

This Week in The Journal

Thalamic Spatiotemporal Development in the Infant Brain

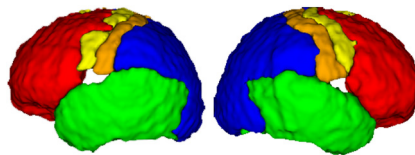
Weihaio Zheng, Leilei Zhao, Zhiyong Zhao, Tingting Liu, Bin Hu, et al.

(see pages 559–570)

Although the thalamus is best known as the sensory “gateway” to the brain, this complex structure contains many distinct nuclei, also fulfilling complex processing functions related to movement, attention, emotion, and consciousness. Thalamic structural and functional connectivity at birth can predict future neurocognitive function. The spatiotemporal development of the thalamus, however, remains poorly understood. Now, Zheng et al. fill in the picture using data from the Developing Human Connectome Project. Conventional magnetic resonance imaging (MRI) technology does not provide detailed structural information about prenatal and infant brains, due to their incomplete myelination. Diffusion MRI (dMRI), on the other hand, does a better job at capturing early brain architecture and provides the brain connectivity information. The current study used dMRI data from 144 preterm-birth and term-birth infants collected between 32 and 44 postmenstrual weeks (PMW) to examine the developmental pattern of thalamic morphology, microstructures, subdivisions, and connectivity, particularly with respect to cortical structures.

Interesting patterns emerged from the data. The thalamus as a whole enlarged drastically between 32 and 34 PMW, followed by a slower growth rate and marked deformation in the lateral thalamic regions between weeks 35 and 38. From weeks 42 to 44, the dorsal and ventral regions displayed alternating periods of rapid expansion. Microstructure fiber integrity increased, and thalamic subdivisions formed in a lateral-to-medial pattern. As expected, thalamic fiber connectivity to external structures increased with age, but major thalamofrontal connections did not emerge until PMW 40 and beyond. Connectivity with frontal, motor, somatosensory, parietal–

occipital, and temporal cortices were spatially distributed along the anterior-posterior axis, similar to the adult brain. This study provides a first comprehensive look at the spatiotemporal development of this important brain structure in the infant human brain, which could lead to greater insights into not only normal development, but also the atypical growth seen in neurodevelopmental disorders. The work may help researchers understand the connections between thalamic structure and function and the neurocognitive results of atypical development.



Thalamic nuclei connectivity to frontal (red), temporal (green), motor (yellow), somatosensory (orange), and parietal-occipital (blue) cortical regions in the infant brain.

New Insights to Neural Processing of Static and Dynamic Objects

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(see pages 621–634)

Humans have the amazing capability to recognize objects literally in the blink of an eye—in <100 ms—as information flows from the retina through visual cortices to the temporal lobe of the brain. The majority of research in this area, though, has focused on static objects, and the work investigating moving objects has mostly involved images of moving people (or other primates). But how objects move also contains rich information about their identity. Now, Robert et al. use a clever experimental design to differentiate the brain processes that work to recognize static versus dynamic objects in humans. To do that, they created

“object kinematograms” by extracting the movement information from videos of moving objects and imparting them onto random patterns of dots, so that objects “appear” only when in motion. They contrast these dynamic images with static images taken from the original videos depicting the objects. Fifteen participants underwent functional magnetic resonance imaging (fMRI) while viewing either static objects or object kinematograms in the following six categories: human, mammal, reptile, tool, pendulum, and ball. Preliminary experiments confirmed that subjects could recognize both animate and inanimate objects from the object kinematograms.

Previous research has shown that the human middle temporal area (hMT+/V5) and the posterior superior temporal sulcus specialize in recognizing moving objects, whereas the lateral occipital cortex, posterior fusiform sulcus, and extrastriate body area preferentially recognize static objects, and parietal brain regions integrate information about form and movement. The fMRI experiments showed that the most ventral and posterior regions showed an activation preference for static objects, whereas the most dorsal and anterior regions preferred dynamic objects. But most surprisingly, all regions examined (with the exception of primary visual cortex) responded to and accurately decoded both dynamic and static objects in both animate and inanimate categories. The data challenge the traditional hypothesis that more dorsal regions process motion while recognition of the object’s form is relegated to a ventral stream; the separation is less strict than previously thought. The study furthers our understanding of the exceedingly complex ways that the human brain makes sense of both static and moving objects, and our world.

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