Audio Transcript: Parallel Networks Dissociate Episodic and Social Functions Across Distributed Cortical Regions Within Individuals
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Within human association cortex, regions form distributed interconnected networks, such as the one shown here, which is often called the default network.

And this network is fascinating to me and many others because it has been linked to multiple advanced human functions, such as remembering our pasts or considering the perspectives of others.

Links between such functions and this single network, largely estimated by averaging across groups of brains, led to some hypotheses that lumped functions together.

But even in group-averaged data, work from our lab and others found some evidence not well-explained by unified network.

To gain precision, similar to other groups, our lab has shifted its approach from averaging across many brains to scanning single individuals multiple times.

Using this higher-resolution method, they recently found two distinct networks that appear tightly interwoven in the regions previously associated with the default network broadly.

Each of these networks is distributed across the entire brain and, with few exceptions, whenever there is a node in one network, such as A, there is also a node in the other, such as B. And this is true even for regions along the midline that were previously difficult to parse and were considered zones of convergence for proposed network subsystems.

The fully distinct, parallel nature of the identified networks implied that they might be functionally specialized.

And prior findings related some specific zones of cortex to specific tasks, as shown for the inferior parietal lobule here on the right.

But we wanted to examine whether different tasks preferentially recruit each of the full networks across distributed cortical regions.

Toward this goal, we conducted 24 scanning sessions with six subjects each scanned four times.

For each subject, we collected about an hour of fixation data to estimate the networks through functional connectivity and collected multiple variants of tasks from two target domains, tapping episodic and social functions.

In the episodic projection tasks, participants answered questions about their pasts or potential futures. So, for example, they might be asked to recall the last time they bought someone a gift or the next time they might order takeout.

In the theory of mind tasks, participants responded either to scenarios in which someone held a false belief or to vignettes featuring emotionally painful events.

Across both domains, tasks featured tightly matched controls, and I'll briefly walk through our analysis methods using subject two as an example.

Before looking at any task data, we used functional connectivity analysis to identify the networks. Here are subject two's results. Note how networks A and B exhibit juxtaposed regions across cortex, with interdigitated patterns in multiple zones, including along the midline.

Once identified, we could select one network, such as A, create a border around the network estimate and overlay it upon a map showing the averaged task activations from each domain. What we find is that the complex pattern of episodic projection task activation, shown in yellow, shows overlap with network A; while the pattern of theory of mind activation, shown in red, shows more overlap with network B.

In orange, you see some overlap between the task domains, which may reflect that there's still some blur, but we observed this differentiated network pattern in the inferior parietal lobule, as might be expected,

but also in frontal cortex – here's network A showing more overlap with the episodic projection map and network B with theory of mind,

as well as along the midline – here's network A in medial prefrontal cortex, and B.

And in posteromedial cortex, quite strikingly, network A's boundary surrounds a triad of episodic projection regions, with an interwoven theory of mind region better-matched by network B's boundary.

And overall, we found robust evidence of a double dissociation, with network A preferentially recruited for episodic projection tasks and network B for theory of mind tasks.

This was true in an initial study, in an independent replication analysis of six additional subjects, and in a triplication study of the same sample size.

Network differences were not limited to specific zones of task separation. Rather, they spanned the cortex, including in midline regions previously difficult to parse

We describe these studies in detail and include formal tests of these observations in a recent publication in the Journal of Neurophysiology.

And to conclude, one question raised by these results is how specialization could arise within parallel networks.
In a recent review, Randy Buckner and I propose a hypothesis that, perhaps early in development, these networks may be at least more amorphous than their fully-developed forms; then early emerging differences in functional coupling may differentially bias specialization.

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