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Brain shape affects children's learning capacities

The anatomy of the brain affects cognitive control, an essential skill for learning and academic success. This is the result of studies performed by the Laboratoire de Psychologie du Développement et de l'Education de l'Enfant (CNRS/Université Paris Descartes/Université de Caen Basse-Normandie), in collaboration with the NeuroSpin Center (CEA). The scientists showed that an asymmetry of the two brain hemispheres relative to a particular pattern of a cortical region could partly explain the performance of 5-year old children during a task designed to measure cognitive control. According to the research team, and depending on the characteristics of their brains, children may have different pedagogical requirements in terms of learning cognitive control. This work, published online in the *Journal of Cognitive Neuroscience* on 30 November 2013, opens new educational perspectives.

Cognitive control is an essential component of intelligence and learning capacity. By detecting and resolving cognitive conflicts when an individual is faced with a problem, this faculty makes it possible to inhibit poor strategies and prefer the best. One of the brain regions where this cognitive control is exercised is the cingulate cortex (or ACC), located on the inner surface of the cortex between the two brain hemispheres. The scientists focused on the anatomy of this region in 5-year old preschoolers, an age at which the brain is rapidly developing.

As a first stage, the scientists performed an anatomical MRI scan on a group of twenty children in the same nursery school class, which enabled them to observe the convolutions of the cingulate cortex. The latter can adopt two configurations: a single form with one sulcus, or a double form with two, parallel sulci. Some of the children displayed the same conformation in both hemispheres, while the hemispheres in others were asymmetrical for this particular pattern.

In the classroom, the researchers then showed the children pictures of animals. On some of these, the body and head corresponded to different animals. When asked to name the animal's body, the children — who impulsively base their decision on the shape of the head — had to resolve the cognitive conflict created by the images.

The scientists measured the response time for each child, as well as the number of correct answers. They thus observed that children whose two hemispheres were asymmetrical at the level of the cingulate cortex achieved better results and consequently displayed greater capacity for cognitive control.

The explanation put forward by the researchers — and which they are now hoping to test — is that asymmetry of the right and left hemisphere corresponds to more lateralization and hence greater specialization of each hemisphere. This may improve the ability to resolve this type of task. These anatomical characteristics are not deterministic concerning cognitive control in children, and even less so as regards intelligence. According to the research team, approximately 20% of inter-individual variability in cognitive control can be explained by these anatomical factors, the remaining 80% being due to various environmental factors, such as education or socio-economic status.

Nevertheless, these results show that depending on the characteristics of their brains, children may have different pedagogic requirements in terms of learning cognitive control, which could be improved through specific training. A new scientific field has thus been opened up, at the interface between brain anatomy, the psychology of cognitive development and education.

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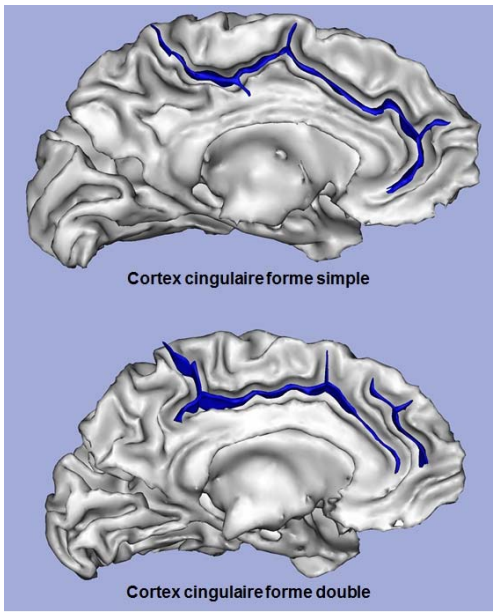
In nursery school, a five-year old girl trying to resolve the cognitive conflict task.



In each brain hemisphere, the cingulate cortex can adopt two configurations: single (top), or double-parallel (bottom). Image obtained by anatomical Magnetic Resonance Imaging (aMRI).

Single type of cingulate cortex
Double-parallel type of cingulate cortex

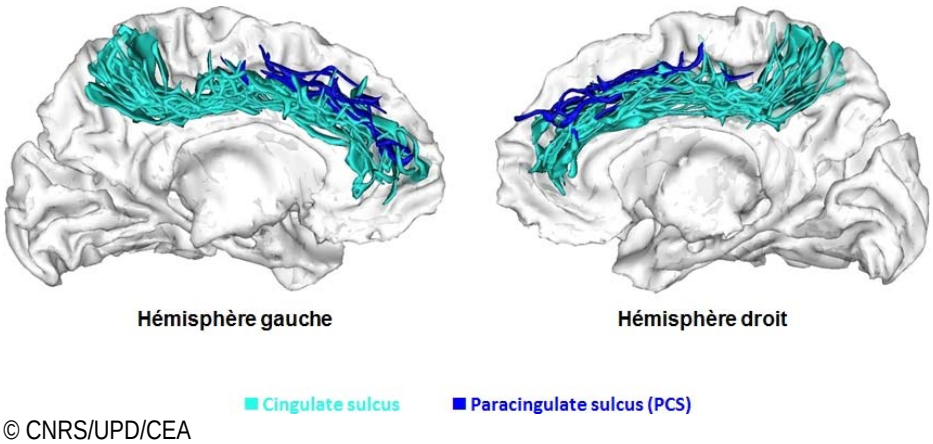


Illustration of variability in types of anterior cingulate cortex in children: each line corresponds to the sulcus of one child. Image obtained by anatomical Magnetic Resonance Imaging (aMRI).

Left hemisphere Right hemisphere

Bibliography

The Shape of the ACC Contributes to Cognitive Control Efficiency in Preschoolers
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