

Significant role of laminar and columnary auditory cortex in avian brain.

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Abstract

Scientists and non-scientists alike have long been fascinated by the origins and evolution of the forebrain and mammalian neocortex,* which houses sophisticated cognitive capabilities. For more than a century, the neocortex was thought to be an independently formed structure that was only found in animals. The mammalian basal ganglion, which was assumed to be engaged in stereotyped instinctual responses, was frequently likened to the no mammalian telencephalon. The updated nomenclature of the avian brain recently embraced a significant change in our understanding of the nature of vertebrate brain structure. The avian Welts and dorsal ventricular ridge, two significant telencephalon components, are recognised as being analogous to palatal components of mammalian brains, which supports the theory that the avian telencephalon has a large cortical component.

Keywords: Extreme hypertriglyceridemia; GPIHBP1 knockout, Transient middle cerebral artery occlusion, Ischemic stroke.

Introduction

The idea that the avian dorsal ventricular ridge comprises populations of neurons and circuits that are comparable to those seen in the mammalian neocortex was first proposed in the 1960s based on parallels in neurotransmitter distribution and afferent connection patterns. The antiquity of these pathways in amniotes was demonstrated by major sensory ascending projections through the thalamus and then on the telencephalon of birds and reptiles, leading to the hypothesis that distinct nuclei of the avian and reptilian telencephalon were homologous to morphologically and physiologically corresponding laminae of the mammalian neocortex. The striking similarities in cell architecture, intratelencephalic connections, gene expression, and functions between certain nuclei in birds and comparable laminae in mammals corroborate this nucleus to lamina homology [1].

The laminar architecture and columnar organisation of the mammalian neocortex are two of its most distinguishing traits, both of which underpin the basic computational procedures needed to their theorised roles. The existence of identifiable cell types organised in six parallel laminae with discrete neuronal connections structured in radial columns characterises the mammalian neocortex. Layer IV, for example, gets a topographically arranged input from the thalamus and redistributes the information to other layers via radially arrayed intrinsic layers connections. As a result, neurons in a cylinder aligned perpendicular to layers tend to share some functional features and are thought to represent local computing units [2].

Birds' and reptiles' cortical regions lack the evident laminar look of evenly parallel layers and have long been thought to

be arranged in a cluster pattern, with individual nuclei of the avian telencephalon performing unitary tasks. The argument that the avian cortex is organised in a manner similar to the mammalian neocortex is significantly weakened by a lack of relevant information that could address this question, and has been used to justify an alternative view postulating homology to noncritical structures of the mammalian allium.

Field L in the caudal nidopallium, the CM, the dorsal nidopallium and the ventromedial region of the intermediate arcopallium make up the auditory telencephalon in birds. The CM and three Field L subdivisions (L1, L2a, and L3) are placed in a sequence of laminae orientated about mediolaterally and divided by the mesopallial lamina. The cell density and alignment of the CM and L1 are both heterogeneous, and each may be further separated into exterior and interior sub layers. The CM externs is made up of loosely packed neurons that run parallel to the ventricle's surface. The CM internes, on the other hand, have a large density of neurons that are not clearly aligned.

Columnar Organization of the Field L/CM Complex: Using slice preparations of chick brains, we placed a highly sensitive tracer, biotinylated dextran amine (BDA), precisely into individual layers of the Field L and CM complex and mapped anterograde and retrograde transport of BDA within the complex to see if functional units in the Field L/CM complex are individual layers or vertical modules across all layers. The injections that resulted were typically tiny (80–200 m in diameter). Transport of BDA always created a column that traversed all levels and was directed perpendicular to the strata, regardless of the tracer's deposition layers.

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The column had a centre region with a relatively high density of labelled fibres and neurons throughout all layers, as well as neighbouring sections with distributed labelling of fibres and neurons in certain cases. The column's core portion ranged in breadth from 300 to 500 metres. Retrograde and anterograde labelled neurons were identified inside or directly adjacent to this core area with few exceptions. Individual or bundles of thick axons coursed down the long axis of the column [3].

The shared evolutionary roots of distinct functional circuits in the brain can be investigated. Although this is well known for brain regions including the spinal cord, brainstem, and olfactory bulb, it opens up a hitherto untapped degree of study for components engaged in higher cognitive tasks. In addition to their present application in studies of motor systems, such as vocal control systems, the conserved evolution of the mammalian neocortex supports the value of birds as a viable animal model in studies of the organisation, development, and information processing of sensory systems [4].

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