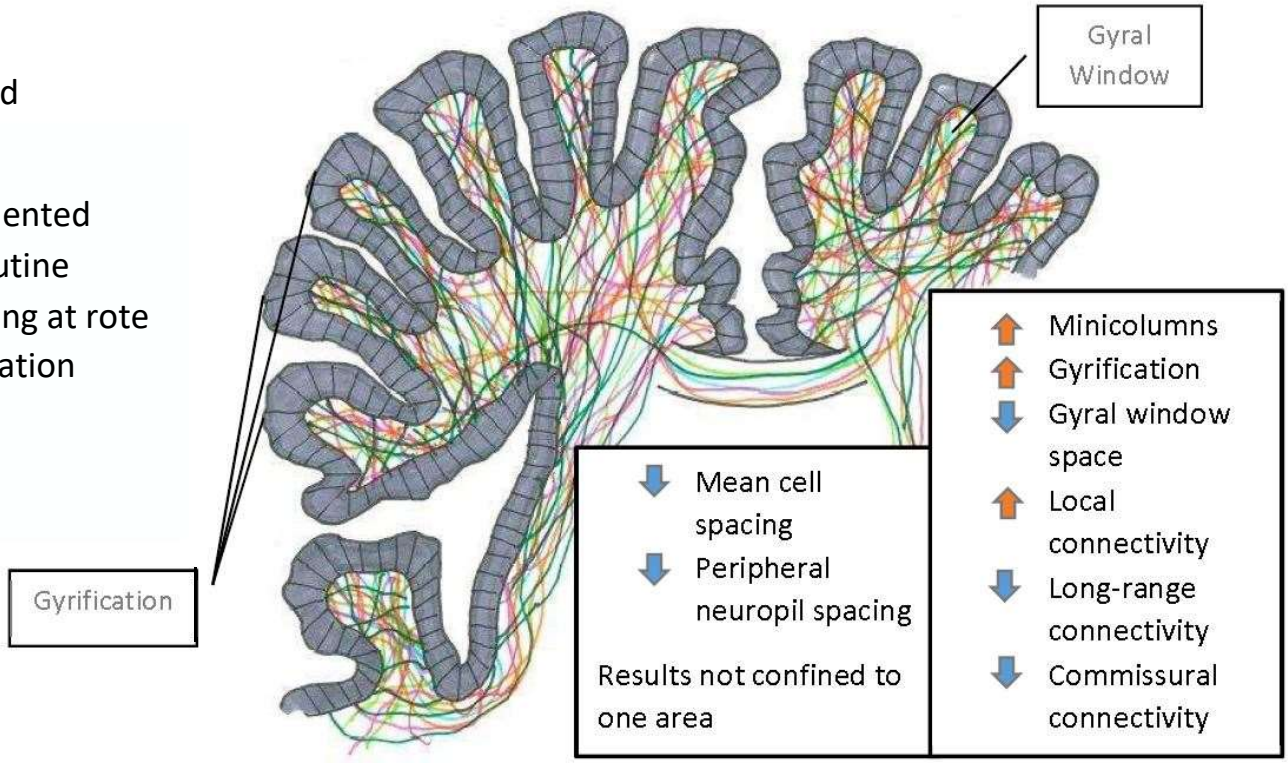
Autistic Brain Structure

Widely accepted characteristics:

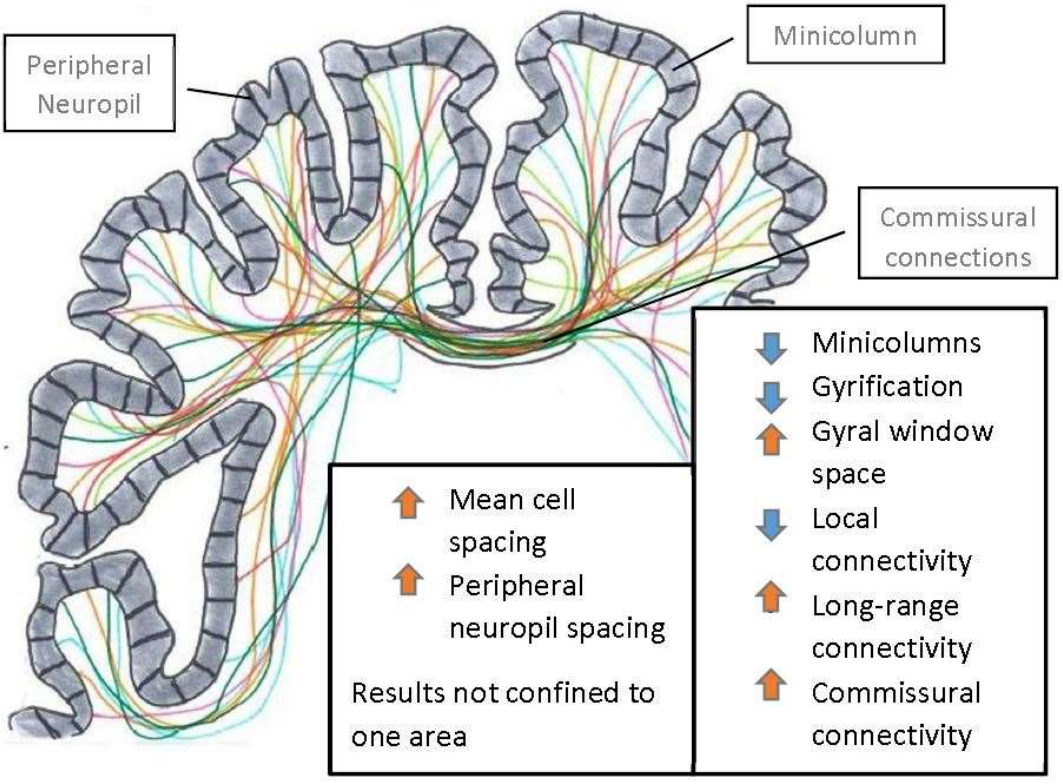
- Detail oriented
- Crave routine
- Very strong at rote memorization



Dyslexic Brain Structure

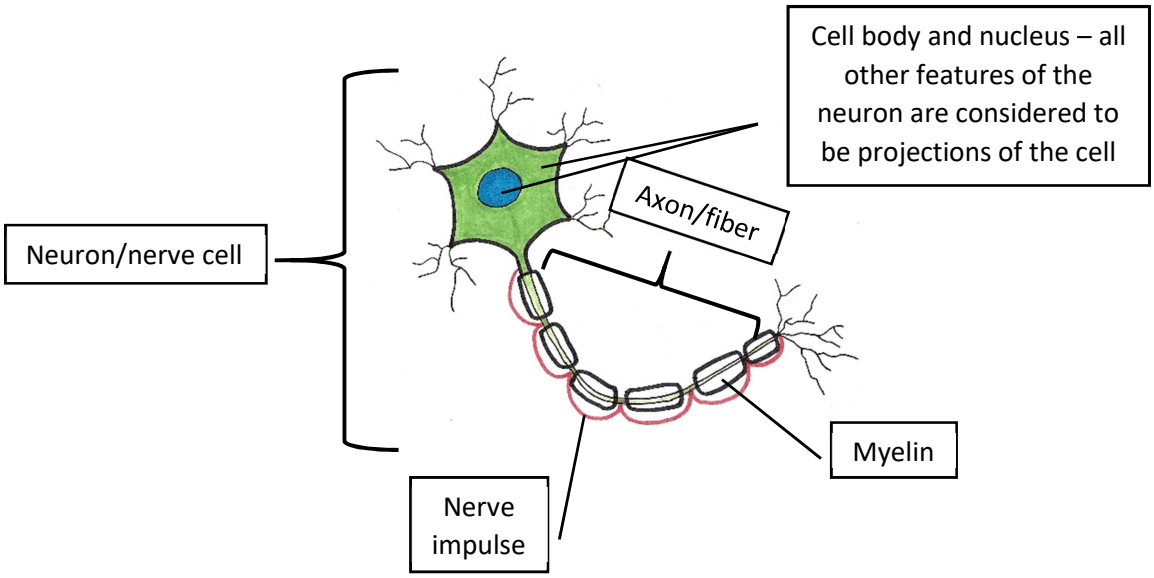
Widely accepted characteristics:

- Conceptually oriented
- Crave difference and variation
- Very weak at rote memorization



This visual interpretation was created by Jennifer Plosz based off of information gathered from Manuel Casanova's work.
It is not meant to be a literal rendering, but rather an explanatory one – proportional differences are exaggerated.

Jennifer Plosz | University of Calgary



Background information, description of findings, and definitions

The brain is organized in a scaffold arrangement where structures or strata have been added at different stages of our evolutionary history. The most superficial strata is the outer rim of the brain called the cerebral cortex. This is the part of the brain that gives rise to cognitive and language functions that differentiates humans from other species.

Most of the cerebral cortex is formed by adjacent radial structures called minicolumns. The main function of the minicolumn is to process information. Although a minicolumn is comprised of cells and their projections some people prefer to think of them as the microprocessor of a computer. However, unlike a computer that has only one microprocessor the cerebral cortex has some 600 million minicolumns. This unit of information processing accounts for the enormous ability of the cerebral cortex to analyze information in parallel fashion.

Minicolumns are arranged in a radial fashion transversing all the different layers of the cerebral cortex. The center or core of the minicolumn is populated by excitatory cells that process information. The periphery of the minicolumn is populated by inhibitory cells that wrap around the core as a shower curtain – peripheral neuropil. This shower curtain of inhibition keeps information within the core of the minicolumn and modulates the way information is processed. Variations in how the minicolumn is structured provides for differences in how we process information.

It is the variations in minicolumnar structures that Casanova has been documenting. Through delving into the cognitive profiles, neuroimaging studies and results of postmortem examination of those considered to be neurodevelopmentally disabled, he postulates that dyslexia and autism stand at the tail-ends of a spectrum describing different cognitive profiles. The comparisons Casanova has made of autistic and dyslexic variations are contrasted with those who are considered neurotypicals.

Autism	Dyslexia
Decrease in the spacing of cells within each minicolumn. The minicolumns are thinner, yet they contain the same average number of cells 80 – 100.	Increase in the spacing of cells within each minicolumn. The minicolumns are wider, yet they contain the same average number of cells 80 – 100.
Decrease of neuropil spacing within each minicolumn.	Increase in neuropil spacing within each minicolumn.
Increase in the number of minicolumns contained in the cerebral cortex.	Decrease in the number of minicolumns contained in the cerebral cortex.
Increase in gyrification.	Decrease in gyrification.
Decrease in gyral window space. As there is greater gyrification, the gyri are thinner, and therefore the gyral window beneath is less spacious.	Increase in gyral window space. As there is less gyrification, the gyri are wider, and therefore the gyral window beneath is more spacious.
Increase in local connectivity, which is theorized to be due to a thinner gyral window, along with more minicolumns, increasing the amount of fibers in the area – more dense.	Decrease in local connectivity, which is theorized to be due to a wider gyral window, along with fewer minicolumns, decreasing the number of fibers in the area – more spacious.
Decrease in long-range connectivity, which is theorized to be as a result of denser white matter.	Increase in long-range connectivity which is theorized to be a result of a less dense white matter
Decrease in commissural connectivity, theorized to be a resultant of less long-range connections	Increase in commissural connectivity, theorized to be a resultant of more long-range connections

Minicolumnar theory: This theory describes the organization of cells within the cerebral cortex. There are groups of cortical cells which are connected both vertically and horizontally into a 6 layer column depending on the brain region. Each minicolumn contains an average of 80 to 100 neurons/nerve cells. Minicolumns have traditionally been studied microscopically or using electrophysiological methods. More recently visualization of these structures has been made using a modification of the MRI technique.

Cerebral cortex: Is a thin layer of grey matter that covers both hemispheres and visually contrasts with the white matter that it covers. Although the cortex is composed of several cell layers, it averages around 3 mm in thickness depending on brain region.

Axons/fiber: the long threadlike part of a nerve cell along which impulses are conducted from one cell to another

Neuropil: a dense network of cell projections having sparse cell bodies. In terms of the minicolumn, the neuropil is the peripheral compartment consisting primarily of inhibitory cells and their connections.

Myelin: a whitish insulating sheath surrounding many axons or nerve fibers, increasing the speed at which impulses are conducted

Grey matter: The outer rim of the brain where neurons arrange themselves in a radial fashion.

White matter: composed of mainly myelinated axons

Gyrificiation: the folding of the cerebral cortex.

Gyral Window: the white matter contained beneath the gyrus/fold. This space is the gateway for fibers coming into or leaving the cerebral cortex.

Commissural connections: the axons/fibers which connect the two hemispheres.

References to Casanova's published works where the different findings are described, you can also visit his blog corticalchauvinism.com:

Casanova, M. F., Araque, J., Giedd, J., & Rumsey, J. M. (2004). Reduced brain size and gyrification in the brains of dyslexic patients. *Journal of Child Neurology, 19*(4), 275-281.

Casanova, M. F., Buxhoeveden, D. P., Cohen, M., Switala, A. E., & Roy, E. L. (2002). Minicolumnar pathology in dyslexia. *Annals of neurology, 52*(1), 108-110.

Casanova, M. F., El-Baz, A. S., Giedd, J., Rumsey, J. M., & Switala, A. E. (2010). Increased white matter gyral depth in dyslexia: implications for corticocortical connectivity. *Journal of autism and developmental disorders, 40*(1), 21-29.

Casanova, M., El-Baz, A., Elnakib, A., Giedd, J., Rumsey, J., Williams, E., & Switala, A. (2010). Corpus callosum shape analysis with application to dyslexia. *Translational neuroscience, 1*(2), 124-130.

Elnakib, A., Casanova, M. F., Gimelrfarb, G., Switala, A. E., & El-Baz, A. (2012, July). Dyslexia diagnostics by 3-D shape analysis of the corpus callosum. *IEEE Transactions on Information Technology in Biomedicine, 16*(4), 700-708.

Williams, E. L., & Casanova, M. F. (2010). Autism and dyslexia: a spectrum of cognitive styles as defined by minicolumnar morphometry. *Medical hypotheses, 74*(1), 59-62.

Williams, E. L., El-Baz, A., Nitzken, M., Switala, A. E., & Casanova, M. (2012, March). Spherical harmonic analysis of cortical complexity in autism and dyslexia. *Translational Neuroscience, 3*(1), 36-40.