

# Where the brain organizes actions

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Researchers have discovered that Broca's area in the brain--best known as the region that evolved to manage speech production--is a major "executive" center in the brain for organizing hierarchies of behaviors. Such planning ability, from cooking a meal to organizing a space mission, is considered one of the hallmarks of human intelligence.

The researchers found that Broca's area--which lies on the left side of the brain about in the temple region--and its counterpart on the right side activate when people are asked to organize plans of action. They said their finding of the general executive function of Broca's area could explain its key role in language production.

Importantly, the researchers found that this executive function of these

cortical regions was distinct from the organization of temporal sequences of actions.

The researchers, Etienne Koechlin and Thomas Jubault of Université Pierre et Marie Curie and Ecole Normale Supérieure, described their experiments in the June 15, 2006, issue of *Neuron*.

In their experiments, the researchers asked volunteers to execute a sequence of button presses when they saw colored squares or letters on a screen. Koechlin and Jubault designed their experiment so that they could precisely distinguish hierarchical planning of tasks from the temporal organization of tasks. The subjects were asked to perform both simple sequences of button presses in response to a stimulus, "simple action chunks," and "superordinate action chunks." Simple action chunks were single motor acts that required sequential action. Superordinate action chunks included "a sequence of categorization tasks, like sorting a deck of playing cards first by color, then by suit, then by rank."

While they performed the tasks, the subjects were scanned using functional magnetic resonance imaging. This scanning technique involves using harmless magnetic fields and radio waves to measure blood flow in brain regions, which reflects brain activity.

Koechlin and Jubault found that Broca's area and its right-brain counterpart were clearly responsible for hierarchical processing.

"Our results provide evidence that Broca's area and its right homolog implement a specialized executive system controlling the selection and nesting of action segments comprising the hierarchical structure of behavioral plans, regardless of their temporal structure," wrote the researchers. "This finding suggests a basic segregation between prefrontal executive systems involved in the hierarchical and temporal organization of goal-directed behaviors, highlighting the specific

contribution of Broca's area and its right homolog to executive control.

"Interestingly, Broca's area is mostly known to be critically involved in human language, especially in processing hierarchical structures of human language and in organizing linguistic segments that compose speech," they wrote. They concluded that "our results support the view that Broca's area implements an executive function specialized for processing hierarchical structures in multiple domains of human cognition. We speculate that the modular executive system of hierarchical control we describe possibly captures key functional components that may explain the critical contribution of Broca's area to human language."

Source: Cell Press

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