

## Connectivity based segmentation of the human red nucleus

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The Red Nucleus (RN) is a large, iron-loaded nucleus located in the ventral midbrain. In monkeys, it is subdivided into a small caudoventral magnocellular part (mRN) and a large rostromedial parvocellular part (pRN). The mRN is more connected with motor and premotor regions of the cortex, interposed nuclei and spinal motor neurons via the rubrospinal tract [1]. By contrast, the pRN is more connected with cortex and is part of the dento-rubro-olivary pathway involved in movement preparation and motor learning. In humans, functional neuroimaging studies suggest RN involvement in complex motor, but also in sensory and cognitive functions. However, none of these studies was able to distinguish between topographically organized subregions of the RN and just a few studies focused on its structural and functional connections. In this regard, we have previously employed Constrained Spherical Deconvolution (CSD) tractography in order to characterise the structural connectome of the RN in the human brain and in vivo, showing robust connectivity profiles with the cerebellum, thalamus, paracentral lobule, postcentral gyrus, precentral gyrus and superior frontal gyrus [2]. Herein, we use high-quality 3T structural and diffusion MRI data from the Human Connectome Project (HCP) and CSD tractography with a connectivity-based segmentation approach, in order to identify topographically distinguished subregions of the RN according to their different cortical and subcortical connectivity profiles. We tracked connections of RN both with inferior olivary nuclei (IONs), interposed nuclei (INs) and dentate nuclei (DNs), as well as with frontal motor and associative cortices. We found that each RN can be subdivided according to its connectivity into two clusters: a large dorsolateral one, more connected with DNs and IONs, and a smaller ventromedial one, more connected with IN. Topographical connections between cortical areas and these two clusters was also evaluated. Our results are in line with previous literature and confirm CSD-based tractography and connectivity-based segmentation as valuable tools for the evaluation of human neuroanatomy.

### References

- [1] Kennedy et al. (1986). Functional and anatomic differentiation between parvocellular and magnocellular regions of red nucleus in the monkey. *Brain Res.* 364 :124-136.
- [2] Milardi et al. (2016). Red nucleus connectivity as revealed by constrained spherical deconvolution tractography. *Neurosci Lett.* 626: 68-73.

### Key words

Red nucleus, cerebellum, magnocellular part, parvocellular part, connectivity, tractography, segmentation