

# To What Extent Does Alzheimer's Have on a Person's Memory?

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## ABSTRACT

Alzheimer's disease is commonly known as fatal memory loss. A sudden change in brain chemistry that causes humans to lose their entire identity; but what really causes this change, and how does the human body slowly deconstruct when the disease is present? It does not help that Alzheimer's disease is as unknown to medicine as a cure for cancer is, but gathering knowledge of the first case of Alzheimer's, along with its history, have catered towards successful scientific discoveries. This led to the answering of how and where the disease starts, along with crucial areas of the brain such as the Hippocampus and different memory pathways such as poly-synaptic and direct. In addition to the scientific aspect, there are additional factors that play into a person's chance of developing Alzheimer's disease. Rarely do genetics make an impact, but the strength of one's memory, along with diet and exercise can impact a person's chances of developing Alzheimer's.

## **Introduction**

"Every 66 seconds someone in the United States develops Alzheimer's. That is one in every ten Americans" ("Alzheimer's Association," 2022). Alzheimer's is a degenerative brain disease that deteriorates one's memory, cognitive function, cellular makeup, and eventually, the ability to carry out the simplest daily tasks. One of the first signs that someone may be stricken with Alzheimer's is symptoms of dementia, including short-term, long-term, and cognitive memory loss. Additionally, neurons lose their ability to communicate with one another, leading to a disrupted connection of necessary information flowing throughout the nervous system that is integral to human's daily functions. The brain is the powerhouse of the human body. It is key to the body operating and yet its complexity mystifies the most renowned doctors and researchers in the world. Alzheimer's disease is one of the many unexplained and untreatable diseases that afflict the brain.

To help you envision the human brain, imagine yourself sitting in Ms. Frizzle's Magic School Bus where you and the bus shrink into a tiny microscopic vessel, are swallowed, and then travel to your brain. As we travel to the brain we will begin by learning the history of Alzheimer's. When we arrive we will explore where and how Alzheimer's starts, learn why some people have a better memory than others and how we can improve our memory. Next, we will learn the difference between short-term and long-term memory, where it is located, and how external factors and genetics might affect someone's chance of getting Alzheimer's. Finally, we will uncover if there are any known cures.

If you are ready, then I am ready: let's board the bus!

In 3.....

2.....

1.....

Let your alzheimer's education begin!

## History of Alzheimer's

As we travel into the body towards the brain, let us start by learning the history of Alzheimer's. "Alzheimer's was first discovered on November 3, 1906, by Alois Alzheimer, ... a clinical psychiatrist and neuroanatomist" (Hippius, 2003). He categorized his finding as "a particularly severe disease process of the cerebral cortex," (Hippius, 2003) but it was very vague on what this disease actually entailed. Before Alois' discovery, he attended Freiburg and Wtirzburg University in Berlin and graduated with his doctorate degree. Later, he and his two colleagues took a position at the Frankfurt Psychiatric Hospital. There, he encountered a 51-year-old woman named Auguste D who had been suffering from dementia, memory loss, disassociation, hallucinations and confusion. Alois was very intrigued by her symptoms and started to document them and took her on as his patient. Throughout her treatment, Alois noted that Auguste "lost herself" (Hippius 2003). This was due to her unidentified Alzheimer's condition. After Auguste died in 1906, Alois was determined to figure out the cause of her death. He sent her records to his lab and continued his research. He identified "a buildup of amyloid plaques and neurofibrillary tangles" (Heerema, 2020). Amyloid plaques occur when "protein clumps together to form plaques that collect between neurons and disrupt cell function" (Heerema, 2020). Her brain also showed cerebral atrophy. "Atrophy of any tissue means loss of cells. In brain tissue, atrophy describes a loss of neurons and the connections between them" (NIH, 2022).

## How and Where Alzheimer's Starts

"Alzheimer's is the most common cause of dementia, accounting for 60-80% of cases" ("Alzheimer's Association," 2022). Dementia is the loss of one's memory, which ultimately leads to a loss of cognitive function and death. It is imperative to note that dementia is not a normal part of aging. As healthy people age, their cognitive brain function slowly declines, but should not diminish in a matter of a few years. "On average, a person who develops Alzheimer's lives for 4-8 years after their initial diagnosis" ("Alzheimer's Association," 2022). This disease is progressive, meaning dementia symptoms worsen. In the first year or two, people with dementia will experience mild memory loss, but as time goes on, individuals will lose the ability to remember their loved ones and hold a conversation. A close friend of my family experienced their mother's struggle with Alzheimer's. Since he works in the film industry, he created and produced a 2021 Oscar contender "Live Action Short Film" to document part of his experience. In the film, "Mother's Day Memories" by Bill Hoversten, the mother's husband passes away, and she is distraught explaining to her son that she cannot find her husband anywhere (Hoversten, 2021). In this production, the mother's inability to remember her husband dying, demonstrates that one of the most common symptoms that affect people with Alzheimer's is difficulty remembering new information. As the disease worsens, symptoms can include disorientation, mood and behavioral changes, difficulty speaking, talking and even swallowing. You might be asking yourself, how does one's memory decline so rapidly? Well, let us explore the science behind the disease.

We will begin by exploring the nerve cells, our communications highway. First of all, microscopic changes in the brain begin long before the first signs of memory loss. The brain has over 100 billion nerve cells, also known as neurons. Their job is to send electrical signals to all parts of the body. They are essentially your body's internal communication system. There are groups of nerve cells that are specifically designated to think, learn and remember. Others help us utilize our five senses. For neurons to work efficiently, brain cells operate in tiny groups. Think of them as mini-factories. "They receive supplies that generate energy, construct equipment and then get rid of the waste" (Alzheimer's Association," 2022). This is the way cells process, store, and send away information. Keeping everything running smoothly requires ample energy and oxygen. "Scientists believe that Alzheimer's disease prevents a part of the cell's factory from running well" ("Alzheimer's Association," 2022). If one part of a factory is not functioning properly, it can lead to a backup or breakdown of the

system. This damage will not stay in one place for long. It will spread to other parts of the factory, that will eventually end in the destruction of the whole factory. “The two main suspects that cause the breakdown of the cell factory are plaques and tangles. Plaques are deposits of a protein fragment called beta-amyloid that builds up in the spaces between nerve cells. Tangles are twisted protein fibers that build up inside cells” (“Alzheimer’s Association,” 2022). This build-up starts a blockage of neurotransmitters. It slows the movement of communication between cells. “As protein fibers inside cells tangle more frequently, and plaques build up in between the protein fragments, this can lead to the destruction of nerve cells because if the message from a nerve [cannot] possibly get through, then that nerve cell has no more purpose to the person’s body” (“Alzheimer’s Association,” 2022). This is how the first symptoms of Alzheimer’s starts.

## The Hippocampus

Now we will continue our journey to Alzheimer’s headquarters, the hippocampus. The hippocampus is the most complex brain structure that is embedded deep into the temporal lobe which is located behind the ears. It is like the mitochondria of our memory - the powerhouse of our brain. “The outer layer of the hippocampus is composed of densely packed neurons that make an S-shaped figure” (Anand et al., 2012). This outer layer of the hippocampus is crucial when it comes to Alzheimer’s because it is the earliest and most severely affected part of the brain that can suffer from severe neuropsychiatric disorders. “The hippocampus has connections to and from different parts of the brain. The Entorhinal Cortex plays an important role in pattern recognition and encoding of memories. Recurrent Collaterals send excitatory input to CA3 cells ... which play a vital role in holding memory” (Anand et al., 2012). Not only does the hippocampus play an important role in memory, but it also helps us navigate, produces our emotional behavior and regulates our hypothalamic functions. “Connections between hippocampus and neocortex are important for awareness about conscious knowledge. An intricate balance is maintained during encoding of memories in the hippocampus and retrieval of experiences from the frontal lobe. When a memory is initially formed, the hippocampus consolidates and stores all the information into a single idea, but over time, different parts of the brain are able to link up with the neocortex region which makes our memory accessible to us later in life” (Anand et al., 2012). Some people have factors that inhibit this process which causes bad memory.

## Memory Pathways

There are two prominent pathways that take part in our learning and our memory loops which consist of old memories coming back into the front of our mind; polysynaptic and direct pathways. “The polysynaptic pathway is very important when it comes to sending signals regarding facts and concepts” (Dutta, 2019). The direct pathway is important for the recollection of events from the past. In the short film, “Mother’s Day Memories,” the mother reminisces with her son about her happiest birthday memory when he was there to blow out her ten candles and her favorite gift received was a stuffed elephant. This is an obvious example of a long term memory moving into the front of her mind, and also her confusion that her son could have been at her ten-year-old birthday party (Hoversten, 2021).

## Why People Have Better Memory Than Others

How do these two pathways work better or worse in people’s brains? “A large body of research has found that the neurotransmitter dopamine affects our ability to recall specific past events, known as episodic memory. Researchers have found that having a greater density of dopamine receptors in the hippocampus results in better episodic memory” (Dutta). Essentially, if you are always happy, then your memory will improve. Just kidding!

The fact is, scientists have discovered new genes in our genome that are linked to having good memory, so not all of it is about mood. “There are three processes that make up someone with good memory; encoding, storage and retrieval” (ABC, 2022). Encoding occurs when we take a sensory input and change it into something our brain can comprehend. For example, touching sand. Our brain knows we are touching something through our sensory receptors, but our brain does not know it is sand until our brain perceives it through our cognitive thoughts.

## **How to Improve Your Memory and Short-Term vs. Long Term Memory**

It is possible to improve your memory because memory is a skill, just like other skills. It can be improved with practice and healthy habits. You can start small. Crossword puzzles can help bring back old memories. For example, a vacation crossword puzzle can help trigger old vacation memories that you had with your family that you feel are hard to recall. Being able to decipher between short-term and long-term memories is another way of exercising our memory’s health. First, “short-term memory has the capacity to store a small amount of information in the mind and keep it readily available for a short period of time” (Cherry, 2022). It is located in the frontal lobe of the cerebral cortex. A person can only remember up to seven items at a time. In order to keep a memory that just happened in the front of your brain, you need to keep repeating it to keep it actively maintained, or it will go into an abyss of forgotten memories. “Most of the information kept in short-term memory will be stored for approximately 20 to 30 seconds, or even less” (Cherry, 2022). Short-term memory can become long-term memory if it is a very significant event that impacted your life, but it takes a lot of mental editing for a memory to be placed in the long-term section as “most information spontaneously decays quickly unless you use rehearsal strategies such as saying the information aloud or mentally repeating it” (Cherry, 2022). In regards to long-term memory, it is stored in our favorite part of the brain, the hippocampus. When a short-term memory becomes a long term one, electric signals, known as nerve cells transfer this information from one storage center to another. The reason why Alzheimer’s sufferers have a harder time remembering memories from a long time ago is because, tangles and blockages form in nerve cells, making it extremely difficult for messages to be transferred from one area of the brain to another. If information can no longer be passed to the hippocampus, it starts to shrink. This is why Alzheimer’s worsens each year. More and more nerve cells get blocked, which rapidly shuts down all pathways leading to the hippocampus. When the hippocampus no longer has any information stored in it, it completely shrinks, sadly ending with the loss of life as the brain no longer has the ability to send electrical signals to vital organs and muscles through the peripheral nervous system.

## **Impact of Diet and Exercise**

Now that we learned about our memory, let us turn our attention to how external factors and genetics might affect someone’s chance of getting Alzheimer’s, beginning with eating habits. “The Mediterranean Diet is scientifically proven to help prevent Alzheimer’s disease. It consists of whole foods like fruit, vegetables, grains, and fish” (“Alzheimer’s Society”). This diet is designed to lower blood pressure and improve cardiovascular health. Aerobic exercise can also improve the performance of the lathe adducts on thinking tests. Both of these healthy habits keep the size of your hippocampus normal, which maintains good memory. “A study in Wales with men the age of 35 and over who had a healthy body weight and ate healthily and exercised regularly were 60% less likely to develop dementia” (NIA, 2021). Another more recent finding is the possible link between bacteria in the gut microbiome and inflammation in the brain. Healthy gut bacteria may protect the brain from inflammation. “Gut bacteria can influence the level of inflammation in our bodies, and we know that inflammation is a key contributor to Alzheimer’s disease” (Silajdzic, 2022).

## Impact of Genetics

As you can see, Alzheimer's may be prevented through external factors, but no matter how healthy you eat and how much you exercise, can Alzheimer's still be inevitable when taking genetics into consideration? Two categories of genes can influence whether a person develops a disease. Risk genes may increase the likelihood of developing a disease, but does not guarantee its presence in the body. "APOE-e4 is the first risk gene identified and remains the gene with the strongest impact risk. Between 40-65% of people diagnosed with Alzheimer's have the APOE-e4 gene" ("Is Alzheimer's Genetic," 2022). Deterministic genes "directly cause disease, guaranteeing that anyone who inherits this gene will develop the specific disease located on the gene" ("Is Alzheimer's Genetic," 2022). Luckily, less than 1% of our population is diagnosed with Alzheimer's because they carry the deterministic gene.

## Any Known Cures

If Alzheimer's is terminal, are there any cures that can prolong a person's life? Current Alzheimer's treatments temporarily improve systems of memory loss and problems with thinking and reasoning. "Cholinesterase Inhibitors (Aricept, Exelon, Razadyne) support communication between nerve cells" (Clinic, 2021). Another drug that is being tested is one that is currently being used to combat cancer. "Saracatinib turns off proteins that allow shapes to start working again" (Clinic, 2021). The mice they are testing it on have experienced a reversal of some memory loss. Some treatments that are being clinically tested right now are targeting microscopic clumps of the protein beta-amyloid plaques "in hope of clearing away toxic proteins in the brain and warding off neurodegeneration" (Abbott, 2022).

Even though we know a lot about the disease itself, we still do not have clarity on what triggers the early deposit of abnormal proteins in the brain or how it damages nerve cells. Scientists also do not know what genes directly trigger Alzheimer's and how the complex genes interact with one another to create such a deadly disease. As of right now, there are no drugs on the market that eliminate or even slow the spread of Alzheimer's. Over "99 percent of clinical trials of Alzheimer's drugs fail, and some major pharmaceutical companies have stopped trying to develop this class of drugs" (Clinic, 2021).

## Conclusion

As we come to our final stop, I would like to thank all of you for coming along with me on my Alzheimer's Magic School Bus ride. I hope that you leave learning at least one interesting fact about the brain and how Alzheimer's affects it. The cause and cure of Alzheimer's disease remains a scientific hurdle, however, there may be a solution to avoiding this disease by incorporating a healthy diet and physical and mental exercise into your life so that and your family members never have to experience the impact of Alzheimer's.

This concludes your ride on the Alzheimer's Magic School Bus! I hope you enjoyed it!  
Watch your step exiting the bus. Ms. Holowaty out!!!

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