Traces of phylogeny and ecology in hippocampal neuron numbers

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Selective pressures adapt the hippocampus to changing information processing requirements. At the same time, the structure of the hippocampus may also reflect phylogenetic history. To test phylogenetic and ecological signal in the hippocampus, we assessed neuron numbers in five hippocampal cell populations in 65 species, representing 11 mammalian orders using the Optical Fractionator. We used z-scored data to account for large differences in species' absolute cell numbers. Species separations by cell numbers were explored in a phylogenetic PCA (pPCA). Along PC1, rodents, primates and ungulates form the extremes of a continuum and are linked by insectivores and carnivores (loadings, positive: CA3, CA1, subiculum, negative: hilus, granule cells). In a pPCA of ratios of cell populations, insectivores (heaviest loading: PC1, granule cells->hilus), primates (PC2, granule cells->CA3), and bats (PC3, CA1->subiculum) disperse in nearly orthogonal directions, linked by rodents where the axes meet. Phylogenetic comparative methods were used to study evolution of cell populations and its correlation to ecological factors. Phylogenetic signal was present in all populations, strongest in hilar and CA3, and weakest in CA1 cells. The best-fitting model for phylogenetic changes of granule, CA1 pyramidal and subicular cells was a constrained configuration model, which was still a viable alternative to an unconstrained model that performed best for hilar and CA3 pyramidal cells. Among ecological factors tested in a PGLS (activity cycle, diet breadth, habitat breadth, home range, social group size and tropic level), diet breadth correlated with granule, hilar and subicular cell numbers, while species home ranges impacted weakly on CA1 pyramidal cells and strongly on the ratio between granule and hilar cells. In conclusion, our results show that CA1 exhibits the lowest level of evolutionary constraint among the species in our sample. Furthermore, our findings underscore the impact of diet breadth on the evolutionary trajectory of the hippocampus.