

Neural Bases of Solving a Numerical Piaget-Like Task in Children and Young Adults

Behavioral data, hemodynamic data (fMRI)
and electrophysiological data (EEG)

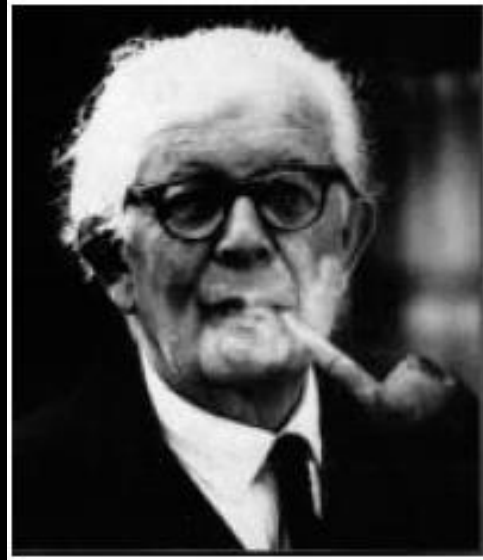


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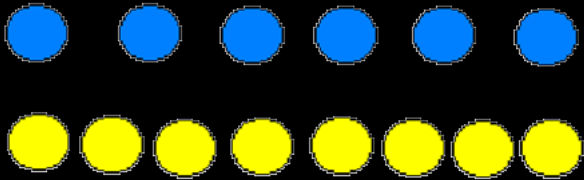




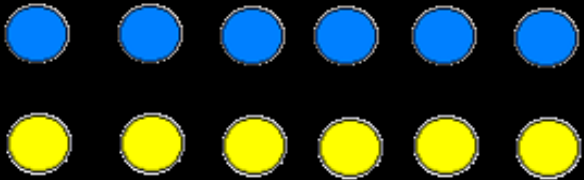
Jean Piaget
1896-1980

The conservation of number task

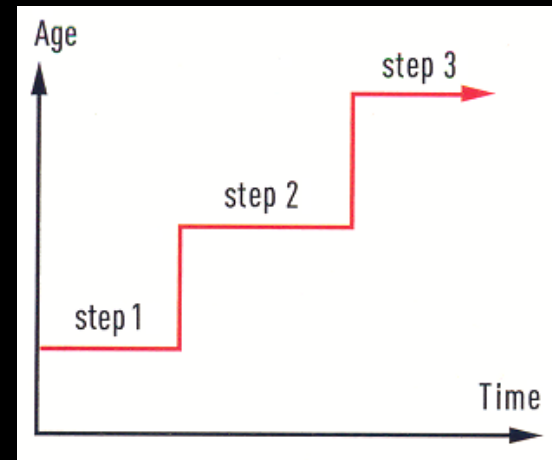
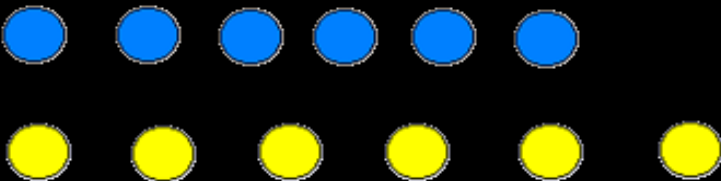
1st stage (4-5 year-old): the child organizes the pattern of objects according to the length.



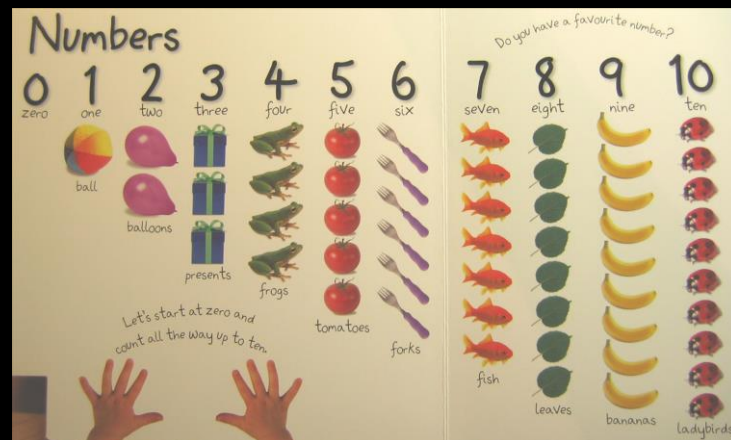
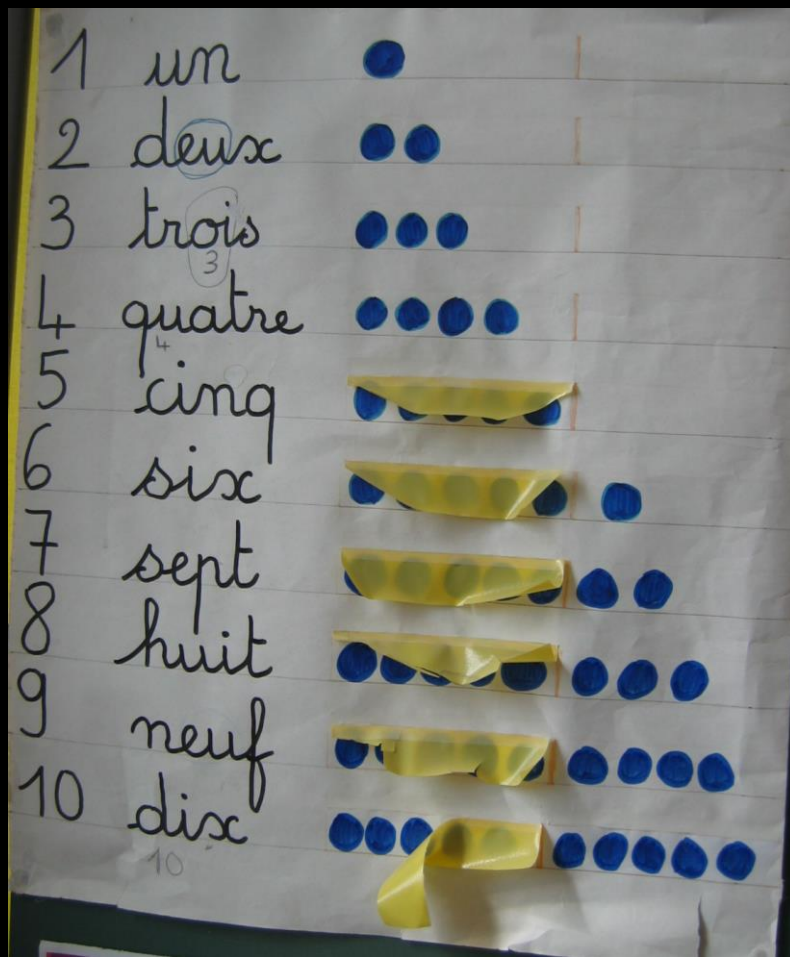
2nd stage (5-6 year-old): the child operates a term to term correspondence.



3rd stage (7-8 year-old): number conservation.



In the real life...



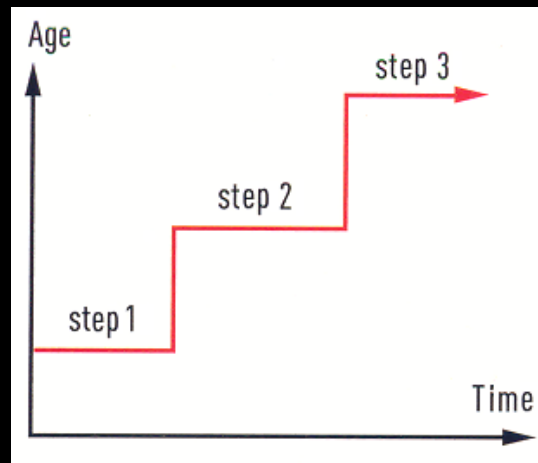
About the development of numerical abilities

Numerical abilities exist in infants and children far before 7-8 year-old

(Wynn, 1992, Houdé, 1997, Melher & Bever, 1967).

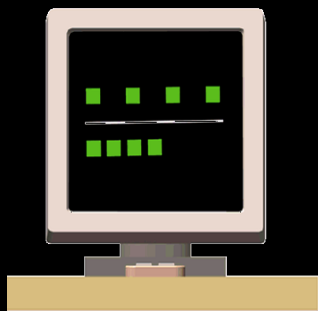
We assumed that the late failure to the Piaget task comes from a **lack of inhibition of the visuo-spatial strategy "Length equals Number"**

(Dempster & Brainerd, 1995; Houdé, 2000).

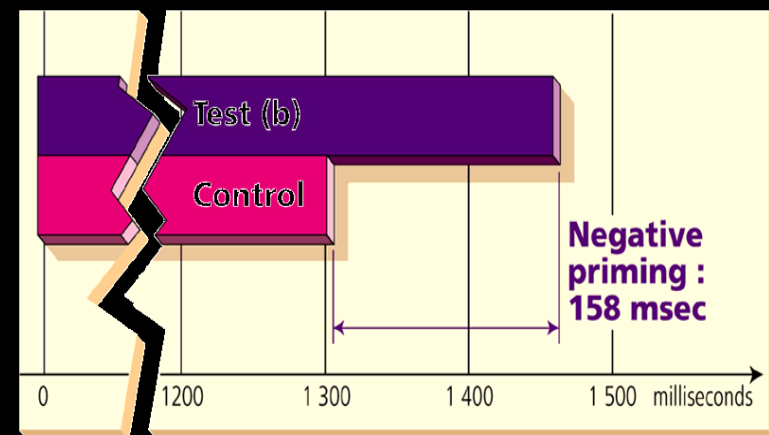
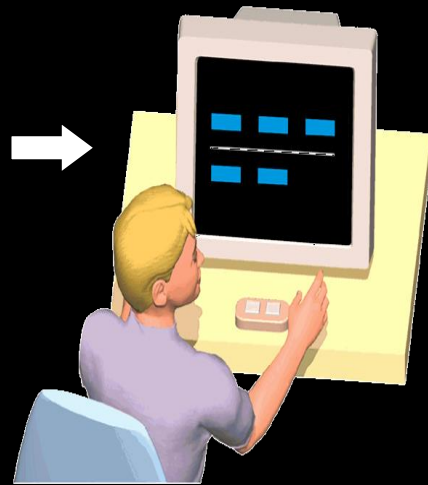


Negative priming paradigm with 8-9 year-old children

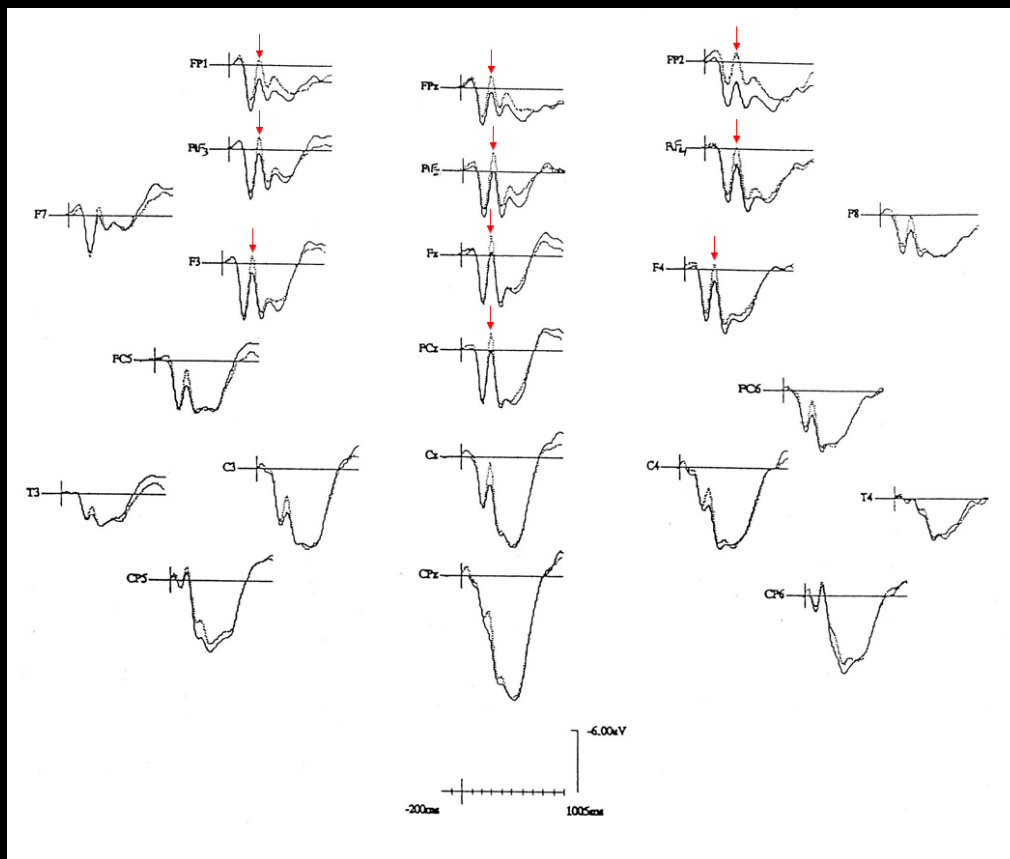
Inhibition of
Length = Number



(b) Activation of
Length = Number



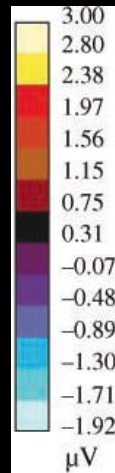
Negative priming paradigm with adults (EEG)



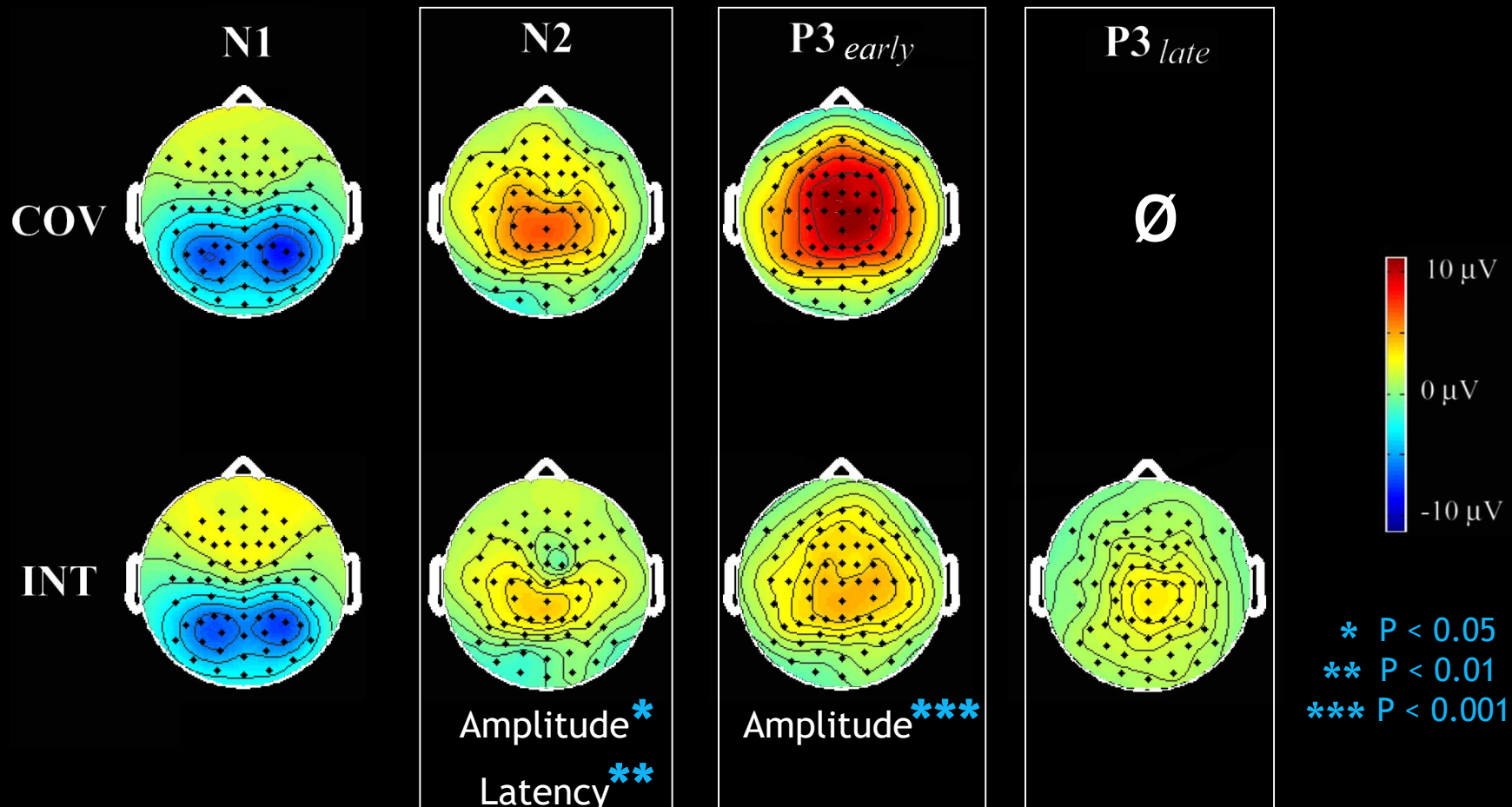
Test (b)



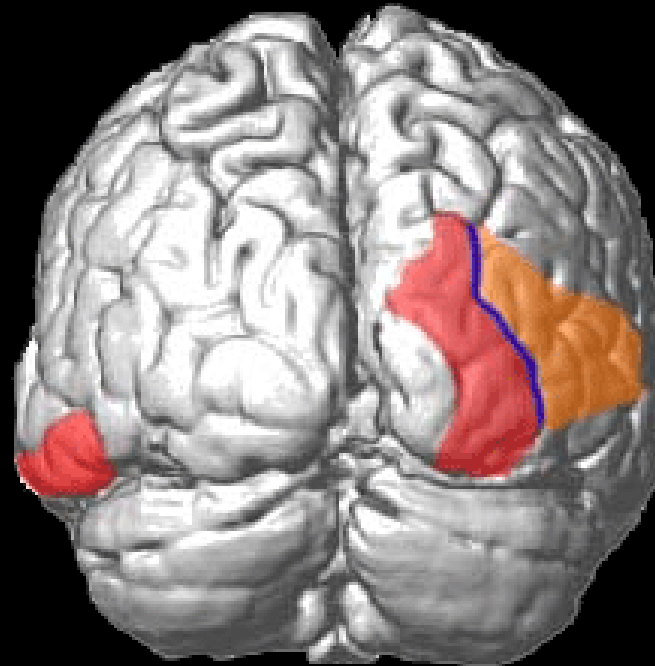
Control



Piaget-like task with adults (EEG and then fMRI)



Piaget-like task with adults (EEG and then fMRI)



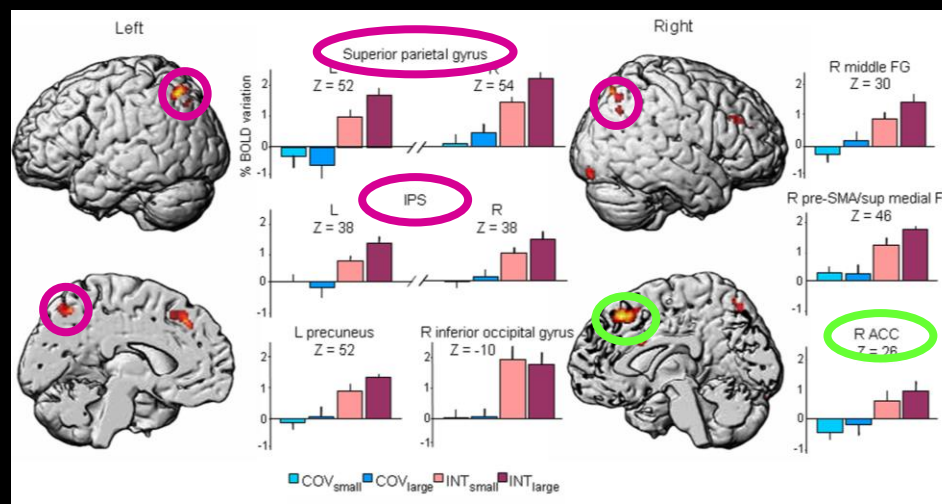
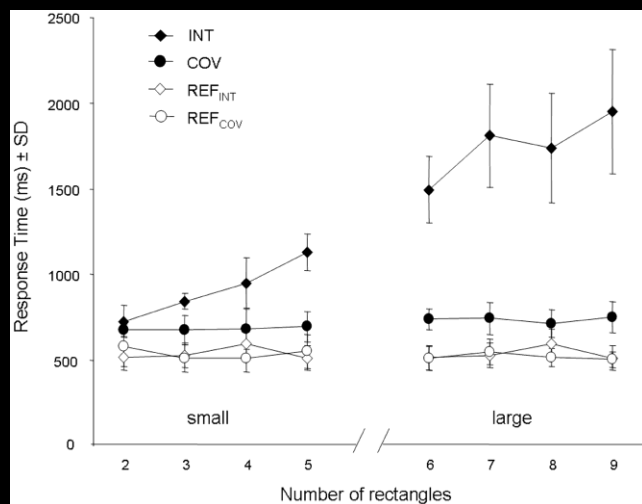
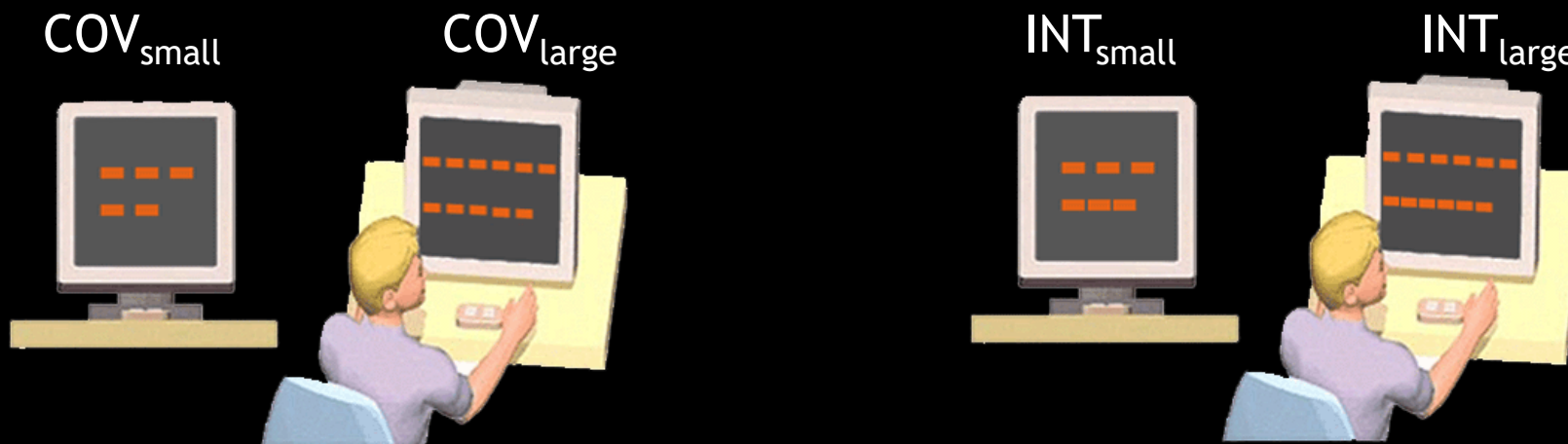
Left inferior temporal g.

Right superior occipital g.

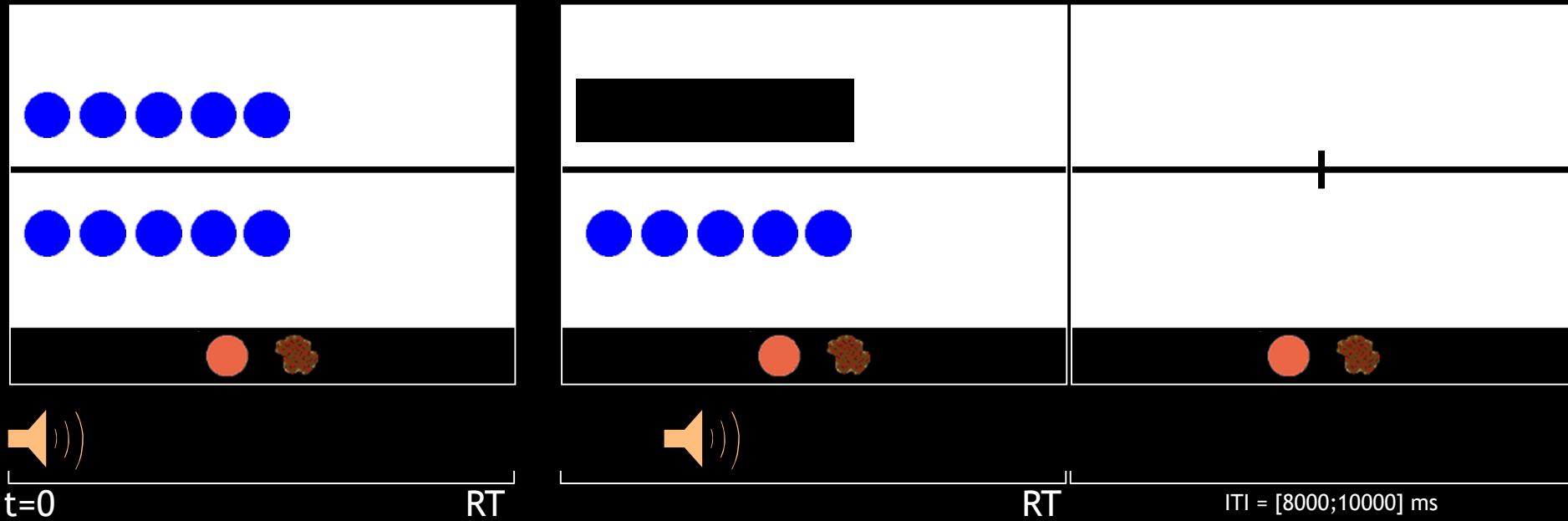
Right middle occipital g.

No prefrontal regions!

Piaget-like task with adults (fMRI)

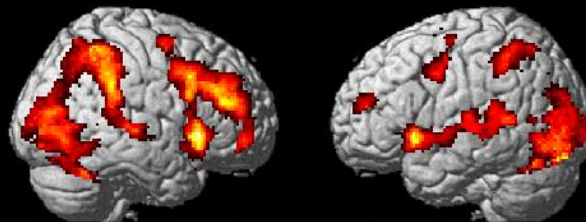


Piaget-like task with 5-6 and 9-10 yo children (fMRI)

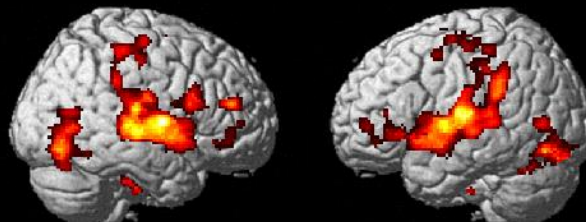


Piaget-like task with 5-6 and 9-10 yo children (fMRI)

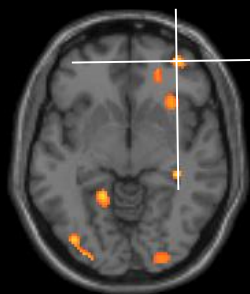
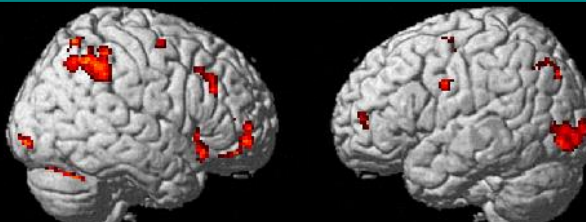
Twelve 9-10 yo
who succeed



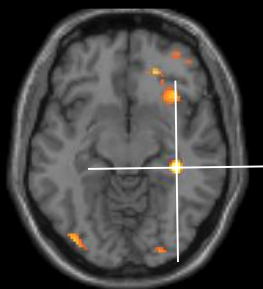
Six 5-6 yo
who failed



=



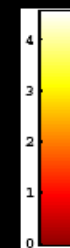
R inferior frontal gyrus



R hippocampus



R intraparietal sulcus

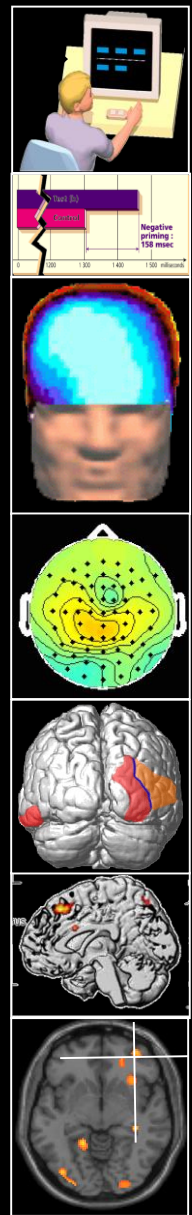


Current study.

1/ behavioral data (RT): specific cognitive cost maximized by the increase of the number of shapes.

2/ electrophysiological data (EEG): energetic cost was evidenced by the occurrence of the N2 and P3 components in adults.

3/ hemodynamic data (fMRI): R inferior frontal gyrus for successful children versus unsuccessful ones
 R ACC for adults
 a counting network in both groups.



This set of studies evidenced that the conservation of number task requires cognitive inhibition to overcome the perceptual biases of number/length for children who are successful to this task.



Cantlon et al., *Plos Biology* 2006

In the perspective of the developmental cognitive neurosciences, our results also confirm that the adults never fully outgrow any of the cognitive and the perceptual biases of their early childhood and their difficulties to inhibit them, or at least, that a specific cost persists for the brain.

Thank you



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Guy Perchey, ...

and all volunteers.

