New Gene Evolution Detected by Genomic Computation
A Driver for Human Brain Evolution

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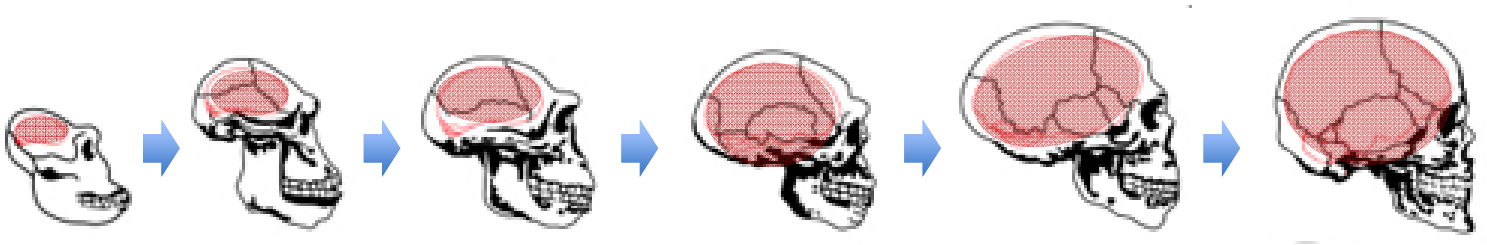
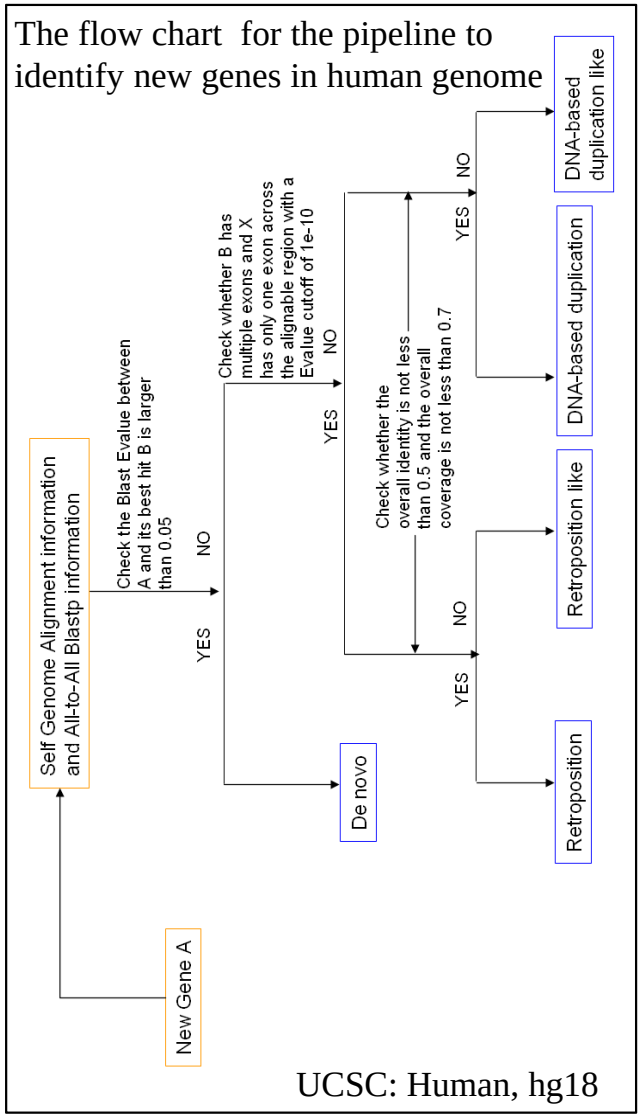
The evolution and wonders of our brains

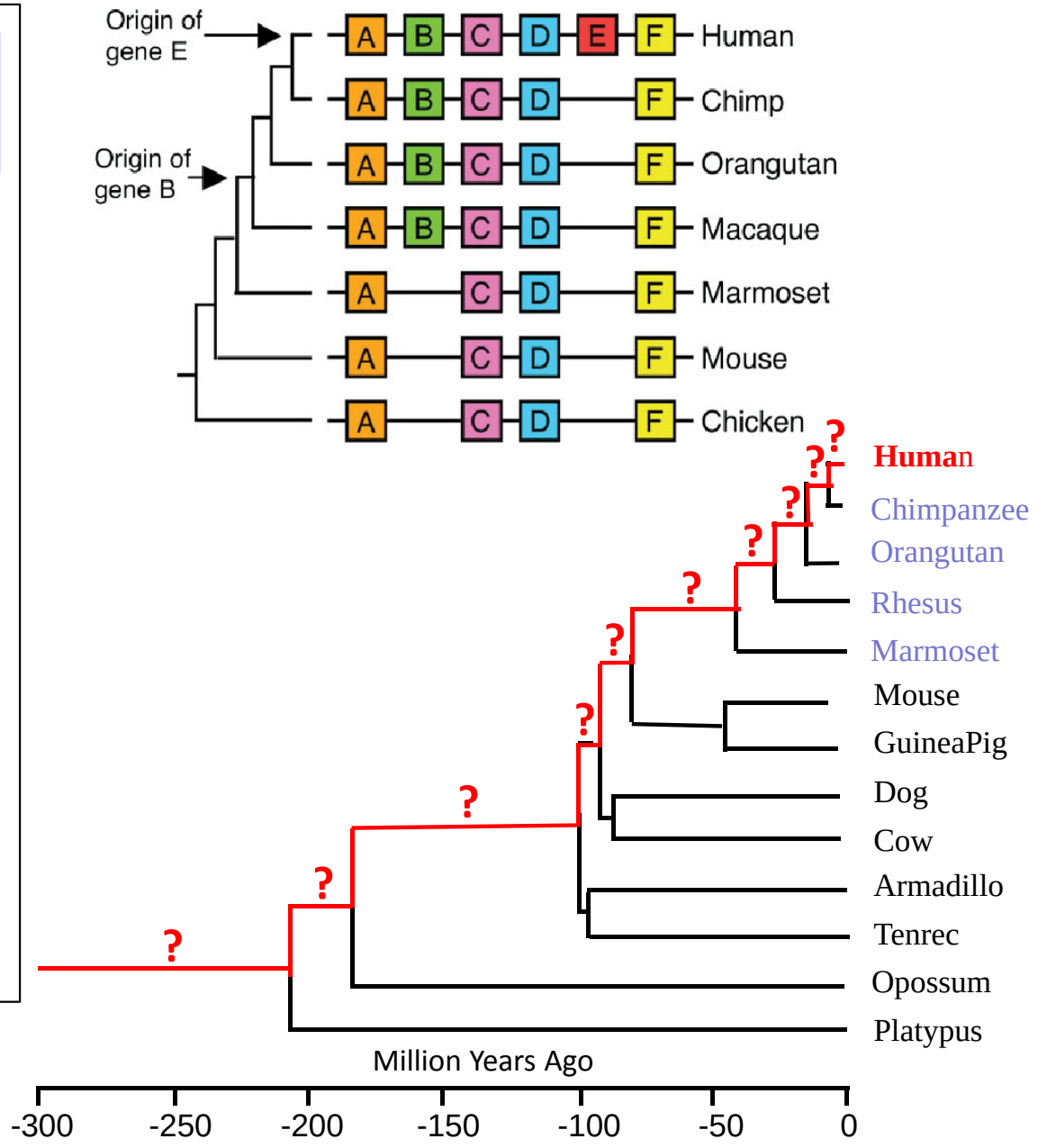


What genetic changes occurred in our ancestors drove evolution?

-- The role of new genes in brain evolution

Computational identification of new genes in vertebrate genomes





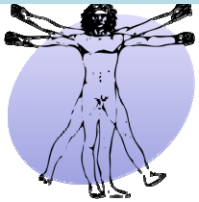
Zhang et al, 2010, Genome Research; Ranz & Parsch, 2012, BioEssays

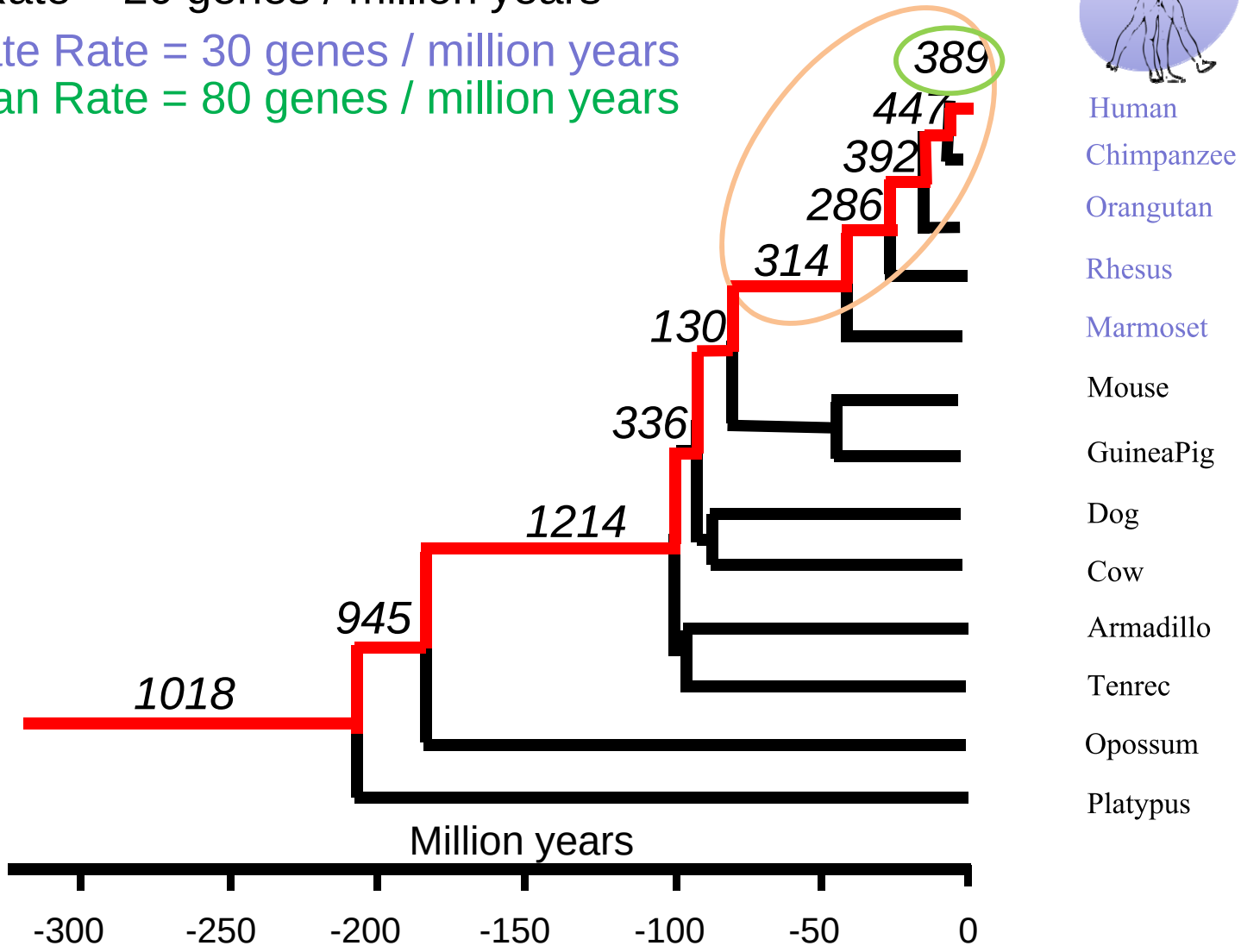
Distribution of identified new genes mapped to the lineage toward humans

Average Rate = 20 genes / million years

Primate Rate = 30 genes / million years

Human Rate = 80 genes / million years

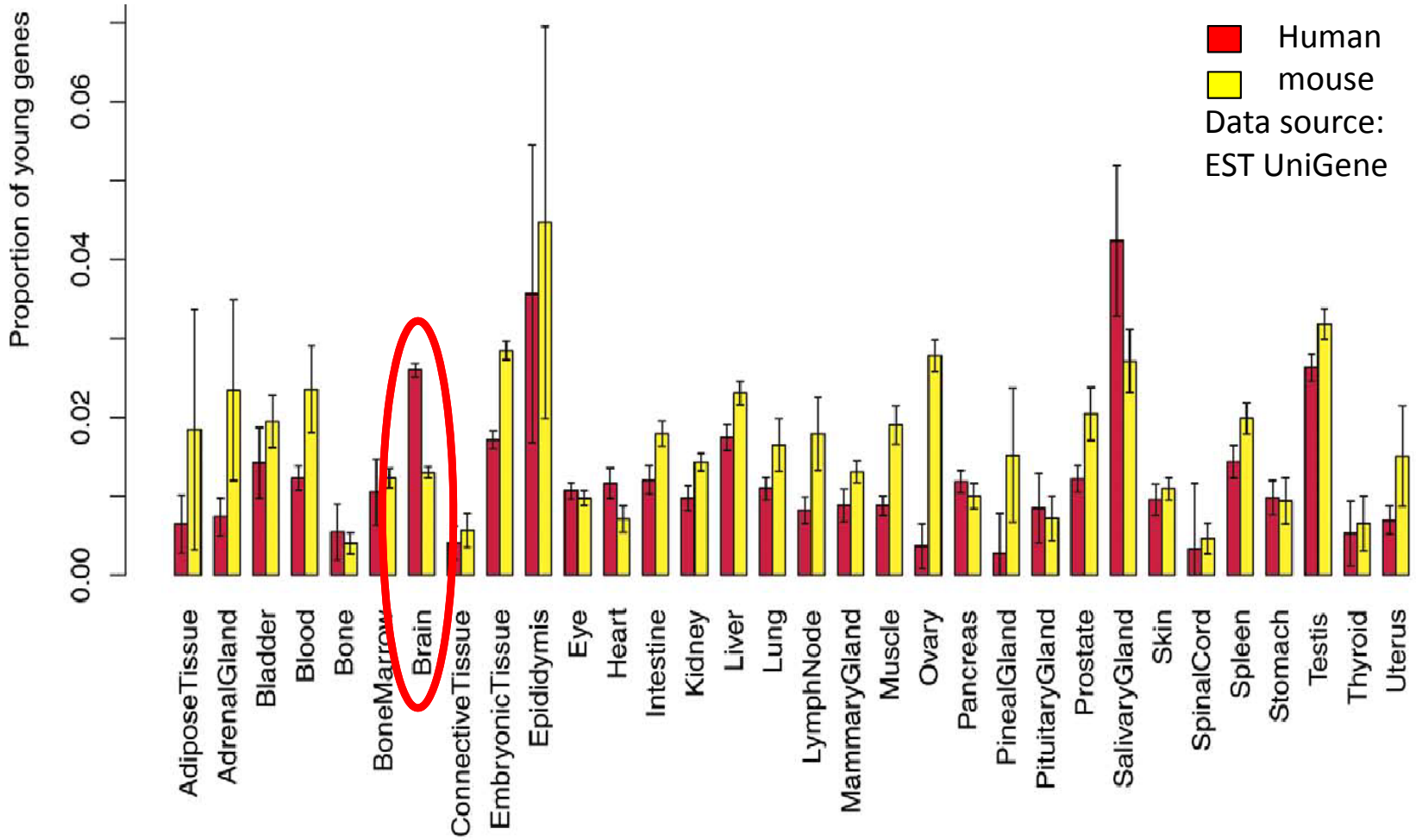




The lineage toward the human: 5500 mammalian new genes; 1800 primate new genes

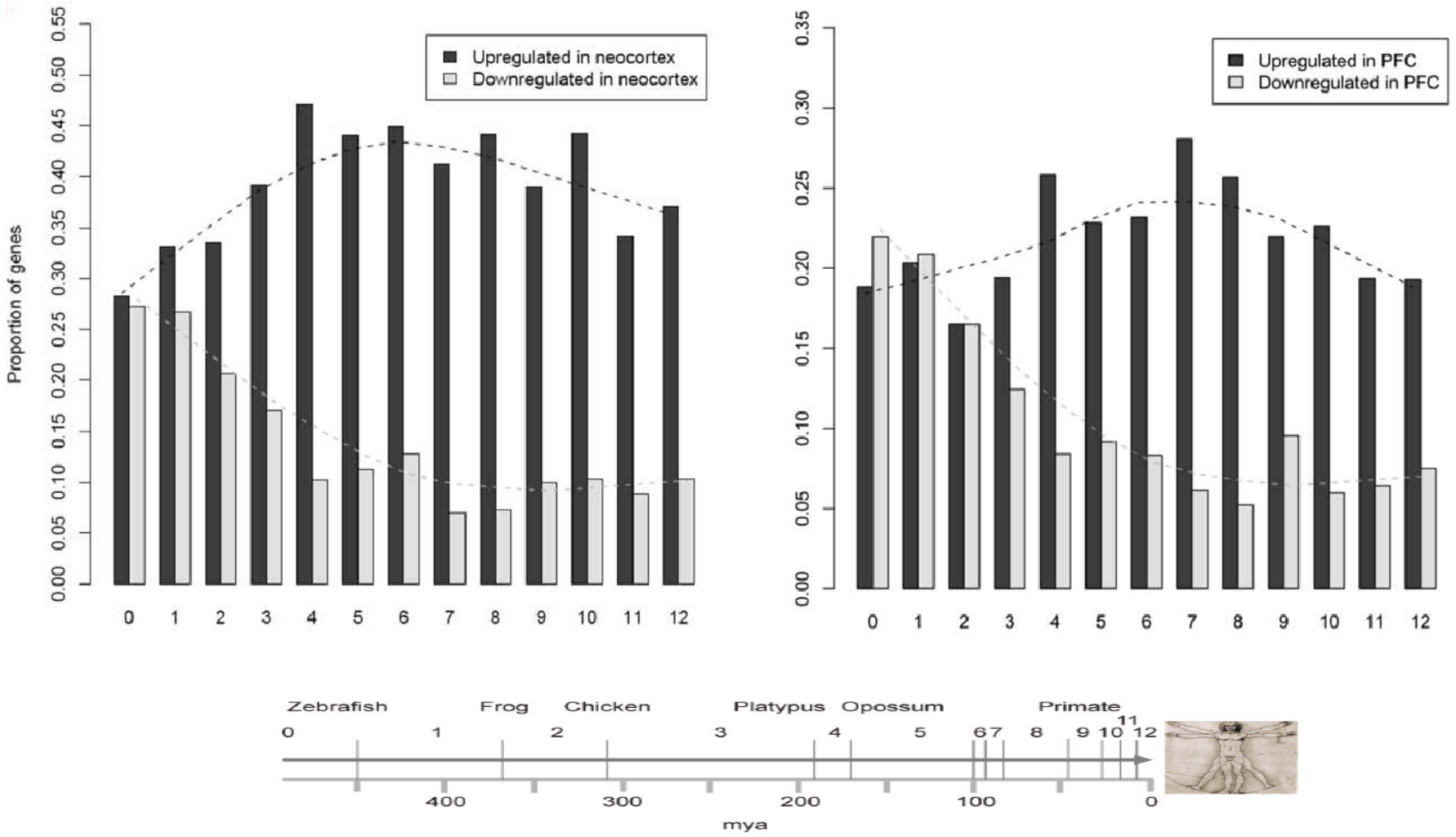
Adapted from: Zhang et al, 2010. PLoS Biol

Looking for new genes that are specifically expressed in human brain



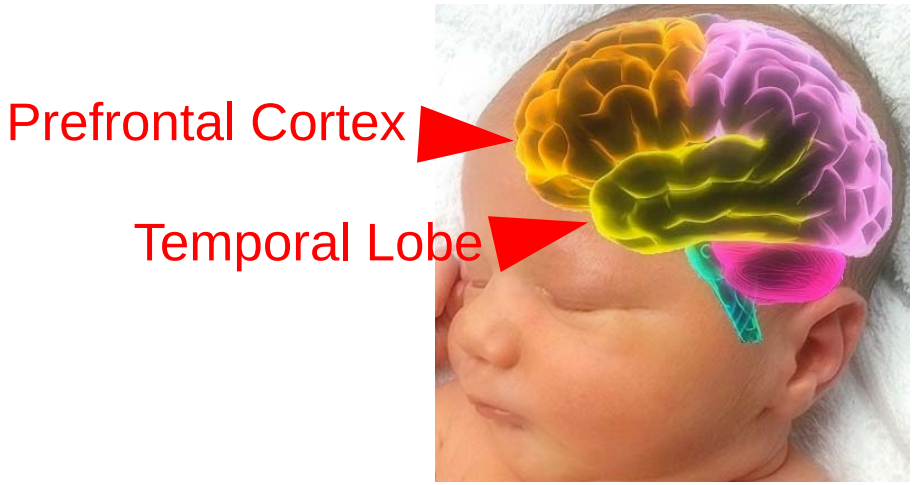
Zhang et al, 2011. PLoS Biol

Expression of new genes that originated in various evolutionary stages

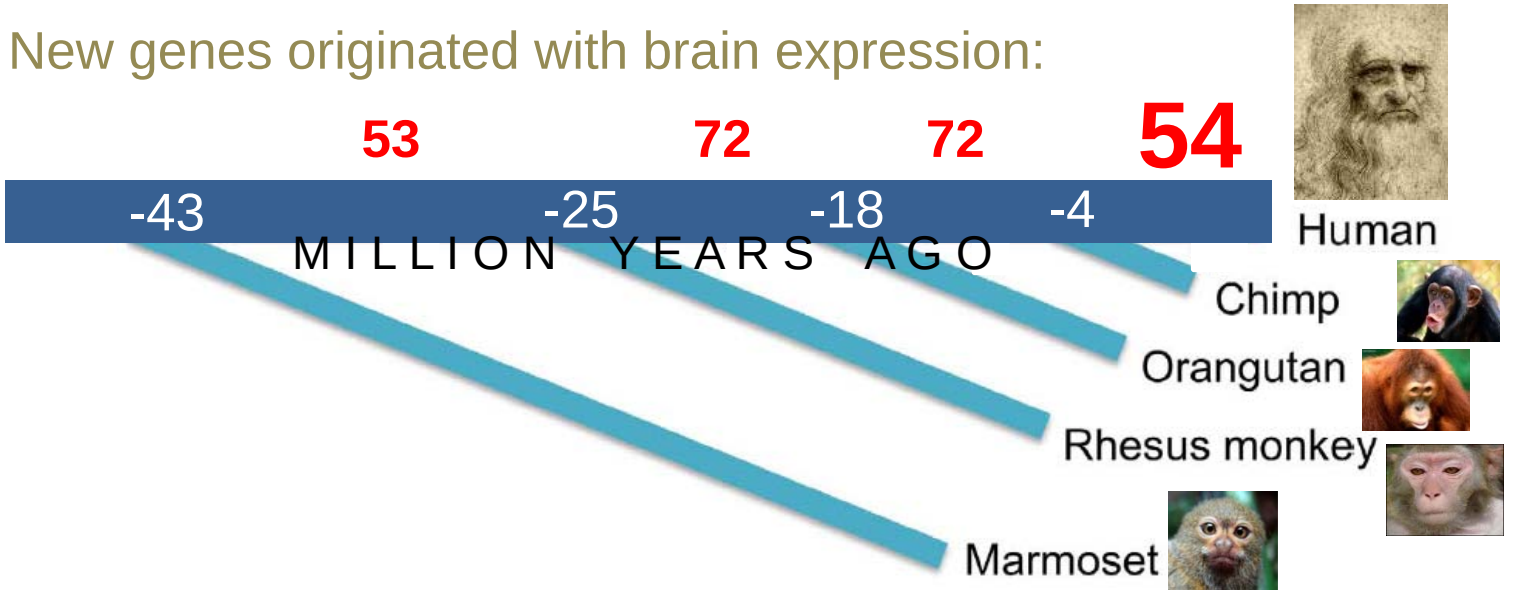


Zhang et al, 2010. PLoS Biol

New genes are expressed in early developing brain

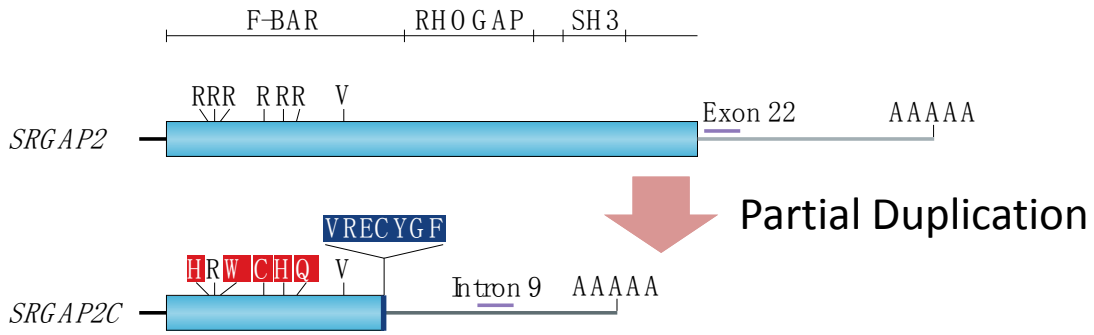


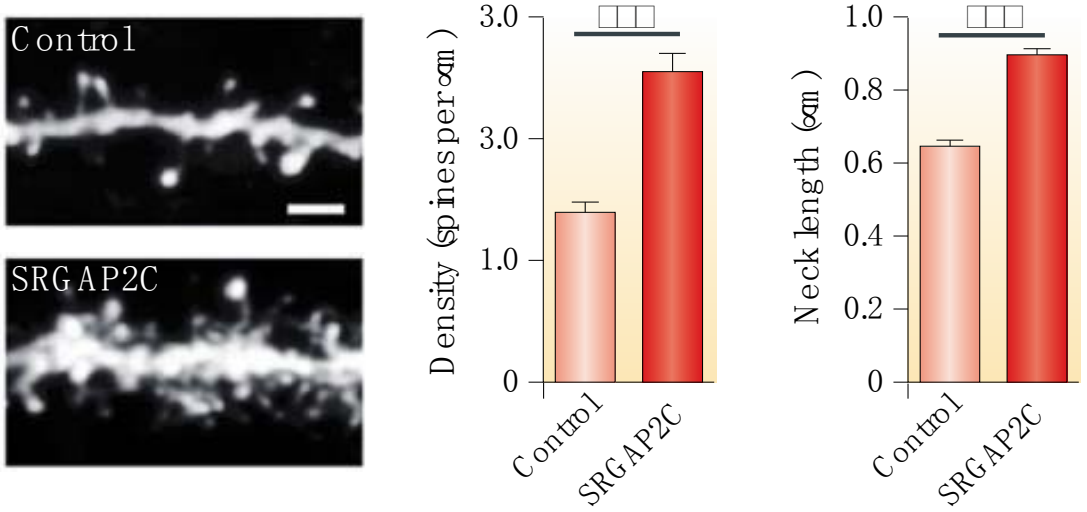
New genes originated with brain expression:



Zhang et al, 2011, PLoS Biology

Possible functions of the human-specific genes: the example of SRGAP2C





The transgenic expression of SRGAP2C in cultured mouse cortical neurons detected a higher proportion of the nerve cells growing denser dendritic spines with longer necks to connect with neighbouring neurons better, which may enhance the 'computing power' of brains.

Charrier et al, 2012, Cell

SUMMARY

1. Evolution of brain was accompanied with origin of new genes.

2. New genes are upregulated in the neocortex, in particular the prefrontal cortex regions, throughout evolution of vertebrates.

3. Many new genes, in particular human-specific, new genes expressed in the prefrontal cortex and temporal lobe, the brain structure involved for cognitive functions.