Human brains share consistent genetic blueprint and possess enormous biochemical complexity

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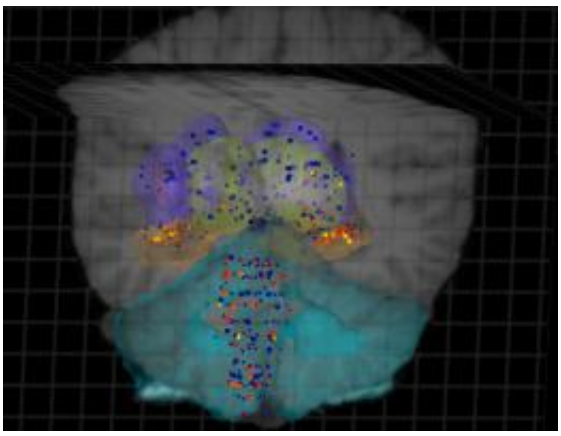

Credit: Allen Institute for Brain Science

Scientists at the Allen Institute for Brain Science reported in the latest issue of the journal *Nature* that human brains share a consistent genetic blueprint and possess enormous biochemical complexity. The findings stem from the first deep and large-scale analysis of the vast data set publicly available in the Allen Human Brain Atlas.

The results of this study are based on extensive analysis of the Allen Human Brain Atlas, specifically the detailed all-genes, all-structures survey of genes at work throughout the human brain. This dataset profiles 400 to 500 distinct brain areas per hemisphere using microarray

technology and comprises more than 100 million gene expression measurements covering three individual human brains to date. Among other findings, these data show that 84% of all genes are expressed somewhere in the human brain and in patterns that are substantially similar from one brain to the next.

"This study demonstrates the value of a global analysis of gene expression throughout the entire brain and has implications for understanding brain function, development, evolution and disease," said Ed Lein, Ph.D., Associate Investigator at the Allen Institute for Brain Science and co-lead author on the paper. "These results only scratch the surface of what can be learned from this immense data set. We look forward to seeing what others will discover."

Key Findings

The results of this study show that, despite the myriad personalities and cognitive talents seen across the human population, our brains are more similar to one another than different. Individual human brains share the same basic molecular blueprint, and deeper analysis of this shared architecture reveals several further findings:

- Neighboring regions of the brain's cortex—the wrinkly outer rind—are more biochemically similar to one another than to more distant brain regions, which has implications for understanding the development of the human brain, both during the lifespan and throughout evolution.
- The right and left hemispheres show no significant differences in molecular architecture. This suggests that functions such as language, which are generally handled by one side of the brain, likely result from more subtle differences between hemispheres or structural variation in size or circuitry, but not from a deeper

molecular basis.

- Despite controlling a diversity of functions, ranging from visual perception to planning and problem-solving, the cortex is highly homogeneous relative to other brain regions. This suggests that the same basic functional elements are used throughout the cortex and that understanding how one area works in detail will uncover fundamentals that apply to the other areas, as well.
- In addition to such global findings, the study provides new insights into the detailed inner workings of the brain at the molecular level—the level at which diseases unfold and therapeutic drugs take action.
- 84% of all genes are expressed, or turned on, somewhere in the human brain.
- Many previously uncharacterized genes are turned on in specific brain regions and localize with known functional groups of genes, suggesting they play roles in particular brain functions.
- Synapse-associated genes—those related to cell-to-cell communication machinery in the brain—are deployed in complex combinations throughout the brain, revealing a great diversity of synapse types and remarkable regional variation that likely underlies functional distinctions between brain regions.

"The tremendous variety of synapses we see in the human brain is quite striking," said Seth Grant, FRSE, Professor of Molecular Neuroscience at the University of Edinburgh and collaborating author on the study. "Mutations in synaptic genes are associated with numerous brain-related disorders, and thus understanding synapse diversity and organization in the brain is a key step toward understanding these diseases and developing specific and effective therapeutics to treat them."

More information: Hawrylycz M.J., Lein E.S. et al., An anatomically comprehensive atlas of the adult human brain transcriptome, *Nature*, September 20, 2012.

Provided by Allen Institute for Brain Science