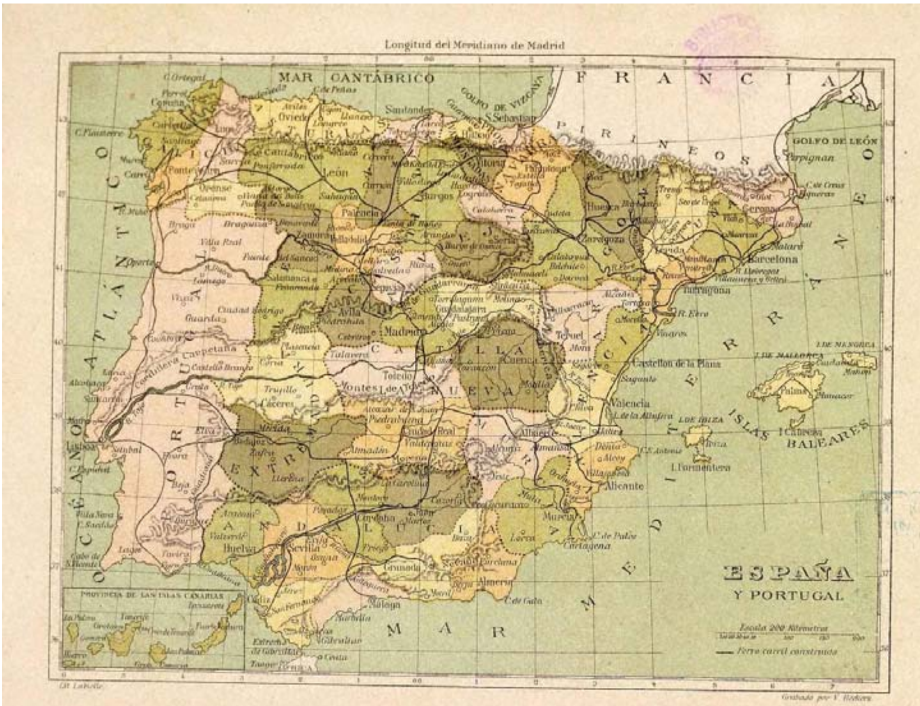
4-3: Change your thoughts, change your life

By Barbara Oakley, PhD



S. Ramon Cajal

Premotor functional connectivity predicts impulsivity in juvenile offenders

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Contributed by Marcus E. Raichle, May 25, 2011 (sent for review February 19, 2011)

Teenagers are often impulsive. In some cases this is a phase of normal development; in other cases impulsivity contributes to criminal behavior. Using functional magnetic resonance imaging, we examined resting-state functional connectivity among brain systems and behavioral measures of impulsivity in 107 juveniles incarcerated in a high-security facility. In less-impulsive juveniles and normal controls, motor planning regions were correlated with brain networks associated with spatial attention and executive control. In more-impulsive juveniles, these same regions correlated with the default-mode network, a constellation of brain areas associated with spontaneous, unconstrained, self-referential cognition. The strength of these brain–behavior relationships was sufficient to predict impulsivity scores at the individual level. Our data suggest that increased functional connectivity of motor-planning regions with networks subserving unconstrained, self-referential cognition, rather than those subserving executive control, heightens the predisposition to impulsive behavior in juvenile offenders. To further explore the relationship between impulsivity and neural development, we studied functional connectivity in the same motor-planning regions in 95 typically developing individuals across a wide age span. The change in functional connectivity with age mirrored that of impulsivity: younger subjects tended to exhibit functional connectivity similar to the more-impulsive incarcerated juveniles, whereas older subjects exhibited a less-impulsive pattern. This observation suggests that impulsivity in the offender population is a consequence of a delay in typical development, rather than a distinct abnormality.

and organization. The functional organization of children's brains is quite different from that of adults, displaying stronger short-distance connections and weaker long-distance connections (9, 10). Adult functional connectivity patterns develop gradually over the course of many years.

In this study we sought evidence for a neural basis of impulsivity, a critical component of self-control. To this end, we evaluated resting-state functional (f)MRI activity in a population of juvenile offenders, as well as two additional cohorts of typical individuals across a broad age range.

All subjects were evaluated using resting-state functional connectivity magnetic resonance imaging (RS-fcMRI). RS-fcMRI studies of functional connectivity are rapidly emerging as a major theme of human imaging research. In this context, functional connectivity refers to spatial patterns of coherence in the spontaneous fluctuations of the fMRI blood-oxygen-level–dependent (BOLD) signal observed during quiet wakefulness (11). These patterns change during the course of typical childhood and adolescent development (9, 10) and during healthy aging (12). Departures from typical functional connectivity have been described in a wide variety of diseases, including Alzheimer's, Parkinson's, schizophrenia, autism, and ADHD (13). Here we investigate the relationship between functional connectivity, impulsivity, and development.

Results

We analyzed RS-fcMRI measures, along with behavioral assess-

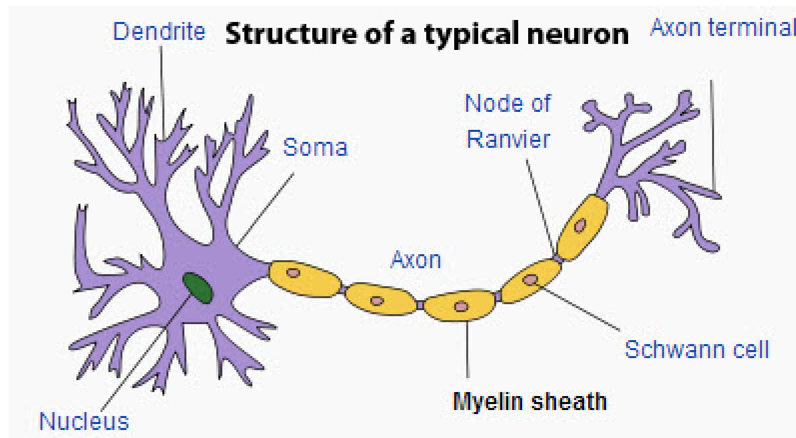
BRIEF COMMUNICATIONS

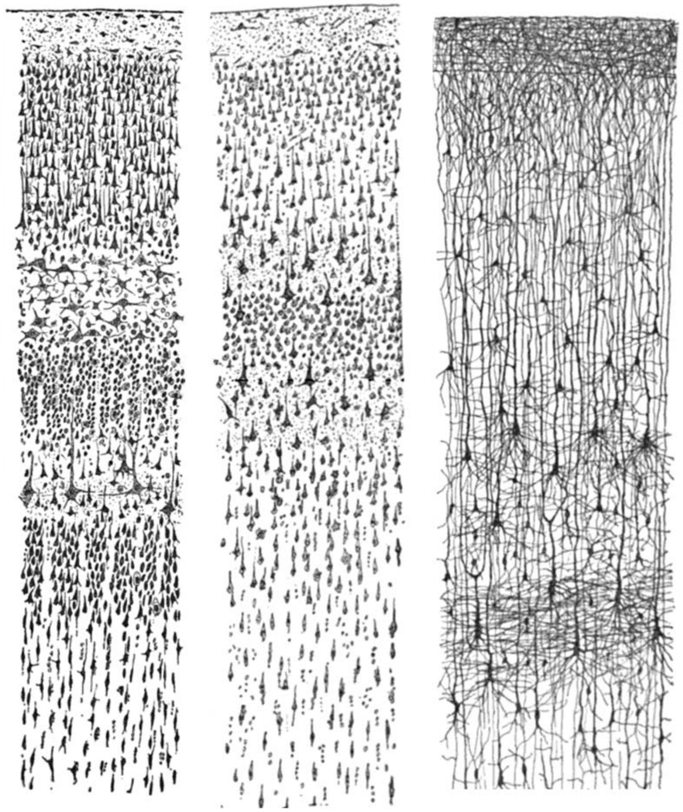
nature neuroscience

Extensive piano practicing has regionally specific effects on white matter development

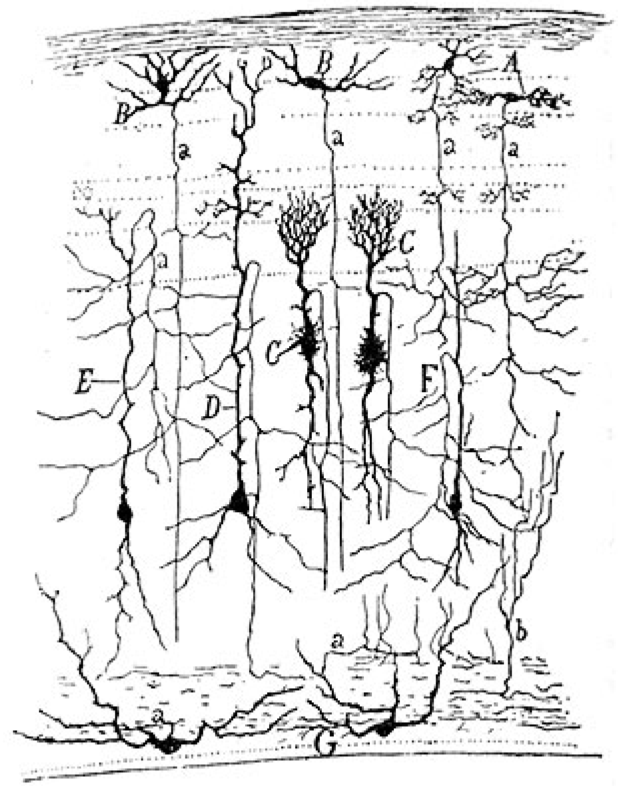
Sara L Bengtsson[1], Zoltán Nagy[1,2], Stefan Skare[2], Lea Forsman[1], Hans Forssberg[1] & Fredrik Ullén[1]

Using diffusion tensor imaging, we investigated effects of piano practicing in childhood, adolescence and adulthood on white matter, and found positive correlations between practicing and fiber tract organization in different regions for each age period. For childhood, practicing correlations were extensive and included the pyramidal tract, which was more structured in pianists than in non-musicians. Long-term training within critical developmental periods may thus induce regionally specific plasticity in myelinating tracts.





Comparative study of the sensory areas of the human cortex, hand drawn by Santiago Ramón y Cajal, 1899



Drawing of a section through the optic tectum of a sparrow, hand drawn by Santiago Ramón y Cajal, 1905

A path in the grounds of Down House.
Darwin regularly walked along this path
for exercise of body and mind.
He called it his "Thinking Path."

Charles Darwin, aged 46 in 1855,

The voyage of the
Beagle, 1831 - 1836

Illustration credits

- España provincial 1850Public Domain, http://en.wikipedia.org/wiki/Mid-nineteenth_century_Spain#mediaviewer/File:Espa%C3%B1a_provincial_1850.jpg
- Anonymous photo of Santiago Ramón y Cajal published by Clark University in 1899. http://en.wikipedia.org/wiki/Santiago_Ram%C3%B3n_y_Cajal#mediaviewer/File:Cajal-Restored.jpg
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- Structure of typical neuron, http://en.wikipedia.org/wiki/Myelin, Original uploader was Quasar Jarosz.
- Santiago Ramón y Cajal in his laboratory, http://en.wikipedia.org/wiki/Santiago_Ram%C3%B3n_y_Cajal#mediaviewer/File:Cajal-mi.jpg
- Three drawings by Santiago Ramon y Cajal, taken from the book "Comparative study of the sensory areas of the human cortex", pages 314, 361, and 363, http://en.wikipedia.org/wiki/Santiago_Ram%C3%B3n_y_Cajal#mediaviewer/File:Cajal_cortex_drawings.png
- Drawing of a section through the optic tectum of a sparrow, by Santiago Ramón y Cajal from "Estructura de los centros nerviosos de las aves", Madrid, 1905. http://en.wikipedia.org/wiki/Santiago_Ram%C3%B3n_y_Cajal#mediaviewer/File:SparrowTectum.jpg
- Charles Darwin by Maull and Polyblank, 1855-crop, http://en.wikipedia.org/wiki/Charles_Darwin#mediaviewer/File:Charles_Darwin_by_Maull_and_Polyblank,_1855-crop.png
- Voyage of the Beagle-en Sémhur - Image:Voyage of the Beagle.jpg by Kipala, Samsara and Dave souza, from a map by User:WEBMASTER, under licence CC-BY-SA. http://en.wikipedia.org/wiki/Charles_Darwin#mediaviewer/File:Voyage_of_the_Beagle-en.svg
- Photo by Tedgrant: A path in the grounds of Down House. Darwin regularly walked along this path for exercise of body and mind. He called it his "Thinking Path". http://en.wikipedia.org/wiki/Charles_Darwin#mediaviewer/File:Darwins_Thinking_Path.JPG

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