Optimizing Alzheimer's Treatment: A Spatiotemporal Agent-Based Model of Combination Therapy in the Hippocampus

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Alzheimer's is a neurodegenerative disease characterized by causes such as amyloid plaque accumulation, microglial dysfunction, and chronic neuroinflammation. Current treatments target the effects of Alzheimer's, such as the decline of cognitive and motor function. Experimental treatments targeting the causation of the disease are currently in the process of testing; however, trials often take decades. This project utilized a probabilistic, computational agent-based model using the Mesa framework and Python coding, calibrated to data collected from the Alzheimer's Disease Neuroimaging Initiative (ADNI) database. The model simulated the hippocampus spatially and temporally, allowing for the implementation of the two treatments that are the focus of this project: Lecanemab and Cromolyn. The project determined the optimal dosage combination of the two treatments depending on the expression of the APOE (Apolipoprotein E) gene, finding that Cromolyn monotherapy works best for homozygous APOE3 while combination therapy is the preferred approach for heterozygous APOE 3/4 and homozygous APOE4. The results imply that Lecanemab, which is commonly prescribed in large doses, is actually harmful in the standard dose and must be paired with an anti-inflammatory treatment. Additionally, the model allows for implementation of future treatments and proposed combinations, enabling scientists to glean an understanding of how different medicines may affect Alzheimer's without running human trials.

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