; Derwinger et al., 2003 or the meta-analysis published by Verhaeghen et al. in 1992).

If we could summarize a variety of research fields and findings into a few useful guidelines, we would say that "good" brain exercise requires variety, challenge and novelty. Read the guidelines below.

Varied, novel and challenging exercises will necessarily induce learning. Learning is critical. When one learns a new fact or a new way of accomplishing a task, neurons and synapses – connections –

in the brain change. This is neuroplasticity as defined early. The changes associated with learning may help increase one's brain reserve, contributing to general brain health.

Learning and changing is never easy. This requires effort. As Dr. James Zull points out learning and changing require getting out of our comfort zones. Often, the fear of failing is a key obstacle to learning.

Recipe for a good mental exercise

- **Variety:** Excessive specialization is not the best strategy for long-term brain health. A better strategy is to stimulate the multiple functions of the brain. This can be done by creating a mental “workout circuit” similar to a physical exercise circuit in a health club since our brains are composed of multiple structures with multiple functions.
- **Challenge:** The goal is to be exposed to increasing levels of challenge, so that a task never becomes too easy or routine.
- **Novelty:** Trying new things is important since very important parts of the brain, such as the prefrontal cortex, are mostly exercised when we learn to master new cognitive challenges.

Brain maintenance: cognitive enhancement first, Alzheimer's delay second

Brain maintenance may play a role in postponing the emergence of dementia-related symptoms. A significant amount of research has been conducted on healthy aging in the past two decades. A number of factors have been associated with reduced risks of developing Alzheimer's Disease symptoms.

Among these factors, mental activities range quite high. As we described earlier, people who remain intellectually active and engaged in hobbies throughout their lives reduce their risk of developing Alzheimer's disease and other dementias. In a 2001 study conducted by Dr. Yaakov Stern, leading researcher on the cognitive reserve, individuals with the highest level of leisure activities presented thirty-eight percent less risk (controlling for other factors) of developing Alzheimer's symptoms. For each additional type of activity, the risks were reduced by eight percent. It is believed that intellectually stimulating hobbies or activities help building up cognitive reserve. This can help postponing the appearance of the dementia's symptoms.

Interestingly, education also seems to have a protective effect. Research into cognitive reserve found that the more education people have, the less they suffer from age-related decline. High levels of education have also been associated with lower risks levels for Alzheimer's disease (Snowdon et al., 1989; Wilson et al., 2002). It is possible that the effect of education is related to the effects of intellectual stimulation as well-educated people are more likely to have cognitively stimulating jobs.

According to Dr. Arthur Kramer (whose interview you can find at the end of this chapter) the two key lifestyle habits that may help someone delay Alzheimer's symptoms and improve overall brain health are to stay physically active and to maintain lifelong intellectual engagement. However, no specific program has been shown to prevent Alzheimer's disease completely.

In sum, brain maintenance in general can be viewed as a way of delaying cognitive declines associated with aging and dementia to occur too early. Note however that, as Dr. Jerri Edwards points out, it is too early to say whether we can really reverse decline in a permanent way. Brain functions are complex and well-conducted studies looking at the long-term effects of brain exercises are yet to be conducted.

What about brain training itself?

We can define brain training as the structured use of cognitive exercises aimed at improving specific brain functions. In this view, preventing Alzheimer's is not the main or only premise (or objective) of brain training. Rather, improving quality of life and cognitive performance is. The same as one goes to a health club and engages in a workout circuit to improve physical abilities, brain training can be viewed as a "mental workout" to help maintain a variety of cognitive abilities relevant to our work and life.

Summary:

Balanced nutrition: As a general guideline, what is good for the body is also good for the brain. Eating a variety of foods of different colors including cold-water fish which contain omega-3 fatty acids and avoiding highly processed foods with added ingredients are recommended. Vegetables, particularly green, leafy ones, are also recommended whereas few well known supplements have shown long-term benefits on memory and other cognitive functions.

Stress management: Chronic stress reduces and can even inhibit neurogenesis. Meditation, yoga, and other calming activities are effective in countering stress. Biofeedback devices that measure heart rate variability and show stress levels in real-time offer a more high-tech option to manage stress.

Physical exercise: Physical exercise has been shown to enhance brain physiology in animals and, more recently, in humans. Physical exercise improves learning through increased blood supply and growth hormone levels in the body. Of all the types of physical exercise, cardiovascular exercise that gets the heart beating – from walking to skiing, tennis and basketball – has been shown to have the greatest effect.

Mental stimulation: It strengthens the synapses or connections between neurons, thus improving neuron survival and cognitive functioning. Good mental exercise requires novelty, variety and increasing levels of challenge.

Important take-away: These pillars are complementary; they do not substitute each other. It is important for a person to recognize their starting point, and identify what pillar they may need to focus more on.

For each pillar or lifestyle factor, it is important to be creative in finding a schedule or routine that works for an individual through trial and error.

According to Dr. Art Kramer, the ideal way would be to combine physical and mental stimulation along with social interaction: "Why not take a good walk with friends to discuss a book? We all lead very busy lives, so the more integrated and interesting our activities are, the more likely we will engage in them."

Adapted from sharpbrains.com. Based on the content from the book [The SharpBrains Guide to Brain Fitness](#) (May 2009, \$19.95), by Alvaro Fernandez and Dr. Elkhonon Goldberg.