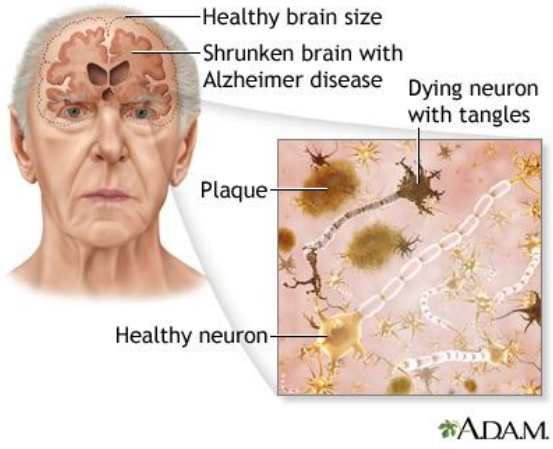
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Causes of Alzheimer's Disease and How Effective Remedies Are in Promoting Memory and Cognitive Abilities among Alzheimer's Patients
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Over six million Americans are diagnosed with Alzheimer's disease – the most common form of dementia. Dementia refers to a loss of cognitive function, meaning acts of remembering, thinking, responding, and reasoning. The vast majority of Alzheimer's patients were diagnosed over the age of 65. However, the complex changes that occur in the brain due to Alzheimer's disease result in symptoms stemming years –even decades– after Alzheimer's initially affected the brain molecularly. The brain utilizes the nervous system to send signals and messages to one's body through neurons, which ultimately allows the brain to function and control our bodies. Alzheimer's disease initially begins when Beta-amyloid (a protein found in the brain that normally functions to repair and grow neurons) clumps into plaque surrounding the neurons. While the Beta-amyloid excessively surrounds the neurons, an Alzheimer's affected brain simultaneously accumulates abnormal Tau (a protein that normally helps stabilize neurons) within the neurons creating tangled bundles of fibers ("What is"). When a brain is exposed to the toxic buildup of these proteins (Beta-amyloids and Tau), the neurons are inhibited and brain activity is restricted, hindering electrical impulses and chemical transmissions between the synaptic regions of axons. This result initially impacts the hippocampus and entorhinal cortex. The hippocampus serves to promote memory, learning, and emotion, while the entorhinal cortex acts as a mediator for the information being transmitted to the hippocampus. Since these regions are the first to be affected by Alzheimer's, the primary symptoms Alzheimer's patients experience are linked to forgetfulness, impaired judgment, and difficulty retaining recently learned information. However, these symptoms often escalate hallucinations, memory loss, and impaired communication as the disease progresses. Over time, these symptoms become more severe since the lack of transmission between the neurons results in cell death and gradually leads to atrophy of the brain ("Alzheimer's Disease Fact Sheet").



Caption:
As the image shows, Alzheimer's results in an atrophy of the brain. In the detailed illustration, the plaque represents the Beta-Amyloid proteins that surround the neurons, and the tangles on the darker neuron represent the Tau proteins. The effects on neurons are illustrated by a contrasting size and color when compared to the healthy neurons (Medline Plus).

The exact causes of Alzheimer's disease are unknown; however, research suggests a combination of age-related factors, genetic heredity, and lifestyle impacts the development of Alzheimer's disease. Age impacts one's vascular system as the arterial elasticity becomes more inelastic, causing insufficient amounts of blood to be transported to the brain. The lack of blood supply to the brain reduces the presence of glucose, which ultimately limits brain activity and can lead to the onset of Alzheimer's ("What Happens"). Another age-related factor that contributes to Alzheimer's is inflammation. Microglial cells are immune cells dedicated to the central nervous system in the brain, which normally function to regulate brain development and maintain neuron transmission. However, when inflammation occurs in the brain, these microglial cells are unable to maintain regulation resulting in the neurons losing their ability to communicate through chemical messengers and reactions ("What is"). These are the main age-related factors that scientists have concluded to potentially cause Alzheimer's in combination with other causes.

In addition to these factors, Alzheimer's disease can also be linked to genetic heredity. A 2021 study by the National Institute of Health concludes the gene Apolipoprotein E (APOE-E4) increases the risk of developing Alzheimer's disease, if inherited. This mutated gene is quite common as roughly 25% of the population carry one copy of the genotype; however, only 2-3% carry two copies. Carrying two copies of the gene significantly increases one's risk of developing Alzheimer's disease because of the diploid nature of human chromosomes. The APOE-E4 gene facilitates the transportation of cholesterol into the bloodstream. The fatty composition of cholesterol promotes the development of Alzheimer's since the brain has difficulty processing such lipids ("Study"). Genetic heredity is seen as one of the most predictable causes of Alzheimer's disease, but scientists agree that it may not be the sole cause of the development of the disease.

Although genetics impact one's chances of developing Alzheimer's disease, one's lifestyle and environmental conditions may also put someone at a higher chance of developing it. People with mild cognitive impairment (MCI) are at greater risk of developing both dementia and Alzheimer's disease. People with MCI experience symptoms more extreme than forgetfulness from aging but not as extreme as Alzheimer's effects. Although not everyone who experiences MCI develops Alzheimer's disease, people with MCI are more vulnerable to contracting the disease ("Alzheimer's Disease"). Furthermore, people who previously experienced head trauma are at higher risk of developing the disease. People who had a severe cause of traumatic brain injury (TBI) have a 4.5 times greater chance of developing Alzheimer's and dementia ("Traumatic Brain Injury"). Severe TBI causes the production of excessive Beta-amyloids and Tau proteins which as discussed previously can damage neurons and prompt the development of Alzheimer's because of the limited chemical transmission between the synaptic regions of axons. (Ramos-Cejudo, et al.). Additionally, the environment may also put one at a higher risk of developing the disease. Higher levels of PM 2.5 which is a particle representing air pollution are linked to a greater chance of getting Alzheimer's disease. A Harvard study concludes that air pollution may not directly cause Alzheimer's disease and

dementia; however, air pollution is associated with a greater risk of developing it. The types of pollution with the greatest effect on the PM2.5 pollution scale stem from agriculture and wildfires. The PM2.5 particle can activate microglial activity and cause inflammation. When inflamed, the neurons have difficulty transporting chemical signals and may result in neuroinflammation. The Harvard scientists conclude the PM2.5 particle doesn't necessarily correlate with being the sole cause for the development of Alzheimer's disease, but it statistically makes people more vulnerable to developing the disease in combination with other factors over a prolonged period of time (Budson).

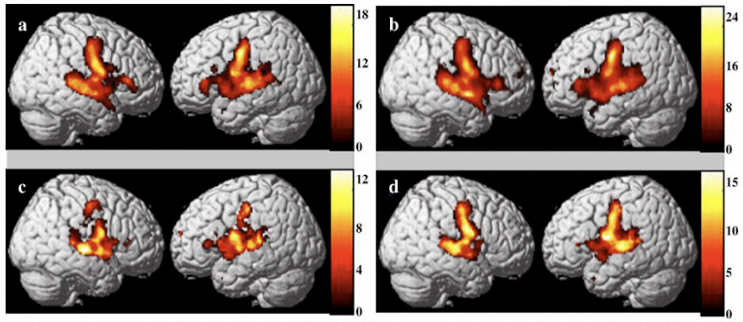
Furthermore, lifestyle and behavior may also impact one's predisposition for Alzheimer's disease. Excessive consumption of alcohol depresses the central nervous system and damages neurons. In order for brain cells to maintain homeostasis, they require growth factors, which are signaling molecules that promote cell growth through the binding signal molecule to its specific receptor. People who excessively consume alcohol produce elevated levels of acetaldehyde as the antidiuretic hormone (ADH) metabolizes alcohol into the toxic substance known as acetaldehyde. However, this substance is later decomposed to acetate which is rarely toxic and can be digested. The strain of excessive drinking harms the ADH which restricts the decomposition and causes elevated levels of acetaldehyde. These elevated levels hinder brain activity and impair memory. More specifically, it can also cause neurodegeneration, the loss of neurons, which places excessive drinkers at a higher risk of developing Alzheimer's disease (Pervin, et al.). Similar to excessive drinking, smoking and the use of nicotine products may also increase one's risk of developing Alzheimer's disease and dementia. Recent studies all conclude that current smokers are 30% more likely to develop dementia and 40% more likely to develop Alzheimer's disease compared to people who have never smoked. These studies also conclude that there is a dose-response relationship, meaning the more one smokes the greater the chance the person is at risk for developing forms of dementia (Puckering). Tobacco is known to cause oxidative stress, which occurs when there are not enough antioxidants to combat the toxic molecules inside of one's cells. Oxidative stress hinders DNA base pairing because of hydroxylation, nitration, and protein carbonylation. These factors cause an excessive increase of calcium through the glutamate DNA base receptor which induces a cell response promoting apoptosis (Gella et al.). Apoptosis causes brain atrophy because of the damaged and dead cells, which ultimately increases one's chances of developing Alzheimer's disease and dementia. Underlying heart problems or diseases may also heighten one's risk of developing Alzheimer's disease and dementia. People with heart problems also often have high blood pressure and greater cholesterol values. High blood pressure values may cause the vascular walls to weaken because of the Beta-amyloid protein buildup. This excessive buildup may hinder blood from reaching the brain which deprives the brain of necessary nutrients ("What Happens"). Scientists have yet to pinpoint the exact causes of developing Alzheimer's disease; however, a combination of the age-related, environmental, and behavioral factors described are proven to increase the chances of developing the disease and other forms of dementia.

Although there are drugs and medication prescribed to people diagnosed with Alzheimer's disease as a form of treatment, there is no scientific evidence that drugs are able to reverse or slow the effects of dementia. Drug treatment rather works to temporarily support and promote memory and cognition. As mentioned, Alzheimer's disease reduces the stimulation of neurotransmitters, chemical messengers within the brain. One significant neurotransmitter that is significantly affected by Alzheimer's disease is Acetylcholine which is known to promote memory, attention, and learning. Drugs targeting Alzheimer's patients commonly include cholinesterase inhibitors which serve to preserve neurons through targeting the Acetylcholine neurotransmitter ("Alzheimer's: Drugs Help"). Drugs and medication may help with promoting memory among Alzheimer's patients, but there are other solutions such as exercise, music therapy, and social interaction that can also foster memory support.

Although Alzheimer's has a severe impact on memory and cognitive abilities, people diagnosed with Alzheimer's are still able to preserve skills that stem from other parts of the brain. Skills such as reading, telling stories, sharing memories, singing, music, dancing, etc. are retained for a longer duration when diagnosed with Alzheimer's disease. These skills are preserved longer since they are controlled by the temporal lobe, motor cortex, cerebellum, etc. rather than the hippocampus and entorhinal cortex which are the first regions of the brain to be affected by the disease ("Alzheimer's Disease"). Therefore, it is significant to Alzheimer's patients' mental and physical health to participate in such activities to stimulate the unaffected parts of the brain for as long as possible before the disease escalates and deactivates brain function.

Exercise is one of the natural ways to encourage memory and delay the onset of extreme symptoms of Alzheimer's disease. Aerobic exercise increases the blood flow and oxygen supply. Supplying the brain with these nutrients helps promote the growth and development of new brain cells. Simultaneously, exercise and increased blood flow help dissolve the cholesterol buildup in blood vessels by decomposing the fatty lipids. Additionally, several hormones are released during exercise, and studies show that some of the hormones are involved in establishing new connections among neurons, which help promote cognitive function. As mentioned previously, the hippocampus region of the brain is in charge of memory and cognitive functions. Exercise helps protect the hippocampus from atrophy and decaying. Maintaining the hippocampal volume is essential for people diagnosed with Alzheimer's disease since it not only helps promote and restore memory but it also can improve heart health (Meng, et al.). The significant benefits that exercise provides to Alzheimer's disease patients cause Abe's Garden and other residential communities for Alzheimer's patients to implement an exercise routine for the residents. Abe's Garden has light to moderate exercises they do with their residents once or twice daily to stimulate their bodies –even for those residents who are generally immobile. The exercises at Abe's Garden range from marching with your legs while sitting down to shaking egg shakers while executing various arm movements. Even light exercises can have a tremendous impact on the physical, mental, and cognitive health of Alzheimer's patients.

In addition to exercise, music therapy is a common activity that many Alzheimer's patients participate in because of its impact on memory and the brain. Listening to familiar music, like music from one's childhood, promotes memory retrieval because of the brain stimulation in areas of the temporal lobe. The brain activity in these regions may trigger memories from one's past and evoke emotion. Therefore, many Alzheimer's patients become more social and responsive when listening to familiar music. When Alhzeimer's patients sing along to these songs they activate regions of the brain that may have been exposed to plaque like Beta-amyloid buildup which helps mitigate the effects of Alzheimer's disease (Leggieri, et al.).



Caption: An MRI is able to spot activation of the temporal lobes during different activities. "a" represents brain activity while speaking. "b" represents brain activity when singing. "c" represents brain activity when humming. "d" represents brain activity during vowel recitation ("Shared").

The MRI image demonstrates how singing along to familiar songs activates and exercises regions of the temporal lobe more efficiently compared to other activities (like talking or humming). Abe's Garden recognizes the extended benefits of music therapy in Alzheimer's patients. Therefore, Abe's Garden hosts several music-related activities throughout the day for the residents. During these activities, the residents sing along to familiar folk songs and popular songs from their childhood/younger years. When singing along, the Alzheimer's patients immediately light up and have a smile stretched across their faces, showing the extent to which music impacts the residents.

Lastly, social interaction is another activity that can alleviate the mental aspect of Alzheimer's disease and revive memory. The brain-derived neurotrophic factor (BDNF) gene is responsible for the genetic code that forms protein around the brain and spinal cord. The BDNF formed protein promotes neuron health by delivering growth factors and assessing cell differentiation and maturation. Studies have found that social interaction is able to retrieve memory in Alzheimer's patients by the increase of BDNF gene expression. The increase of BDNF increases the synaptic plasticity which allows for the chemical transmission between axons (Hsiao, et al.). The extensive benefits of reviving memory among Alzheimer's patients by simply fostering social interaction causes Abe's Garden to be successful since the concept of a residential community revolves around social interaction. Abe's Garden hosts many activities for their residents, and the combination of exercise, music therapy, and social interaction helps retrieve memory, supports the mental and physical health of the Alhzeimer's residents, and generates an environment where the residents can thrive throughout their Alhzeimer's journey.

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