The neuronal modules for sensorimotor and cognitive functions are organized in so-called provincial hubs with intracommunity connections that interact task-dependently via connector hubs. Thalamic subnuclei may serve not only as provincial hubs but also in higher order nuclei as connector hubs. Thus, in addition to its function as a cortical relay station of sensory input, the human thalamus can be seen as an integrative hub for brain networks of higher multisensory vestibular function. Imaging studies on the functional connectivity have revealed a dominance of the right side in right-handers at the upper brainstem and thalamus. A connectivity-based parcellation study has confirmed the asymmetrical organization (i.e., cortical dominance) of the parieto-insular vestibular cortex, an area surrounded by other vestibular cortical areas with symmetrical (nondominant) organization. Notably, imaging techniques have shown that there are no crossings of the vestibular pathways in between the thalamic nuclei complexes. Central vestibular syndromes caused by lesions within the thalamocortical network rarely manifest with rotational vertigo. This can be explained and mathematically simulated by the specific coding of unilateral vestibular dysfunction within different cell systems, the angular velocity cell system (rotational vertigo in lower brainstem lesions) in contrast to the head direction cell system (directional disorientation and swaying vertigo in thalamocortical lesions).

Summary: The structural and functional separation of the two thalamic nuclei complexes allowed a lateralization of the right and left hemispheric functions to develop. Furthermore, it made possible the simultaneous performance of sensorimotor and cognitive tasks, which require different spatial reference systems in opposite hemispheres, for example, egocentric manipulation of objects (handedness) and allocentric orientation of the self in the environment by the multisensory vestibular system [1].

[1]

Brandt T, Dieterich M. Thalamocortical network: a core structure for integrative multimodal vestibular functions. Curr Opin Neurol. 2019 Feb;32(1):154-164. doi: 10.1097/WCO.0000000000000638. PMID: 30461462.