BABEŞ-BOLYAI UNIVERSITY CLUJ-NAPOCA
FACULTY OF MATHEMATICS AND COMPUTER SCIENCE
COMPUTER SCIENCE IN ROMANIAN SPECIALIZATION

DIPLOMA THESIS
Alzheimer's Disease Detection

Supervisor
Prof.dr. Horia F. Pop

Author
Ichim Ștefan

2024

Abstract

Lorem ipsum Lorem ipsum

Contents

1 Introduction

There is no denying that humanity stands at a previously inconceivable point in healthcare and medicine, which naturally have led to hindrances in senescence, populations increasingly reaching older stages of life. Furthermore, studies which take into account multiple case scenarios show that population is expected to reach 9.2 billion by the age of 2050, leading to an uprise of 21% in the elderly. [KC and Lutz(2017)]

With that being said, researchers' concern has has taken a turn towards diseases occurring at these later parts of human lives, some of them considered treatable while others less so. One of such disorders is Alzheimer's Disease, or AD, considered to be the most likely predecessor of dementia. Alzheimer's Disease is a brain disease, neurodegenerative, which in time diminishes cognitive skills such as memory, thinking and speaking, and in due course even removes the ability of accomplishing simple activities vital to one's daily life. On top of that, it is an incurable disorder, which only underlines even further the reasons why early detection stand of such great importance, so that appropriate actions can be taken by both the medical team and the one diagnosed, along with their relatives and close ones.

The brain of a healthy human represents a cluster of neurons by the number of bilions which together amount to what actions and reactions we have, through a process of signal propagating. Through our sensory mechanism, which includes hearing and seeing, receptors carry out the tasks of sending signals (Fig 1) using designated channels all the way to the neurons inside the brain, where new specific signals are formed and sent back, resulting in what we call actions. [Sivadas and Broadie(2020)]

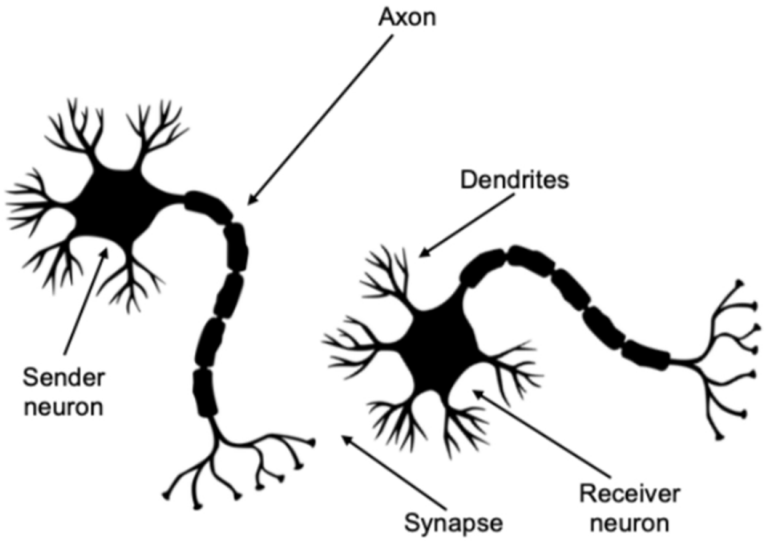

Figure 1: Communication between neurons

Alzheimer's Disease intervenes in this process by gradually decreasing the utility function of each neuron, leading to the atrophy of the brain's proficiencies, as neurons

imminently die one by one.

There are three major factors included in the dynamic between AD and neurons. First of all, a key advantage of neurons which many other cells lack, and which accomplishes their long survival, is the ability to repair themselves, form new connections, or changing current ones' magnitude. Secondly, synaptic connections, which solidify the signal transmission process, and lastly the intake of glucose and oxygen necessary for their normal functioning. It is believed these fundamental attributes of a healthy human receive considerable drawbacks upon the disease's presence. [NIH(2024)]

Causes

While the factors which lead to Alzheimer's Disease are not yet properly understood, past research and studies prove that some of the most commonly met criterias which lead to a diagnostic include genetic inheritance - chances of developing Alzheimer's Disease increase by 30% when another close relative suffers from it [Harvard(2019)], lifestyle and environmental factors.

Genetical Inheritance

Genes represent instructions passed down from generation to generation, which contain information regarding how various cells need to behave. Some roles played by these include defining one's height, or the color of hair and eyes.

Advances in genetic research have led to discover 80 genetic areas that can possibly play a part in AD development [NIH(2019)]. One of the more known genes which raises the risk of Alzheimer's Disease is the apolipoprotein E (APOE) gene, which comes in forms such as $\epsilon_2, \epsilon_3, \epsilon_4$. A pair of two such APOE genes, one from each parent, gets passed down to the next generation resulting in 6 possible cases. Among them, the (ϵ_4, ϵ_4) combination having the highest risk of AD, only increasing, not guaranteeing it, and in contrast, ϵ_2 provides a higher degree of protection against it.

External Factors

Besides genetical inheritance, researchers have drawn conclusions regarding causes of Alzheimer's Disease to contain a plethora of other outside factors, which we can have a higher influence on. Among these can be found vascular conditions - high blood pressure, heart diseases - and metabolic diseases - obesity and diabetes [NIH(2019)].

Symptoms

Before beginning the discussion about its effects, a noteworthy fact is that brain structure modifications, whether they may be neurofibrillary tangles or plaques of amyloid,

occur several years before any cognitive issues manifest at all, a stage of the disease titled preclinical.

References

[Harvard(2019)] Medical School at Harvard. Alzheimer's in the family, 2019. URL https://www.health.harvard.edu/mind-and-mood/alzheimers-in-the-family.

[KC and Lutz(2017)] Samir KC and Wolfgang Lutz. The human core of the shared socioeconomic pathways: Population scenarios by age, sex and level of education for all countries to 2100. *Global Environmental Change*, 42:181–192, 2017.

[NIH(2019)] National Institue of Aging NIH. Alzheimer's disease genetics fact sheet, 2019. URL https://www.nia.nih.gov/health/genetics-and-family-history/alzheimers-disease-genetics-fact-sheet.

[NIH(2024)] National Institue of Aging NIH. What happens to the brain in alzheimer's disease?, 2024. URL https://www.nia.nih.gov/health/alzheimers-causes-and-risk-factors/what-happens-brain-alzheimers-disease.

[Sivadas and Broadie(2020)] Athira Sivadas and K. Broadie. How does my brain communicate with my body? *Frontiers for Young Minds*, 8, 2020.