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Interindividual memory differences are linked to corticothalamic networks during memory encoding and retrieval

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Encoding new memories relies on functional connections between the medial temporal lobe and the frontoparietal cortices. Multi-scan fMRI revealed changes in these functional connections before and after memory encoding, potentially modulated by the thalamus. As different thalamic nuclei are interconnected with distinct cortical networks, we hypothesized that variations in cortico-thalamic recruitment may support individual memory performance.

We performed a multi-scan fMRI protocol in two independent samples of healthy adults (N1=29, mean age=26; N2=108, mean age=28), including a baseline resting-state scan preceding an associative memory task with encoding and retrieval phases. To minimize registration bias, individual activity and functional connectivity (FC) were analyzed in the native space. Thalamic nuclei were segmented on the individual T1 and grouped into four subdivisions (anterior, medial, ventral, posterior).

By employing a Structural Equation Modeling framework to explore the interplay between baseline FC, task-related activity, and memory performance, we found a positive association between resting-state FC of the medial thalamic subdivision within the frontoparietal network and memory performance across samples (p-values between 0.01 and 4×10−5). This direct relationship was mediated by decreased activation of the anterior subdivision during encoding (p-values between 0.05 and 0.006) and by increased activation of the medial subdivision during retrieval (p-values between 0.05 and 0.004). Additionally, we identified three distinct clusters of individuals displaying different corticothalamic patterns across memory phases.

Rather than relying on the conventional approach of averaging across individuals, this study emphasizes that the cortico-thalamic functioning involving the anterior and medial thalamus underlies interindividual variability in associative memory encoding.

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