Absolute Number of Thalamic Parafascicular and Striatal Cholinergic Neurons, and the Three-Dimensional Spatial Array of Striatal Cholinergic Neurons, in the Sprague-Dawley Rat: Modern Stereological Studies

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Abstract

The absolute number of neurons and their spatial distribution yields important information about brain function and species comparisons. We investigated thalamic parafascicular neurons and striatal cholinergic interneurons (CINs) because the parafascicular neurons are the main excitatory input to the striatal CINs. This circuit is involved in specific types of learning and behavioral flexibility and is of increasing interest. In the Sprague-Dawley rat, the absolute number of thalamic parafascicular neurons and striatal CINs is unknown. They were estimated in this study using modern stereological counting methods. Complete sets of serial 40 μm glycol methacrylate sections, from each of six young adult rats, were used to quantify neuronal numbers in the right parafascicular nucleus (PFN). Complete sets of serial 20 μm frozen sections, from each of five young adult rats, were immunostained and used to quantify cholinergic neuronal numbers in the right striatum. For the striatal CINs, their spatial distribution, in three dimensions, was also determined from exhaustive measurement of the x, y, z coordinates of each large interneuron in 40 μm glycol methacrylate sections in sampled sets of five consecutive serial sections from each of two rats. Statistical analysis of spatial distribution was undertaken by comparing observed three-dimensional data with computer models of 10,000 pseudorandom distributions, using measures of nearest neighbour distance and Ripley's K-function for inhomogeneous samples. We found that the right PFN consisted, on average, of 30,073 neurons (with a coefficient of variation of 0.11). The right striatum consisted, on average, of 10,778 CINs (0.14). The statistical analysis of spatial distribution showed no evidence of clustering of striatal CINs in three dimensions in the rat striatum. This is consistent with previous findings in the mouse striatum [1]. The results provide important data for the transfer of information through the PFN and striatum, species comparisons, and computer modelling [2].

References

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