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BRAIN RESEARCH

Research Report

Regional variability in age-related loss of neurons from the primary visual cortex and medial prefrontal cortex of male and female rats

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ABSTRACT

During aging, changes in the structure of the cerebral cortex of the rat have been seen, but potential changes in neuron number remain largely unexplored. In the present study, stereological methods were used to examine neuron number in the medial prefrontal cortex and primary visual cortex of young adult (85–90 days of age) and aged (19–22 months old) male and female rats in order to investigate any age-related losses. Possible sex differences in aging were also examined since sexually dimorphic patterns of aging have been seen in other measures. An age-related loss of neurons (18–20%), which was mirrored in volume losses, was found to occur in the primary visual cortex in both sexes in all layers except IV. Males, but not females, also lost neurons (15%) from layer V/VI of the ventral medial prefrontal cortex and showed an overall decrease in volume of this region. In contrast, dorsal medial prefrontal cortex showed no age-related changes. The effects of aging clearly differ among regions of the rat brain and to some degree, between the sexes.

1. Introduction

During aging, the rat shows behavioral deficits on a variety of tasks, including the spatial version of the Morris water maze (Frick et al., 1995), the Barnes circular platform task, the eight-arm radial maze (reviewed by Rosenzweig and Barnes, 2003), spatial delayed nonmatch-to-sample (Aggleton et al., 1989), recall of passive-avoidance (Winocur, 1988), and Hebb–Williams mazes (Winocur and Moscovitch, 1990). It is well established that there is no loss of neurons with age in the hippocampus, even in rats with spatial learning deficits (Rapp and Gallagher, 1996; Rasmussen et al., 1996), though decreases in the size of perforated synapses do occur in learning-impaired aged rats (Nicholson et al., 2004). We have also shown that male rats lose dendritic branches from hippocampal neurons during aging (Markham et al., 2005). Nevertheless, evidence of structural changes in the cerebral cortex, such as changes in the number of neurons that may be contributing to changes in task performance, remains limited. In fact, deficits in learning the spatial version of the Morris water maze have instead been correlated with degree of photoreceptor loss in the retina (O'Steen et al., 1995; Spencer et al., 1995), suggesting a possible role for the visual system in age-related performance deficits. Interestingly, decreases in dendritic spine density and dendritic extent during aging have been found in the primary visual cortex (Oc1) (Ruiz-Marcos et al., 1992; Feldman and Dowd, 1975). Changes in

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Abbreviations: mPFC, medial prefrontal cortex; Oc1, primary visual cortex; PL, prelimbic; IL, infralimbic; ACd, dorsal anterior cingulated; ACv, ventral anterior cingulated; CE, coefficient of error; ER, estrogen receptor

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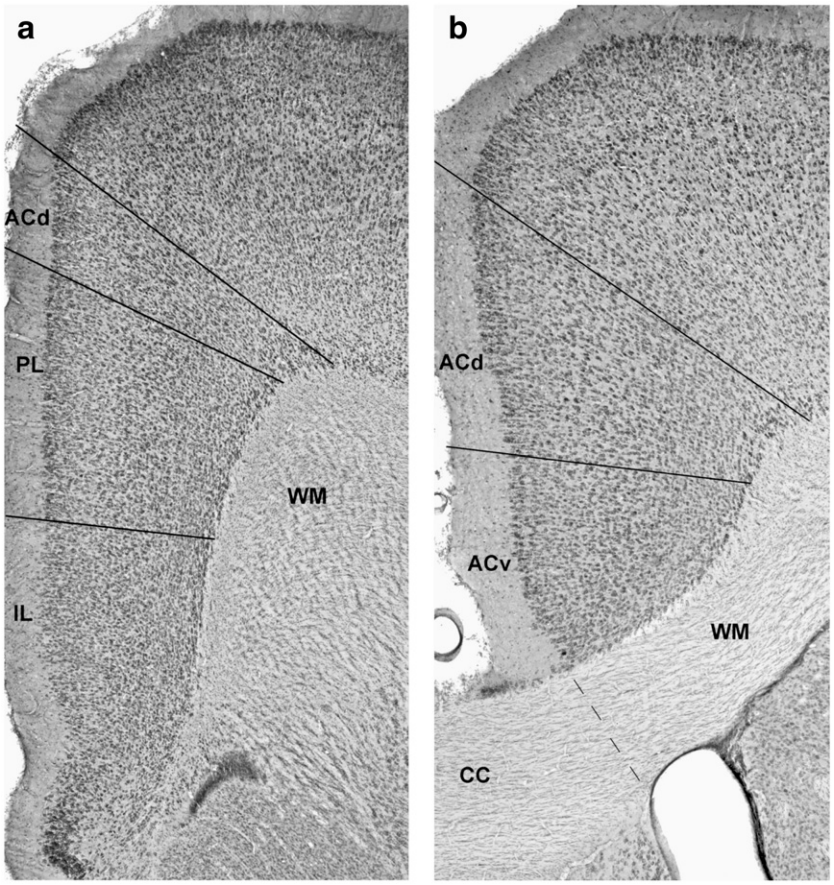

Fig. 1 – Coronal sections through the mPFC, showing parcellated subregions of dorsal mPFC (ACd, ACv) and ventral mPFC (PL, IL). The white matter (WM) and the corpus callosum (CC) are also shown. Reprinted with permission from Markham, Morris, and Juraska (2007).

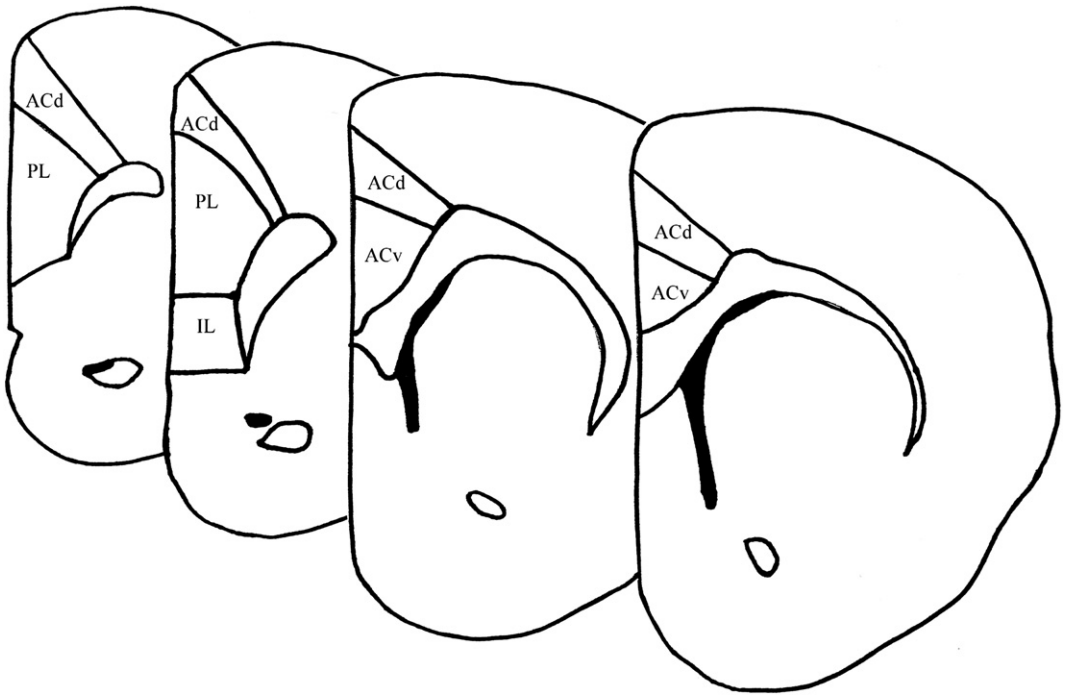

Fig. 2 – Diagram depicting parcellated subareas of dorsal mPFC (ACd, ACv) and ventral mPFC (PL, IL).