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Global network community and non-uniform cell density in the macaque brain

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The important question, how the global network architecture connecting cortical regions keeps balances between integration and segregation of information processes, have been asked to understand the design of the brain [1,2]. This study aimed to clarify how topological characteristics of such global network architecture relate with physiological characteristics inside of segmented cortical regions in the monkey brain [3]. Especially, I focused on cell densities (densities of neurons or non-neurons) as the representative characteristics of segmented cortical regions [4], and compared the cell densities with network topologies of cortico-cortical fiber tracts [Figure1-A]. To reduce biases in comparisons, I surveyed many topological measures as wide as possible. Total number of evaluated network measures was 27.

As the result, surprisingly, only participation coefficient (PCs) showed significant correlations with cell densities [3]. Although a previous study reported that cell densities significantly change on the anterior-posterior coordinate [5], spatial coordinates did not correlate significantly with participation coefficients. Participation coefficient is the topological measure evaluating how often each node (segmented brain region) connects to other nodes locating different communities (modules). The modules, which detected based on a computational criterion [3], corresponded with visual, somatosensory, auditory, and two associative modules [Figure1-C]. The associative modules simultaneously showed low neuron density and high participation coefficient, which means there are diversive connections with different modules. These findings led us to

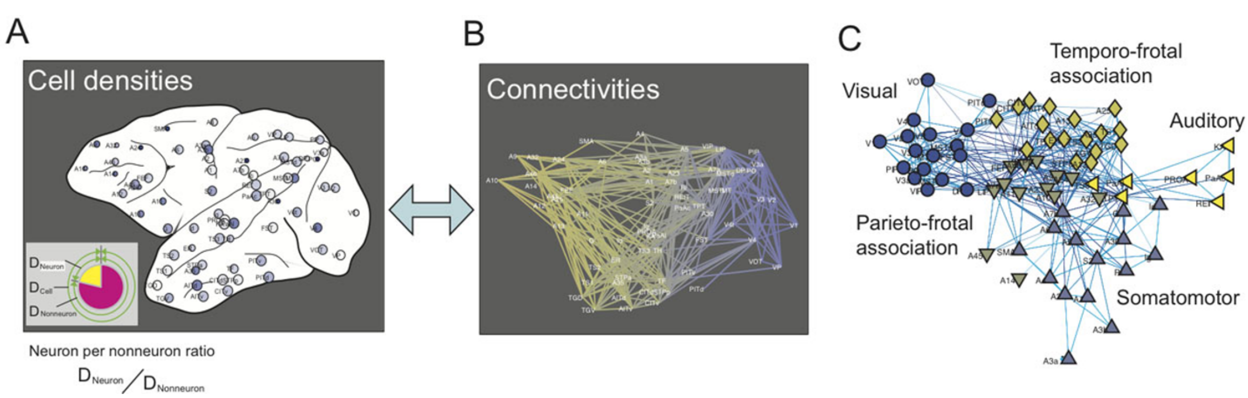

Figure1 (A) is cell densities at segmented 69 cortical regions. Denser color at each region indicates higher density of neurons. (B) is the network organization of white matter fibers. (C) Community (Modular) structures of monkey cortical networks. The locations of nodes were determined using the Fruchterman–Reingold algorithm. Differences of markers indicate five different modules determined using a community detection algorithm.

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the conclusion that the brain is designed for achieving integrative information process at associative brain regions by sacrificing number of elements (neurons).

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