

Aging in the Canine and Feline Brain



Charles H. Vite, DVM, PhD^a, Elizabeth Head, MA, PhD^{b,*}

KEYWORDS

• β -Amyloid • Cat • Dog • Cognitive dysfunction • Neuron loss • Tau

KEY POINTS

- Brain atrophy, neuron loss, decreased neurogenesis, and oxidative stress but few tau-associated disorders are observed in aging dog brains.
- Cerebrovascular pathology can be extensive in canine brain aging.
- β -Amyloid protein, associated with Alzheimer disease in humans, is increased with age in the dog brain and is linked to signs of learning and memory impairments.
- Lysosomal storage diseases in dogs are associated with similar types of neuropathology as are observed with aging and Alzheimer disease.
- Few studies describe the neurobiology of aging in cats but interesting similarities and differences from dogs have been reported.
- Feline Niemann-Pick type C disease has several neuropathologic and clinical similarities to Alzheimer disease.

INTRODUCTION

This article reviews canine and feline brain aging. Several key features are discussed and compared, including general aging characteristics and neuropathology. Aging dogs and cats show many similarities in terms of brain changes but also some important differences. Several research groups have been working with aging dogs and cats to test various theories of aging and to develop therapeutics that will be beneficial to both species.

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^a Department of Clinical Studies, School of Veterinary Medicine, University of Pennsylvania, Section of Neurology & Neurosurgery, Department of Clinical Studies - Philadelphia, 3900 Delancey Street, Philadelphia, PA 19104, USA; ^b Department of Pharmacology & Nutritional Sciences, Sanders-Brown Center on Aging, University of Kentucky, 800 South Limestone Street, 203 Sanders Brown Building, Lexington, KY 40515, USA

* Corresponding author.

E-mail address: elizabeth.head@uky.edu

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The median life span of dogs varies as a function of breed, with larger breeds typically having shorter life spans than smaller breeds.¹⁻³ For the purposes of this article, several studies that are described have been collected in purpose-bred beagles and additional companion animals and clinical data are shared when available. Beagles have a median life span of 13.9 years, with no significant differences between males and females.⁴ A young beagle less than 5 years old is similar to humans who are less than 40 years old.³ Middle-aged beagles between 5 and 9 years are similar to humans between 40 and 60 years and beagles more than 9 years old are similar to humans more than 60 years old. However, the larger the breed of dog, the shorter the life span and thus biological age may vary across breeds given a specific age.¹

In a laboratory setting and in the veterinary clinic, studies of aging dogs report that some but not all aged dogs are impaired on different measures of learning and memory (see Refs.⁵⁻⁷). Not all old dogs are impaired and not all types of learning and memory are equally affected. Neurobiological changes, as described later, can account for some, but not all, of the clinical signs of cognitive decline in aging dogs.

NEUROBIOLOGY OF AGING IN THE DOG

This article describes several neurobiological changes associated with aging in dogs (Table 1).

Brain Atrophy

Old dogs often show marked ventriculomegaly at postmortem examination associated with thinning of the cerebral cortex and the subcortical white matter.⁸ Magnetic resonance imaging (MRI) studies performed on aged beagle and German shepherd

Neurobiological Outcome Measures	Canine	Feline	NCL or MPSI	NPC Disease
Brain atrophy	Yes	NA	Yes	Yes
β -Amyloid	Yes	Yes	Yes	Yes
Tau	Yes	Yes	NA	Yes
Cerebral amyloid angiopathy	Yes	Yes	NA	NA
Infarcts	Yes	NA	NA	NA
Vascular disease	Yes	NA	Yes	NA
Lipofuscin accumulation	Yes	Yes	Yes	NA
Caspase activation	Yes	NA	Yes	Yes
DNA fragmentation	Yes	NA	NA	NA
Neuron loss: hippocampus	Yes	NA	Yes	Yes
Neuron loss: caudate	NA	Yes	Yes	Yes
Neuron loss: locus coeruleus	Yes	Yes	NA	NA
Neuron loss: Purkinje cerebellar cells	Yes	NA	Yes	Yes
White matter degeneration	Yes	NA	Yes	Yes
Inflammation	Yes	NA	Yes	Yes
Oxidative damage	Yes	NA	Yes	Yes
Gliosis	Yes	NA	Yes	Yes

Abbreviations: MPSI, mucopolysaccharidosis type I; NA, not available; NCL, neuronal ceroid lipofuscinoses; NPC, Niemann-Pick type C.

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