ANCIENT GENOMIC PASSENGERS (LINE-1), MODERN NEURAL ARCHITECTS

For decades, most non-coding sequences — transposable elements in particular — were dismissed as "junk DNA," the inert debris of genomic evolution and largely viewed as genomic parasites. This view began to shift with the ENCODE project, which revealed that much of the non-coding genome is biochemically active and potentially regulatory. A recent study (1) builds on this perspective by showing that thousands of evolutionarily young LINE-1 copies are actively expressed in human pluripotent stem cells and early brain organoids, where they function as cis-regulatory elements and alternative promoters for nearly one hundred protein-coding and non-coding genes, including key neurodevelopmental regulators. Locus-specific CRISPR interference reveals that silencing these L1 promoters abolishes L1-driven transcripts and disrupts neural differentiation, producing smaller cerebral organoids and broad transcriptional shifts. These findings demonstrate that human-specific L1 insertions are not genomic bystanders but are contributors to early brain development — likely influencing primate and human brain evolution by transforming former "junk" into essential regulatory circuitry.

1. https://pubmed.ncbi.nlm.nih.gov/40848716/