# Memory loss in aging and dementia: Dendritic spine head diameter predicts memory in old age

August 8 2024, by Jeff Hansen

Credit: CC0 Public Domain

Over the course of life, memory fades with varying degrees, robbing older people of the ability to recollect personal experiences. This

progressive, nearly inevitable process has long been hypothesized as a consequence of nature's removal of dendritic spines, a key component of synapses, from brain neurons as they age.

A study, titled "Dendritic spine head diameter predicts episodic memory performance in older adults" published in *Science Advances*, led by researchers at the University of Alabama at Birmingham and Rush University Medical Center, Chicago, Illinois, now provides evidence that the preservation of past life experiences is maintained by the quality—not the quantity—of synapses in old age.

"This is a paradigm breaker," said Jeremy Herskowitz, Ph.D., associate professor in the UAB Department of Neurology and corresponding author of the study.

"For 35 years, the predominant dogma was that memory decline is mediated predominantly by loss of dendritic spine, which are a surrogate for synapses. As we age from 40 through 85, there is natural loss of dendritic spines and synapses, which is completely normal.

"This natural loss can contribute to the lack of cognitive sharpness that we all feel as we age. However, we demonstrate that, even though there is synapse loss, the ones that are left can compensate for that loss."

Herskowitz says this has an enormous implication. "Even in older individuals, people aged 80, 90 or 95, there is still enough plasticity in synapse formation to retain memory. This means a therapy to remodel dendritic spines and synapses could dramatically facilitate memory as you age or if you are experiencing memory impairment due to Alzheimer's disease dementia."

The study was made possible by the Religious Orders Study and Rush Memory and Aging Project, or ROSMAP, at Rush University.

ROSMAP enrolls Catholic nuns, priests and brothers age 65 or older, who are without known dementia at time of enrollment. Participants receive medical and psychological evaluations each year and agree to donate their brains after death.

Herskowitz and colleagues studied postmortem brain samples from 128 ROSMAP participants. The participants had an average age of 90.5 years at the time of death, with variable cognitive performance scores and Alzheimer's disease-related neuropathology. They all had undergone yearly cognitive testing for episodic memory, visuospatial ability/perceptual orientation, perceptual speed, semantic memory, and working memory.

The study included two samples from each brain, one from the temporal cortex, which has structures vital for long-term memory, and one from the frontal premotor cortex.

After staining the brain samples, photographing thin slices and building three-dimensional digital reconstructions of 55,521 individual dendritic spines on 2,157 neurons, researchers used two statistical methods, one employing innovative machine learning, to see if any of 16 different spine morphology measurements correlated with any of 17 different measures of brain function, age and Alzheimer's disease neuropathology.

One of the brain function measures was episodic memory—the ability to remember everyday events and past personal experiences.

For neurons from the temporal cortex, researchers found that dendritic spine head diameter, but not the quantity of spines, improved prediction of episodic memory in models containing β-amyloid plaque scores, neurofibrillary tangle pathology and sex.

Larger head diameters were associated with better episodic memory

performance, supporting the emerging hypothesis that, in the temporal cortex, synaptic strength is more critical than quantity for memory in old age.

"Targeting pathways that maintain spine head diameter or synaptic strength, rather than pathways that maintain or generate new spines or synapses, could potentially yield greater therapeutic benefits for older adults in preclinical phases of Alzheimer's disease," Herskowitz said.

A dendrite is a branched extension from a neuron body that receives impulses from other neurons. Each dendrite can have thousands of small protrusions called spines.

The head of each spine can form a contact point called a synapse to receive an impulse sent from the axon of another neuron. Dendritic spines can rapidly change shape or volume while forming new synapses, part of the process called brain plasticity. Creating or eliminating synapses is a fundamental mechanism of brain function.

Collecting the tens of thousands of spine measurements took two and a half years. This painstaking work started in 2019 and continued through the COVID-19 pandemic, as UAB researchers worked under COVID restrictions, Herskowitz says.

**More information:** Courtney K. Walker et al, Dendritic spine head diameter predicts episodic memory performance in older adults, *Science Advances* (2024). DOI: 10.1126/sciadv.adn5181

Provided by University of Alabama at Birmingham

old age (2024, August 8) retrieved 8 August 2024 from https://medicalxpress.com/news/2024-08-memory-loss-aging-dementia-dendritic.html