Healthy Brain Aging: Reducing Risk for Alzheimer’s Disease and Other Dementias
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Overview on Dementia of the Alzheimer’s Type: The most common cause of dementia in the elderly is Alzheimer’s disease. Age is the biggest risk factor for Alzheimer’s dementia, but age interacts with genetics and with modifiable lifestyle health behaviors. Alzheimer’s disease typically presents as an amnestic dementia in which the earliest clinical symptom is progressive impairment in new “declarative” learning and memory. The neuropathology of AD involves the formation of amyloid plaques in the extracellular space and neurofibrillary tangles in the microtubules of the axon of the neuron, but impairment in new learning and memory does not emerge until there is considerable loss of neurons and synapses in critical points in the network of structures in the medial temporal lobe memory system. The detection and differential diagnosis of the early clinical stages of AD depends in large part on the proper assessment of new learning and memory using standardized tests that have good normative data for age.

Two general principles for delaying dementia are “what is good for the heart is good for the brain” and “use it or lose it.” The capacity to form new memories (learn new facts or events) typically declines to near zero early in the clinical course of AD. However, previously well learned long-term declarative memories for facts and events remains relatively well preserved in the early clinical course of AD, and although existing long term memory will decline with advancing dementia, many long-term “declarative” memories will remain partially or fully preserved in the middle to late stages of AD. In addition, procedural memories for skills and habits remain relatively preserved in the early stages of dementia of the Alzheimer’s type. Residual long-term declarative memories and residual procedural memory capacity for skills and habits can be used to help promote quality of life and functionality in patients with AD.

This paper includes a summary of research on risk and protective factors for dementia and specific recommendations on how you can lower your risk for dementia by raising your brain reserve capacity.

A significant subset of individuals who clearly meet neuropathological criteria for Alzheimer’s disease at autopsy were cognitively intact during life! That is, even though their brains had the signs of Alzheimer’s disease, during life they did not display the symptoms of the disease.

- Religious Orders Study and the Memory and Aging Project: About 1/3 of people ages 82-85 who met neuropathologic criteria for intermediate or high likelihood of AD did NOT have clinical dementia or amnestic MCI when they died (Bennett et al., 2006; Alzheimer’s Dis Assoc Disord. Jul-Sep;20 (3 Suppl 2):S63-8).

- The Nun Study: Small Infarcts add “insult to injury” to an Alzheimer’s brain (Snowdon et al., 1997; JAMA. 277(10): 813-7): AD brain + small infarct(s) → 93% w/symptoms of dementia before death; AD brain + no infarcts → 57% w/symptoms of dementia at death.
Q: Why the “disconnect” between neuropathological burden and cognitive impairment?

A: Brain Reserve Capacity (neural reserve and cognitive reserve).

With regard to lower risk, an important distinction needs to be made with regard to lowering risk for the underlying Alzheimer’s neuropathological changes versus lowering risk for dementia or cognitive impairment. Increasing brain reserve capacity can decrease risk for dementia without affecting underlying Alzheimer’s pathology because evidence indicates one can tolerate a higher Alzheimer’s neuropathological burden without reaching the threshold for cognitive impairment if one has a higher brain reserve capacity (see two studies discussed above).

Although lifestyle factors can clearly affect risk for dementia (i.e., memory and other cognitive impairment), there is little evidence to date that lifestyle factors can affect underlying Alzheimer’s neuropathology. However, one study that suggests that it might is the following. Linguistic ability in early life and cognitive function and Alzheimer's disease in late life: Findings from the Nun Study. Snowdon DA, Kemper SJ, Mortimer JA, et al. (1996). JAMA 275: 528-32. Idea density, a measure of linguistic ability in early life, were derived from autobiographies written at a mean age of 22 years. Approximately 58 years later, the women who wrote these autobiographies participated in an assessment of cognitive function, and those who subsequently died were evaluated neuropathologically. Low idea density in autobiographies written in early life were associated with low cognitive test scores in late life. Among the 14 sisters who died, neuropathologically-confirmed Alzheimer's disease was present in all of those with low idea density in early life and in none of those with high idea density. Thus, low linguistic ability in early life was a strong predictor of poor cognitive function and Alzheimer's disease in late life.

The #1 fear of persons age 55 or older is Alzheimer’s dementia. It is the #2 fear for those under age 55. The prevalence of dementia doubles every 5 years after age 65. According to one epidemiological study, the prevalence of AD is 3% for those aged 65-74, 19% for those aged 75-84, and 47% for those aged 85 and above. Studies may differ on the estimated prevalence of AD, but all agree that AD increases exponentially with age. With the aging of the baby boomers, AD is expected to triple by the year 2050 (from 5→15 million in the U.S.). It is an emerging epidemic in the U.S. and worldwide.

Although the prevalence of dementia doubles every 5 years after age 65, if the onset of dementia can be delayed by 5 years, it would cut the prevalence of dementia in half. For example, in a study of more than 200 bilingual and monolingual patients with Alzheimer’s disease, bilingual patients reported showing initial symptoms of the disease at about 77.7 years of age—5.1 years later than the monolingual average of 72.6 (Bialystok et al., 2007). Likewise, bilingual patients were diagnosed 4.3 years later than the monolingual patients (80.8 years of age and 76.5 years of age, respectively). Craik, F. I., Bialystok, E., & Freedman, M. (2010). Delaying the onset of Alzheimer’s disease: Bilingualism as a form of cognitive reserve. Neurology, 75(19), 1726–1729.

There are 50 or more causes of dementia in older adults, but “numero uno” is Alzheimer’s disease. However, at least half of the cases of Alzheimer’s dementia have some other neurological factor contributing to the dementia, e.g., presence of cerebrovascular disease like some small infarcts or white matter disease that adds “insult to injury” providing an additional hit to the brain hastening the appearance of cognitive decline. The other top causes of dementia are vascular dementia, Lewy
Body disease, and Frontotemporal dementia (either the behavioral variant subtype or the language variant (i.e., primary progressive aphasia). Alzheimer’s disease is an amnestic dementia, i.e., it typically begins with impairment in new “declarative” learning and progresses from mild to severe impairment before there is a clear impairment in other cognitive abilities like language and visuospatial functioning. The primary cause of this early progressive anterograde memory impairment is damage in the medial temporal lobe of the brain (e.g., in amnestic MCI, there is a 60% loss of neurons in layer II of the entorhinal cortex, 47% loss of cells in the CA1 subfield of the hippocampus, and a 40% loss in layer II of the entorhinal cortex which causes a disconnection syndrome in the memory circuit.

Dementia is due to the interaction of Age x Genetics x Environment (A.G.E.), in which many environmental lifestyle factors are modifiable. You may be genetically at risk to develop AD sooner or later, but by optimizing your lifestyle health habits, you can make it later rather than sooner, and if you delay the onset of dementia long enough you may effectively, not just postpone, but actually prevent dementia.

The #1 risk factor for dementia/Alzheimer’s disease is age, thus Alzheimer’s disease is disease of aging. A similar set of factors affect longevity and the chronic/degenerative diseases of aging including Alzheimer’s disease. There is an unusually high concentration of centenarians in Loma Linda, California. Loma Linda is an hour east of Los Angeles where about a quarter-million people live. The reason they're so healthy is because most of them are Seventh Day Adventists. Seventh Day Adventists place a high priority of treating the human body as a temple, which means they don't drink, don't smoke, eat very little meat, exercise, and every week beginning with sundown on Friday, they rest for an entire day (i.e., they observe the Sabbath) – a day of rest that counters stress. As a result they live an average of 10 years longer than most Americans. Dr. Larry Beeson, who has been involved in researching the health of Seventh Day Adventists for the last 50 years, said that "Adventists have approximately the same proportion of people who die of cancer or heart disease or stroke, but the age that they get diagnosed is much later." Thus, lifestyle clearly has a very large effect on delaying chronic diseases of aging and increasing longevity. These same factors have a significant effect on risk for dementia.

Genetics: There are three, relatively rare, autosomal dominant gene mutations (APP, PSEN1, PSEN2) that guarantee that you will develop Alzheimer’s dementia (these are young onset gene mutations that result on an onset of dementia between ~30 to 50 years). There is a more common “susceptibility” gene (ApoE4) for Alzheimer’s disease that increases both your risk for developing AD and increase your risk for developing AD at a younger age than if you did not have an ApoE4 gene. The ApoE gene comes in three different alleles: ApoE2, ApoE3, ApoE4. You inherit one of these variants from each of your parents. E3 is the most common in the general population and is neutral for Alzheimer’s disease. ApoE4 increases your risk for AD and is associated with earlier onset. Many people with ApoE 3, 3 (homozygous for the e3 allele having inherited one from each parent) still can develop Alzheimer’s disease but the risk is lower and if they develop AD, the age of onset on average is later. On average, if you are E3,3 (homozygous for the e3 allele) and if you develop AD, it will be around age 85 years on average. If are heterozygous for E4 (i.e., E3,4), then
you are at higher risk than E3, 3 and will develop AD on average around age 75. If you are homozygous (i.e., E4, 4), then you are much higher risk and on average will develop AD at age 66.

**Neuropathology of AD:** The major neuropathological changes in AD consist of the accumulation of amyloid plaques outside the neuron in the extracellular space, the formation of neurofibrillary tangles in the neurons that eventually kill the neurons, and then the neuron and synapse loss. The basic component of plaques and tangles are abnormal misfolded proteins, beta-amyloid in the case of plaques, and hyper-phosphorylated tau in the case of the neurofibrillary tangles. It is the neuron and synapse loss that happens later in the preclinical period that eventually reaches a threshold of loss that leads to the onset of decline in memory and other cognitive functions.

**Summary:** The most common cause of dementia in the elderly is Alzheimer’s disease. Age is the biggest risk factor for Alzheimer’s dementia, but age interacts with genetics and with modifiable lifestyle health behaviors. Alzheimer’s disease typically presents as an amnestic dementia in which the earliest clinical symptom is progressive impairment in new “declarative” learning and memory. The neuropathology of AD involves the formation of amyloid plaques in the extracellular space and neurofibrillary tangles in the microtubules of the axon of the neuron, but impairment in new learning and memory does not emerge until there is considerable loss of neurons and synapses in critical points in the network of structures in the medial temporal lobe memory system. The detection and differential diagnosis of the early clinical stages of AD depends in large part on the proper assessment of new learning and memory using standardized tests that have good normative data for age. Two general principles for delaying dementia are “what is good for the heart is good for the brain” and “use it or lose it.” The capacity to form new memories (learn new facts or events) typically declines to near zero early in the clinical course of AD. However, previously well learned long-term declarative memories for facts and events remains relatively well preserved in the early clinical course of AD, and although existing long term memory will decline with advancing dementia, many long-term “declarative” memories will remain partially or fully preserved in the middle to late stages of AD. In addition, procedural memories for skills and habits remain relatively preserved in the early stages of dementia of the Alzheimer’s type. Residual long-term declarative memories and residual procedural memory capacity for skills and habits can be used to help promote quality of life and functionality in patients with AD.

**Drugs to treat Alzheimer’s dementia:** There are three approved cholinesterase inhibitors for the treatment of Alzheimer’s disease: donepezil (Aricept) 1996, rivastigmine (Exelon) 2000, galantamine (Razadyne) 2001. The drugs inhibit the enzyme that breaks down the neurotransmitter acetylcholine at the synapse, thereby increasing the availability of acetylcholine at the synapse. In addition, memantine (Nemenda) was approved in 2003 for treatment of moderate to severe AD, and it works by regulating the activity of the neurotransmitter glutamate and is thought to prevent glutamate neurotoxicity. In 2014, the FDA approved Namzaric (which combined donepezil and memantine) for the treatment of moderate to severe Alzheimer’s disease. Note: last drug approved was 13 years ago. These medications facilitate some people’s ability to carry out everyday activities and may improve thinking, memory, or speaking skills. They also may help with certain
behavioral symptoms. However, although these palliative drugs offer some modest symptom improvement in some individuals, they do not stop or reverse the underlying disease process, and do not slow the progression of the dementia, and help some people for only months to a couple of years. On average, these drugs have at best modest improvement in cognition.

Alzheimer’s disease is a chronic/ degenerative disease of aging. Other chronic diseases of aging are heart disease, diabetes, and cancer generally. In each of these chronic diseases of aging, you can lower your risk for these diseases by optimal lifestyle health habits or by treating some of the risk factors pharmacologically like hypertension and high total cholesterol. When these conditions occur, they might be treated with medications, surgery, radiation, chemotherapy, but even when receiving these treatments, modification of lifestyle health habits are still strongly recommended. Thus, you might as well do in the first place (early in life), what you will have to do in the second/last place, i.e., optimize your lifestyle health habits. If done in the first place, you may prevent these disorders and avoid having to have these other treatments (all of which have side effects).

**Two major research designs of prevention studies:** Two major research designs are observational studies (aka: correlational studies, epidemiological studies) and experimental studies (aka: randomized control studies or double-blind placebo control studies, which can be human or animal studies, but typically are short-term studies). Because observational studies are correlational without random assignment to an experimental group and a control group, you cannot definitively infer causality. However, experimental studies have the disadvantage that they are usually not long-term studies, mainly because it is typically not practical or ethical to randomly assign people to two different groups, e.g., healthy Mediterranean diet vs. an unhealthy “junk food” diet. Thus, we are often piecing together evidence from long-term observational studies with either short-term human or animal experimental studies.

**MacArthur Study on Successful Cognitive Aging:** [Rowe, J.W. & Kahn, R.L. (1997) Successful Aging, The Gerontologist, 37 (4), 433-440]. Four variables were found to be direct predictors of change or maintenance of cognitive function with aging (explaining 40% of the variance in cognitive test performance): education, strenuous activity in and around the home [associated with dose-related increases in BDNF (brain-derived neurotropic factor) in the hippocampus and neocortex], peak pulmonary flow rate (i.e., lung capacity), and self-efficacy (people’s belief in their capabilities to organize and execute the courses of action required to deal with prospective situations).

**Barnes and Yaffee (2011):** The projected effect of risk factor reduction on Alzheimer's disease prevalence. *Lancet Neurol.* 2011 Sep;10(9):819-28. Seven potentially modifiable risk factors for AD are *diabetes, midlife hypertension, midlife obesity, smoking, depression, cognitive inactivity or low educational attainment, and physical inactivity.* Up to half of AD cases worldwide (17.2 million) and in the USA (2.9 million) are potentially attributable to these factors. A 10-25% reduction in all seven risk factors could potentially prevent as many as 1.1-3.0 million AD cases worldwide and 184,000-492,000 cases in the USA.


- Diabetes + pre-diabetes = 52% (115 million)
- Hypertension + pre-hypertension = 62% (150 million)
- High LDL cholesterol = 32% (74 million)
- Obesity + overweight = 69% (total = 156 million)
- Metabolic syndrome = 35% (~79 million).

- Diabetes = 29.1 million (14.3%) [Diabetes: ≥AGE 65 = 33%; 45-64 = 17.5%; 20-44 = 5.0%] + Prediabetes = 86 million (38%); HNT=70 million (29%) + Prehypertension = 80 million (33%); High LDL Cholesterol = 73.5 million (31.7%); Obesity (BMI = 30 or higher) = 78.6 million (34.9%) + Overweight (BMI = 25-29.9%) = 33.9%; Metabolic Syndrome = 34.7% (46.7% for age 60 or older). Metabolic Syndrome = 3 or more of 4 (fasting glucose≥100mg/dL; abdominal obesity = waist size >40 for men, >35 for women; triglycerides ≥150 mg/dL); HDL cholesterol ≤40 mg/dL in mean or >50 mg/dL in women); blood pressure (>130 systolic or >85 diastolic).

- Smoking (the leading cause of preventable disease and death in the US): 16.8% of adults (40 million) age 18 or older currently smoke cigarettes.

- Exercise: 80% of adult Americans (age 18 and older) don’t get recommended exercise according to the CDC. Those least likely to engage in physical activity were ages 65 and older. Half the adults in the United States are meeting the aerobic guidelines and a third are meeting the muscle-strengthening recommendations. The U.S. government recommends adults get at least 2.5 hours of moderate-intensity aerobic exercise each week or one hour and 15 minutes of vigorous-intensity activity. Adults should also engage in muscle-strengthening activities like lifting weights or doing push-ups at least twice per week.

- Sleep: An estimated 50-70 million US adults have sleep or wakefulness disorder. According to data from the National Health Interview Survey, nearly 30% of adults reported an average of ≤6 hours of sleep per day and 35.3% reported <7 hours of sleep. 35% of Americans report their sleep quality as “poor” or “only fair.” 20% of Americans reported that they did not wake up feeling refreshed on any of the past seven days. Only 31% of high school students reported getting at least 8 hours of sleep on an average school night. 48.0% of US adults reported snoring. 37.9% reported unintentionally falling asleep during the day at least once in the preceding month. 4.7% reported nodding off or falling asleep while driving at least once in the
preceding month. The National Department of Transportation estimates drowsy driving to be responsible for 1,550 fatalities and 40,000 nonfatal injuries annually in the United States.

- **Nutrition:** >88% of the population failed to meet daily intake recommendations for total vegetables, dark green veggies or orange ones; ≥96% failed to meet daily intake recommendations for legumes and whole grains; 75% of Americans consume less whole fruit than what is recommended; 84-98% of Americans fell short of their recommended intake of milk (except for young children and adolescent boys); 86-89% of people over age 70 take in more calories per day from solid fats than is recommended; ≥99% of children 8 and under ate more margarine and other solid fats than federal guidelines recommend; and most age groups consume too much added sugar (e.g. 99% of kids 8 & under exceeded the recommended daily allowance for added sugar, while only 50-65% of some age groups exceeded the daily recommendations).

**CDC Top Ten Causes of Death in U.S. in 2013:** (Total deaths ~2,600,000 million)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Cause</th>
<th>Deaths</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Heart disease (~600,000)</td>
<td>~600,000</td>
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<tr>
<td>2</td>
<td>Cancer (~600,000)</td>
<td>~600,000</td>
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<tr>
<td>3</td>
<td>Chronic lower respiratory diseases (~150,000)</td>
<td>~150,000</td>
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<tr>
<td>4</td>
<td>Accidents* (~130,000)</td>
<td>~130,000</td>
</tr>
<tr>
<td>5</td>
<td>Stroke (~130,000)</td>
<td>~130,000</td>
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<tr>
<td>6</td>
<td>Alzheimer’s disease (~85,000)</td>
<td>~85,000</td>
</tr>
<tr>
<td>7</td>
<td>Diabetes (~75,000)</td>
<td>~75,000</td>
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<tr>
<td>8</td>
<td>Influenza and pneumonia (~57,000)</td>
<td>~57,000</td>
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<tr>
<td>9</td>
<td>Nephritis and related disorders (~47,000)</td>
<td>~47,000</td>
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<tr>
<td>10</td>
<td>Suicide (~41,000)</td>
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* Accidents include: ~30,000 from unintentional falls; ~34,000 from MVAs; and ~39,000 unintentional poisonings including drug overdose deaths, such as those from opioid analgesics.

**Some additional risk/protective factors for Alzheimer’s dementia that have been reported in the research literature:**

- **Protective factors:** conscientiousness, educational and occupational attainment, purpose in life (greater purpose in life is associated with a reduced risk of AD and MCI).
- **Risk factors:** neuroticism, psychological distress depressive symptoms, negative life events.

Conscientiousness refers to an individual’s tendency to control impulses and be goal directed (aka: will, work, dependability). Conscientiousness is inversely associated with risk of developing an AD-like dementia. A high conscientiousness score (90th percentile) was associated with an 89% reduction in risk of Alzheimer’s disease compared with a low score (10th percentile). Results were not changed by controlling for other personality characteristics, activity patterns, vascular conditions, or other risk factors. Conscientiousness was also associated with decreased incidence of MCI and reduced cognitive decline. It was also unrelated to neuropathologic measures. Thus, the mechanism by which consciousness is linked to cognitive maintenance are unclear.

It is thought that there are three major mechanisms of action underlying the aforementioned lifestyle risk factors: inflammation, oxidative stress (i.e., free radicals) and amyloidosis. Conversely, the three major mechanisms underlying protective factors are thought to be anti-inflammatory, anti-oxidative stress, and/or anti-amyloid.
Increase your “brain reserve capacity” (BRC) in order to decrease your risk for dementia.

Brain Reserve Capacity, including Biological & Psychological Reserve:

- The concept of brain reserve capacity is based on the finding that a third or more of individuals meeting neuropathological criteria for Alzheimer’s disease do not have dementia (i.e., a dissociation between the neuropathology and cognitive status in many individuals).
- To optimize brain reserve capacity (both biological reserve & psychological reserve including neural reserve & cognitive reserve), strive to maximize protective factors and minimize risk factors for dementia (“accentuate the positive & eliminate the negative”). Protective factors promote homeostasis, whereas risk factors cause dyshomeostasis. Another way to express how to optimize BRC is to optimize neurodevelopment early in life and neuroplasticity throughout life, while minimizing neurotoxicity and neurodegeneration. Your twin goals should be to strive to be healthy & happy or, more broadly, strive for wellness & well-being.

<table>
<thead>
<tr>
<th>Biological Reserve: (Wellness ~ Healthy)</th>
<th>Psychological Reserve: (Well-Being* ~ Happy)</th>
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<tbody>
<tr>
<td>“What’s good for the heart (and all the body organ systems) is good for the brain.”</td>
<td>“Use it or lose it”</td>
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<td>“You are only as healthy as the lining of your blood vessels.”</td>
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<tr>
<td><strong>Neural/Brain reserve</strong> (brain structure/hardware): neurons &amp; synapses, glial cells, blood vessels</td>
<td><strong>Cognitive reserve</strong> (brain function/software): Attention, memory, thinking, etc. Enrich your environment &amp; your life experiences (lifelong learning) → enrich your mind → enrich your brain’s synaptic connections (synaptic plasticity) → enrich your brain</td>
</tr>
<tr>
<td><strong>Body reserve</strong>: body systems i.e. heart &amp; circulatory system, lungs &amp; respiratory system etc., etc.</td>
<td><strong>Emotional reserve</strong>: If discouraged or depressed, ability to cheer/psyche oneself up; if anxious, ability to calm down/self-soothe.</td>
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*Well-being consists of the following five primary/core components: positive emotions, engagement, positive relationships, meaning & purpose, and achievement (PERMA). In addition, well-being includes the following secondary components: self-determination, self-esteem, vitality, optimism, and resilience.

**Holistic Health**: Holistic health recognizes that health is dependent upon the whole person, i.e., the interaction of all bodily systems. A core concept of holistic health is homeostasis or homeostatic balance within each system and among systems. Often there is a narrow homeostatic range that is healthy, whereas excesses and deficiencies are considered dyshomeostasis, which if chronic, can lead to chronic or degenerative diseases of aging. Chronic dyshomeostasis is toxic (damaging) to cells & blood vessels of the body & brain, whereas optimum homeostasis minimizes damage to cells and blood vessels with aging and allows to recovery from the stress of living. The brain runs on two major fuels delivered by the blood supply: glucose and oxygen makes the brain “GO.” Disruption of regulation of glucose metabolism (e.g., insulin resistance and associated fasting hyperglycemia and hyperinsulinina associated with diabetes and prediabetes) and/or disruption of regulation of oxygen (e.g., from COPD, asthma, sleep apnea) will have both short-term and long-term negative effects on brain function and structure.
The “Necessary Nine” Protective Lifestyle Factors (aka the “Universal Nine”): The “necessary nine” protective lifestyle factors are a “universal” set of lifestyle behaviors that that lower your risk for all-cause morbidity & mortality including dementia. These “Necessary 9” are:

- Nutrition
- Stress Control
- Cognitive Stimulation
- Exercise
- Toxin Avoidance
- Social Engagement
- Sleep
- Accident/Injury Prevention
- Spirituality (i.e. Meaning & Purpose)

Nutrition, Exercise, Sleep, Stress Control, Toxin Avoidance, Accident/Injury Prevention, Cognitive Activity, Social Engagement, and Spirituality (especially Meaning & Purpose). Optimizing these “Necessary 9” lifestyle factors produces a double “win-win-win” situation: I) a) decrease risk for heart disease/stroke, b) decrease risk for diabetes, c) decrease risk for dementia (or extend you’re a) lifespan, b) health-span, & c) dementia-free span). II) a) you will feel better, b) look better, and c) function better in the here and now. Note that Hippocrates (460 BC – 370 BC) two and half millennia ago, the “Father of Western Medicine,” said the following: “let food be thy medicine,” “walking is man’s best medicine,” “everything in excess is opposed to nature,” and “if we could give every individual the right amount of nourishment and exercise, not too little and not too much, we would have found the safest way to health.”

Humans (i.e., human’s body, brain, and mind) evolved in the natural world over millions of year. During most of this several million years of our evolutionary history, the environment forced us to eat right and exercise (it would repeatedly push us out of our comfort zone, e.g., we had to work to eat). Increasingly in recent history, man has created a man-made self-indulgent environment (i.e., an artificial, unnatural environment) that caters to his twin drives for comfort and convenience. We were governed by the law of effect, especially the law of immediate effect (immediate gratification, reward, reinforcement, relief, comfort) and by the law of least effort (law of convenience, path of least resistance). For example, man has created a man-made artificial self-indulgent environment filled with processed “junk” foods that are high in calories, low in nutrition and provides immediate intense gratification (due to refined sugar/sweets, salt and saturated fat) (law of effect, i.e., law of immediate gratification). In addition, man has created an environment that permits a sedentary lifestyle that indulges his tendency to conserve calories by not engaging in exertion unless he has to (i.e., law of least effort (or maximum convenience). This man-made self-indulgent environment removes some beneficial pressures from the natural environment that encouraged certain healthy behaviors and which placed limits on certain unhealthy behaviors. Thus, this man-made self-indulgent environment is in some ways not conducive to man’s long-range welfare.

Two Major Modifiers of Risk and Protective Factors: Combined & Cumulative Effects.

Combined effects = dementia risk is the result of the combination of multiple risk and protective effects (i.e., it is multi-factorial). Variety can be a positive multi-factorial variable, e.g., eating a rainbow of colors in vegetables, fruits, and berries provides a wide variety of phytonutrients/antioxidants. Cumulative effects = dementia risk changes according to the dose and duration of exposure to each risk/protective factor (chronic exposure has the biggest effects). The optimal dose is one that is not too little and not too much (neither a deficiency nor excess). Remember Hippocrates’ admonition “everything in excess is opposed to nature,” and “if we could give every individual the right amount of nourishment and exercise, not too little and not too much, we would
have found the safest way to health.” In optimally managing risk and protective factors by engaging in optimally adaptive lifestyle habits, it can be said that “the earlier the better, but it is never too late to do some good.”

**More Details on the “Necessary 9”:** In brief, eat less, exercise more, sleep more, stress less, avoid toxins, prevent accidents/injuries (be careful), think & learn more, love more, and have more purpose. **Nutrition:** “let food be thy medicine” – Hippocrates. **Exercise:** “walking is the best medicine” – Hippocrates. **Sleep:** “knits up the raveled sleave of care... balm of hurt minds, chief nourisher in life’s feast” - Shakespeare. **Stress:** “have the courage to change what you can, the serenity to accept what you can’t change, and the wisdom to know the difference” – Reinhold Niebuhr and Epictetus; **Avoid accidents:** “better to be safe, than sorry.” **Cognitive stimulation:** “use it or lose it.”

1. **Nutrition:** The MIND diet (Mediterranean-DASH Intervention for Neurodegenerative Delay) reduced Alzheimer's risk by 53% among strict adherents and by 35% among those who followed it pretty well, "Even moderate adherence to the MIND diet showed a statistically significant decreased risk of developing Alzheimer's disease (Morris MC et al. “MIND diet associated with reduced incidence of Alzheimer's disease. Alzheimer’s Dementia, 2015 11(9):1007-14). So, eat like a Mediterranean (heavily whole food plant-based diet: Veggies; berries & fruits; beans & legumes; whole grains, nuts & seeds; herbs & spices; fish (especially cold water fish rich in omega-3 fatty acids); poultry & some lean meat & dairy. Eat the good macro-nutrients, i.e., good carbs, proteins & fats and avoid the bad. Good carbs are relatively unprocessed, unrefined whole food carbs like whole grains & beans. Bad carbs are processed, refined carbs like refined sugar and white flour. Good proteins are whole food plant-based proteins, fish, and lean meat, whereas bad proteins are excess animal protein. Good fats are monounsaturated fats and polyunsaturated fats, whereas bad fats are saturated fats and transfats (partially hydrogenated oils). There is an obesity epidemic in the U.S., and there is a huge amount of literature that shows that fat people die of cardiovascular disease more than thin people, and this literature adjusted for smoking, alcohol, blood pressure, cholesterol etc.

2. **Exercise:** According to the CDC, adults need at least: 2 hours and 30 minutes of moderate-intensity aerobic activity (i.e., brisk walking) every week and muscle-strengthening activities on 2 or more days a week that work all major muscle groups (legs, hips, back, abdomen, chest, shoulders, and arms). OR 1 hour and 15 minutes of vigorous-intensity aerobic activity (i.e., jogging or running) every week and muscle-strengthening activities on 2 or more days a week that work all major muscle groups. OR an equivalent mix of moderate- and vigorous-intensity aerobic activity and muscle-strengthening activities on 2 or more days a week that work all major muscle groups. **More time equals more health benefits:** If you go beyond the minimum recommended amount per week, you'll gain even more health benefits.

Fitness vs. Fatness: In terms of sticking with an exercise program versus sticking with a diet (losing weight and maintaining weight loss), a much higher percentage of people who take up exercise stick with it and become permanently fit. 80-95% of people regain all the weight they lose and more over 3-5 years. Furthermore, the fit, but fat, individual has almost half the risk of death of the unfit, fat individual. Fat but fit people are at only slightly more risk of death than thin fit people. Nonetheless, fit & thin is the ideal.
3. **Sleep:** Get your beauty sleep. Early to bed, early to rise, makes a man healthy, wealthy and wise (Ben Franklin).

Sleep that knits up the raveled sleave of care,  
The death of each day’s life, sore labor’s bath,  
Balm of hurt minds, great nature’s second course,  
Chief nourisher in life’s feast.  
(Macbeth – William Shakespeare)

More than a third of the population is not getting enough sleep. Sleep is vital to your well-being. It affects both mental and physical health. Amyloid plaques develop more quickly in the brains of sleep deprived mice. It has been proposed that chronic sleep deprivation and associated failure of the glymphatic clearance system could lead to a build-up of beta amyloid and contribute to amyloid plaque deposition and Alzheimer’s disease progression. The restorative nature of sleep appears to be the result of the active clearance of the by-products of neural activity (i.e., potentially neurotoxic waste products like beta-amyloid) that accumulate during wakefulness thus helping to restore metabolic homeostasis. Sleep is associated with a 60% increase in the interstitial space, resulting in a striking increase in exchange of cerebrospinal fluid with interstitial fluid, which in turn increases the rate of beta-amyloid clearance during sleep.

A good night’s sleep consists of 4-5 sleep cycles. Each cycle includes periods of deep sleep and rapid eye movement sleep. As the night goes on, the portion of that cycle that is in REM sleep increase. This pattern of cycling and progression is critical to the biological of sleep. **The National Sleep Foundation Recommends New Sleep Durations: National Sleep Foundation Completes Rigorous Study and Updates Recommended Sleep Times at Each Life Stage** to avoid the health risks of chronic inadequate sleep (February 2, 2015) published in **Sleep Health: The Journal of the National Sleep Foundation.** Recommended sleep ranges for different age groups: **Newborns (0-3 months): 14-17 hours each day (not more than 19), Infants (4-11 months): 12-15 hours (not more than 18), Toddlers (1-2 years): 11-14 hours (not more than 16), Preschoolers (3-5): 10-13 hours (not more than 14), School age children (6-13): 9-11 hours (not more than 12), Teenagers (14-17): 8-10 hours (not more than 11), Younger adults (18-25): 7-9 hours (not more than 11), Adults (26-64): 7-9 hours (not more than 10), and Older adults (65+): 7-8 hours (not more than 9). However, sleeping more than nine hours per night on a regular basis may be appropriate for young adults, individuals recovering from sleep debt, and individuals with illnesses.

Sleep helps you think more clearly, have quicker reflexes and focus better. It affects your mood and how you interact with others. Sleep affects hormones, the immune system, appetite, breathing, blood pressure and cardiovascular health. Sleep duration may be an important regulator of body weight and metabolism. An association between short habitual sleep time and increased body mass index (BMI) has been reported in large population samples. Habitual sleep duration below 7.7 h was associated with increased BMI. Sleep restriction affect the appetite hormones (leptin and ghrelin). Leptin is an appetite suppressant and ghrelin is a potent appetite stimulator. Short sleep duration is associated with decreased leptin and increased ghrelin which
results in increased appetite. These hormone alterations may contribute to the BMI increase that occurs with sleep curtailment.

**Loss of sleep** can cause fatigue and moodiness. It impairs thinking, reasoning, problem-solving and attention to detail. It is associated with being less productive at work and puts you at much higher risk for traffic accidents. **Chronic insomnia** can cause exhaustion, irritability and difficulty concentrating. **Chronic sleep deficit** can put you at higher risk for depression, obesity, heart disease, stroke, and infections. **Lack of sleep** can produce diabetic-like conditions in otherwise healthy people. It can negatively affect the efficiency of vaccinations. **Sleep apnea** causes sleep deprivation, decreases blood oxygen levels, triggers a fight or flight stress response, blood pressure spikes, heart rate fluctuates, and the brain wakes up to start your breathing again.

Sleep can be disrupted by many things, including stimulators such as caffeine, distractions like light from TVs, cell phones, tablets, and e-readers can prevent you from falling asleep. Sleep can be affected by illness, medications, and sleep disorders. To obtain good quality sleep: go to bed the same time each night and get up the same time each morning, sleep in a dark, quiet, comfortable environment; exercise daily (but not right before bedtime), limit the use of electronics before bed, relax before bedtime (warm bath, reading), avoid alcohol and stimulants late in the day, avoid nicotine, consult health care professional if you have ongoing sleep problems.

4. **Stress Control**: It is the nature of human existence that life has its ups and downs (joys & sorrows, victories & defeats). To be psychological healthy (optimally adaptive), one has to be resilient and be able to optimally cope with both ups and downs. "If—" is a poem by British Nobel laureate Rudyard Kipling and is a literary example of Victorian-era stoicism.

> If you can keep your head when all about you  
> Are losing theirs and blaming it on you,  
> If you can trust yourself when all men doubt you,  
> But make allowance for their doubting too;  
> If you can meet with Triumph and Disaster  
> And treat those two impostors just the same;  
> If you can fill the unforgiving minute  
> With sixty seconds’ worth of distance run,  
> Yours is the Earth and everything that’s in it,  
> And—which is more—you’ll be a Man, my son.

---Selection from “If” by Rudyard Kipling

Based on findings linking dementia with chronic stress, having effective tools to address stress can be an important part of Alzheimer's prevention, not to mention achieving and maintaining optimal health in general. When you're experiencing acute stress, your body releases stress hormones (such as cortisol) that prepare your body to either fight or flee the stressful event. Your heart rate increases, your lungs take in more oxygen, your blood flow increases, and
parts of your immune system become temporarily suppressed, which reduces your inflammatory response to pathogens and other foreign invaders.

"Short-term increases in cortisol are critical for survival. They promote coping and help us respond to life's challenges by making us more alert and able to think on our feet. But abnormally high or prolonged spikes in cortisol—like what happens when we are dealing with long-term stress—can lead to negative consequences that numerous bodies of research have shown to include digestion problems, anxiety, weight gain, and high blood pressure." (McEwen BS, Sapolsky RM. 1995)

When stress becomes chronic, your immune system becomes less sensitive to cortisol, and since inflammation is partly regulated by this hormone, this decreased sensitivity heightens the inflammatory response and allows inflammation to get out of control. Inflammation, in turn, is a hallmark of most diseases, from diabetes to heart disease, cancer, and Alzheimer's disease.

"Rats with high levels of the stress hormone corticosterone showed structural changes in the brain and short-term memory deficits. Older animals with higher levels of stress hormones in their blood have 'older' frontal cortices than animals with less stress hormones, thus, stress may act as a pacemaker of aging in this key brain region." (McEwen BS, Sapolsky RM. 1995)

Elevated levels of cortisol affect your memory by causing a gradual loss of synapses in your prefrontal cortex. In addition, human and animal studies have shown that stress reduces hippocampal volume, alters synaptic plasticity and firing properties of hippocampal neurons, and impairs various hippocampal-dependent memory tasks. Glucocorticoids like cortisol are thought to be mediators of the myriad stress effects on the hippocampus. (McEwen BS, Sapolsky RM. 1995. Stress and cognitive function. Curr Opin Neurobiol 5: 205–216). Stress may be a trigger for the onset of Alzheimer's disease. One study reported that 72 percent of Alzheimer's patients had experienced severe emotional stress (or grief) during the two years preceding their diagnosis as compared to only 26% in the control group.

One general strategy for preventing chronic stress is to be philosophical about life. Be wise, optimize. Optimize, then rejoice. Practice optimization: the art and science of living. Optimal attitude + optimal action → optimal adaptation. Optimal attitude = an “optimization” attitude which includes both an optimal “can do” attitude for things that you can change for the better and an optimal “acceptance attitude” for things you cannot change. Additional important optimal attitudes include the “gratitude” attitude (in which you are thankful for the blessings in your life) and a “forgiveness” attitude (in which you have understanding and forgiveness towards those that have hurt you). Optimization = Do your best, don’t worry about the rest (i.e., combine optimally adaptive action with optimally adaptive acceptance). Do the right thing. Take care of business (TCB). Play the cards you are dealt. When given lemons, make lemonade. Make the best decision given the best information available to you at the time. Get over it, let go and move on. Accept that sometimes your best will not be good enough. Remember the best revenge is living well. Remember we are all a “work in progress.” Be your own boss (BYOB), i.e., strive for self-mastery, i.e., ability to tell yourself what to do, and what not to do (in accordance with your values and with universal truths), and acting accordingly.
Practice “Zen-Stoicism” that is embodied in the “Serenity Prayer” (aka Wisdom Prayer): Change what you can for the better, accept what you can’t change, and have the wisdom to know the difference. You can’t change the past, other people (or their opinions), genetics, or random/chance events. Conversely, you can change your present and future, yourself (both your thoughts and actions), your lifestyle, and how you react to random adverse events. Have high aspirations but low expectations that way you continue to aspire and strive, but are seldom disappointed which is experienced as a loss due to failure for expectations to be met.

5. **Toxin Avoidance**: Smoking, excess alcohol, drug use; refined carbohydrates (refined sugar & white flour), excess salt & unhealthy fats (trans fats & excess saturated fat); viruses & bacteria (Rx: hygiene and sanitation), pesticides & herbicides, air & water pollution, toxic emotions & toxic people, excess UV light (eyes & skin) & excess noise. i.e. avoid toxins and unhealthy addictions (addictions to toxins and addictions that cause excesses).

6. **Accident/Injury Prevention**: Better to be safe than sorry. Head injuries increase later risk for dementia. Injuries in general can interfere with the ability to exercise and thus negatively affect health. A major cause of head injuries, other injuries, and death are motor vehicle accidents. Drive carefully and defensively. Drive a safe, well maintained vehicle. Obey traffic laws. Don’t speed. Buckle up. Be extra careful when driving in inclement weather. Know how to get where you are going so you are not distracted from paying attention to traffic. Don’t drive when intoxicated, fatigued, upset or distracted. Also, be careful to prevent falls. Stay physically fit, but avoid overuse injuries. Move with good biomechanics.

7. **Cognitive Activity**: Possibly one of the worst things you can do when you retire is become reclusive and inactive. The mind is like a muscle – if it is not exercised, its capabilities will fade. So in addition to continuing some sort of regular exercise habit, seniors should also exercise their brains. Reading books, solving puzzles and just simply engaging in conversation are all great ways to keep the brain sharp and functioning well into later life. Becoming reclusive and spending a lot of time in front of the television, while on occasion may offer relaxation, should not monopolize your time. Keeping active will not only help keep you mentally sharp and physically healthy, but will also elevate your mood and help you be happy well into your golden years.

8. **Social Engagement**: It is now believed the evolution of the human brain was driven both by tool use and social interaction. The human being is a social animal, and the human brain is a “social brain.” It has been proposed that the evolution of language and human intelligence was driven by social needs and pressures to communicate, to cooperate and compete, and to control impulses so as to get along with others. People need people. It’s important to maintain social connections and frequently enjoy the company of friends and family or join social groups and activities that will enable social interaction with peers.

9. **Spirituality (Meaning & Purpose)**: Greater purpose in life is associated with a reduced risk of AD and MCI in community-dwelling older persons. Boyle et al. Effect of a purpose in life on risk of incident Alzheimer’s disease and mild cognitive impairment in community-dwelling older persons. *Arch Gen Psychiatry*. 2010 Mar;67(3):304-10. Reason to get out of bed in the morning, reason to live. In addition, scientific studies show people who pray and go to church...
are healthier according to Dr. Harold G. Koenig, director of The Center for Spirituality, Theology and Health at the Duke University Medical Center and author of *The Healing Power of Faith*. Koenig says people of faith cope better with stress, have better health, both physically and mentally, experience greater well-being because they have more hope, they're more optimistic, they experience less depression, less anxiety, and live longer.

**Behavioral Change.**

Behavioral change is required for optimal lifestyle health habits but as most of us have experienced, it is “easier said than done.” That is because “knowledge” and “doing” are different mental/brain systems. Knowledge consist of well-established declarative memories that require the medial temporal lobe memory system (including the hippocampus) to be learned/acquired and are stored in the associations cortices of the brain. The “doing” or “action” systems require frontal lobe systems for conscious/executive control and the basal ganglia for the learning and storage of new procedural memories for habits and skills. If you want to change your behavior, you have to use executive control to train or condition new skills and habit in the same way that you would acquire the skill to play a musical instrument like the violin or an athletic skill like playing golf. It takes deliberate practice (conscious effort and attention, i.e., work) to develop a new skill or habit, but once a skill/habit is acquired and well-established, it becomes easy/automatic. Practice makes perfect. It is said that it takes approximately 10,000 hours of deliberate practice to become world class in any field, i.e., to master a complex set of skills. However, simple skills can be acquired quickly. Self-mastery requires a complex of skills that no one can be perfect at but one can gain increasing degrees of mastery. So consider “self-mastery” as a lifetime project and that you are always a “work in progress” that can continually improve through deliberate practice.

There are two major behavioral control systems: 1) volitional control and 2) habitual control. Volitional control (aka executive control) is conscious, effortful, and requires, utilizes and depletes mental energy, whereas habitual control is more automatic, effortless, and makes lower demands on mental energy. Volitional control involves conscious attention and conscious choice, whereas habitual control involves more automatic attention and choice. Volitional control is needed in novel situations and in situations in which one must override a habitual response. Volition is need in making new habits and in breaking bad habits. However, one’s a new habit is well-established, it no longer requires volition and becomes relatively automatic and effortless (i.e., it becomes a dominant response in one’s response hierarchy). The establishment of a habit frees the volitional system to focus on new behaviors. Thus, one major goal is to use the volitional system to create new adaptive habits and extinguish old maladaptive habits. Cultivate grit. Grit is a combination of passion and perseverance. Grit is required to sustain the conscious deliberate practice necessary to develop skills and make achievements. **Talent x effort = skill; skill x effort = achievement** (Angela Duckworth, *Grit: The Power of Passion and Perseverance*, 2016).

According to the law of least effort, people are more likely to do things that are easy (i.e., relatively effortless) than to do things that are difficult (i.e., effortful). Volitional behaviors are behaviors that are not yet habits and require more effort, conscious attention/choice/control, and
mental energy than do behaviors that have become habitual. Habitual behaviors (well-learned habits and skills) are more automatic, effortless, and require less mental energy. But new habits and skills are created through deliberate practice which requires volition (conscious attention, choice and control) which is effortful (i.e., work). You have to force yourself (make an effort) to engage in deliberate practice, but the huge benefit is that specific behavior that is practiced will eventually become a well-learned skill/habit, i.e., become more automatic and effortless. The other major benefit from forcing yourself to practice to develop a new skill or habit is that in addition to creating a new specific adaptive habit/skill, you are also practicing the general volitional skill/habit (i.e., you are strengthening your general willpower muscle to do things that are difficult), which will make it more likely in the future that you will do the hard things that are necessary.

**In summary, knowledge is often necessary but not sufficient** for behavioral change. Behavior is either conscious control or automatic control. Consciously-controlled behavior is volitional (volition, will, willpower, executive control), whereas automatically-controlled behavior is habitual (habits and skills). Volition is effortful, requires conscious attention, and utilizes and depletes mental energy. In other words, volitional behavior is work, i.e., you have to make an effort/you have to force yourself. Habits (both habits of mind & habits of behavior), once established, are effortless, require little conscious attention, and have a low mental energy requirement. “Man is a creature of habit” (G. Stanley Hall, 1844 – 1924) – both good and bad habits. Habits once established are automatic and effortless (i.e., easy).

However, to make and break habits requires deliberate practice (i.e., volition, conscious control, executive control). **Practice makes perfect** (e.g., it is said that it takes approximately 10,000 hours of deliberate practice to become world class in any field, i.e., to master a complex set of skills. With repetition (i.e., deliberate practice through conscious attention, choice and control), new habits are formed and then become self-perpetuating (i.e., become easier, i.e., habits can be performed without conscious attention or thought), which in turn frees your conscious attention to focus on other things.

The litmus test to guide your behavioral choices (i.e., choosing whether “to do or not to do - that is the question”) is to ask yourself whether a particular action choice “helps” or “hurts” yourself or others (i.e., is it helpful or harmful, adaptive or maladaptive, constructive or destructive). If it helps, then you have a “green light” to take that action (it’s a “go,” a “do”), whereas if it hurts yourself or other, then you have a “red” light (“no go,” “don’t do”). In practical strategic terms, “to do or not to do” can be translated into “to delay or not to delay,” i.e., if the action is helpful (adaptive) then “don’t delay, whereas if it is harmful, then “delay.” For example, if you crave a piece of chocolate cake, you may want to adopt a delaying tactic. You may succeed in delaying indefinitely or at least long enough to decrease the frequency of the maladaptive behavior. You may succeed in delaying indefinitely or at least long enough to decrease the frequency of the maladaptive behavior.

Below are famous quotes bearing on the proposition that repetition via deliberate practice can both strengthen your willpower and train new habits.

“We are what we repeatedly do. Excellence, then, is not an act, but a habit.” -Aristotle (384 – 322 BC)

“We are spinning our own fates, good or evil, and never to be undone. Every smallest stroke of virtue or of vice leaves its never so little scar.” -- William James (1842-1910).
“Keep the faculty of effort alive in you by a little gratuitous exercise every day. That is, be systematically ascetic or heroic in little unnecessary points, do every day or two something for no other reason than that you would rather not do it, so that when the hour of dire need draws nigh, it may find you not unnerved and untrained to stand the test. Asceticism of this sort is like the insurance which a man pays on his house and goods. The tax does him no good at the time, and possibly may never bring him a return. But if the fire does come, his having paid it will be his salvation from ruin.” -- William James (1842-1910).

“There are no shortcuts—everything is reps, reps, reps.... From the bodybuilding days on, I learned that everything is reps and mileage. The more miles you ski, the better a skier you become; the more reps you do, the better your body.” -- Arnold Schwarzenegger (1947 - ), Total Recall: My Unbelievably True Life Story

Behavioral change can be best achieved by making conscious choices to change both one’s automatic thoughts and one’s behavior. Automatic thoughts include one’s well-established beliefs, attitudes, mindsets (i.e., habits of mind) and one’s automatic behaviors (i.e., one’s habitual behaviors). This can be accomplished through applied behavioral analysis (ABA) and through cognitive-behavior modification techniques (i.e., operant conditioning). ABA involves identifying the ABCs, i.e., antecedents, behavior, and consequences. In operant conditioning (aka, instrumental conditioning), the antecedents are called discriminative stimuli (aka stimulus control) and the consequences provide either reinforcement or punishment. The basic principle or operant conditioning (aka; the “law of effect”) states that “responses that produce a satisfying effect in a particular situation become more likely to occur again in that situation, and responses that produce a discomfiting effect become less likely to occur again in that situation.”

However, immediate consequences have a powerful effect on the immediately preceding behavior, whereas delayed consequences have a weak effect. Thus, if there are immediate pleasurable consequences but delayed negative consequences, the immediate pleasurable effects tend to control the immediately preceding contingent behavior/action. For example, the immediate consequence of eating a piece of chocolate cake is immediate gratification (positive reinforcement, pleasure, bliss, a rush), whereas the delayed consequence may be becoming obese and developing cardiovascular/cerebrovascular disease, diabetes, and/or cancer.

To resist giving into the temptation (impulse, craving) and eating the cake, one needs to use one’s imagination to do two things: a) degrade the anticipated immediate pleasure of eating the cake and b) bridge the delayed negative consequences (i.e., make the delayed consequences salient and visit in the here and now). For example, a) one can imagine that cockroaches were crawling over the cake just moments ago, and b) one can also imagine being obese with clogged arteries and laying on a gurney being wheeled into an operating room to have your chest cut open for quadruple bypass surgery. In this way, you have both degraded the immediate allure of cake and bridged the delay adverse consequence of having to have coronary artery bypass graft surgery for severe coronary heart disease. Human beings have vivid imaginations; harness the power of your imagination to improve your self-mastery skills of self-control, self-discipline, and emotional self-regulation.
Premack's principle, or the relativity theory of reinforcement, states that an opportunity to engage in more probable behaviors (or activities) will reinforce less probable behaviors. In layman’s terms, if you work first, then you can rest or enjoy some other rewarding activity (if work first, then rest/play). If necessary, this can be done repeatedly throughout the day, i.e., accomplish something (Take care of business = TCB), then rest/play for a while, then accomplish something else and rest/play for a while. Force yourself to score at least one little victory in terms of working first, and then enjoying a contingent reward because these small victories can strengthen your willpower over the time and in addition condition good automatic habits.

I am reminded of the 1986 Smith Barney commercial in which John Houseman famously said “Smith Barney, they make money the old fashioned way, they earn it.” You probably have many times employed this principle in your life, but perhaps you don’t use it as often as you could to change your behavior for the better. Harness the power of the law of effect (i.e., contingent reinforcement, operant conditioning, Premack’s principle) to improve your self-control & self-discipline. Premack's principle suggests that if a person wants to perform a given activity, the person will perform a less desirable activity to get at the more desirable activity; that is, activities may themselves be reinforcers. An individual will be more motivated to perform a particular activity if they know that they will be able to partake of a more desirable activity as a consequence. Stated objectively, if high-probability behaviors (more desirable behaviors) are made contingent upon lower-probability behaviors (less desirable behaviors), then the lower-probability behaviors are more likely to occur. More desirable behaviors are those that individuals spend more time doing if permitted; less desirable behaviors are those that individuals spend less time doing when free to act. Premack’s principle has been used by therapists practicing applied behavior analysis.

Environmental Modification: Raising and lowering barriers to behavior. Raising barriers to a behavior will decrease the probability of that behavior occurring, whereas lowering barriers to a behavior can increase the probability of the behavior occurring. If you want to eat healthier and/or lose weight, don’t keep high calorie junk foods in the house, i.e., raise the barrier for eating junk food by making it less easily accessible. Conversely, if you want to increase the likelihood of exercising after work, have your exercise clothes & shoes laid out in advance so that you can easily and quickly get ready for that activity, i.e., lowering the barrier for an adaptive behavior.

Have a flexible “growth” mindset and regard yourself as a “work in progress:” We are all a “work in progress.” We should be striving throughout life for greater degrees of self-mastery (self-regulation). Self-mastery is “being your own boss” (BYOB), i.e., “being able to tell yourself what to do and what not to do, and acting accordingly.” The opposite of self-mastery is self-indulgence which can be described as “I want, what I want, when I want it, and I want it now.”

Self-mastery skills include self-control, emotional self-regulation, and self-discipline. Self-control (or impulse control) is the ability to control one’s appetites and depends on the ability to delay gratification. Emotional self-regulation involves being able to cheer or psyche yourself up when you are down and being able to calm yourself down when you are anxious, agitated, or the like.
Self-discipline is synonymous with the work ethic which is composed of the start ethic + persist ethic + finish ethic. A major aspect of self-discipline is effective goal-directed behavior (i.e., executive functioning). Effective goal-directed behavior consists of the following steps/stages:

1. Discover universal truths
2. Determine values
3. Set goals
   - Feedback control: monitor, evaluate, reinforce
   - Make plans (and backup/contingency plans)
   - Implement plans (executive, taking action)

The seven virtues of self-mastery: be heroic, be acetic, be stoic, be hedonistic, be agapic, be strategic, & be comedic.

- **Heroic** = courage to act (self-discipline)
- **Acetic** = self-control over one’s appetitive drives
- **Stoic** = emotional self-regulation/homeostasis
- **Hedonistic** = capacity for enjoyment
- **Agapic** = love (loving kindness)
- **Strategic** = be smart, anticipate and act accordingly
- **Comedic** = exercise a sense of humor.

Below are two inspirational passages; one is from Teddy Roosevelt, and the other is the poem “Invictus” (meaning “unconquerable” or “undefeated” in Latin) by William Ernest Henley, written while Henley was hospitalized and being treated for tuberculosis of the bone.

“It is not the critic who counts; not the man who points out how the strong man stumbles, or where the doer of deeds could have done them better. The credit belongs to the man who is actually in the arena, whose face is marred by dust and sweat and blood; who strives valiantly; who errs, who comes short again and again, because there is no effort without error and shortcoming; but who does actually strive to do the deeds; who knows great enthusiasms, the great devotions; who spends himself in a worthy cause; who at the best knows in the end the triumph of high achievement, and who at the worst, if he fails, at least fails while daring greatly, so that his place shall never be with those cold and timid souls who neither know victory nor defeat.”
- Theodore Roosevelt (1858 – 1919)
Invictus
by William Ernest Henley (1849-1903)
Out of the night that covers me,
Black as the pit from pole to pole,
I thank whatever gods may be
For my unconquerable soul.
In the fell clutch of circumstance
I have not winced nor cried aloud.
Under the bludgeonings of chance
My head is bloody, but unbowed.
Beyond this place of wrath and tears
Looms but the Horror of the shade,
And yet the menace of the years
Finds and shall find me unafraid.
It matters not how strait the gate,
How charged with punishments the scroll,
I am the master of my fate,
I am the captain of my soul.

Recommended Reading on Brain Health and Preventing Dementia


The Alzheimer's Prevention Program: Keep Your Brain Healthy for the Rest of Your Life by Gary Small, M.D. and Gigi Vorgan, 2012


Recommended Reading on Behavioral Change


Mindset: The New Psychology of Success (How we can learn to fulfill our potential) by Carol S. Dweck, Ph.D., 2007

The Marshmallow Test: Mastering Self-Control Book by Walter Mischel, Ph.D., 2014

Learned Optimism: How to Change Your Mind and Your Life by Martin E. P. Seligman, Ph.D., 2006

Flourish: A Visionary New Understanding of Happiness and Well-Being by Martin E. P. Seligman, Ph.D., 2012

Authentic Happiness: Using the New Positive Psychology to Realize Your Potential for Lasting Fulfillment by Martin E. P. Seligman, Ph.D., 2004

Willpower: Rediscovering the Greatest Human Strength by Roy F. Baumeister, Ph.D. and John Tierney, 2012