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BrainScope—a new view on the brain

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Researchers at the Leiden University Medical Center (LUMC) and TU Delft have developed a web portal that serves to advance brain research. Using BrainScope, researchers can quickly and interactively explore gene activity in the brain. "BrainScope reveals patterns that you would otherwise never notice," says Prof. Boudewijn Lelieveldt (Medical Delta professor and affiliated with LUMC and TU Delft).

Prof. Lelieveldt is the lead investigator of a publication about BrainScope in *Nucleic Acids Research*. First author Sjoerd Huisman, doctoral candidate in Bioinformatics at TU Delft, has already presented BrainScope at numerous conferences: "People were very enthusiastic. The web portal simply runs on a PC in a browser and it works really fast."

BrainScope is based on two brain atlases containing data on gene activity in both the adult and the developing human brains. These atlases developed by the Allen Institute for Brain Science (Seattle, US) are shared publicly through brain-map.org. To compile the adult atlas, some 3,700 tissue samples from different areas of the brain were studied for activity of approximately 20,000 genes.

"It's a huge database with a wealth of information," says Huisman. "Using this public data, you can perform two types of analyses: either compare the activity pattern of genes in the brain, or compare tissue samples in terms of gene activity. Up until now, however, it was difficult to obtain a clear, complete overview of all genes in the entire brain. With BrainScope we have filled this gap."

BrainScope enables researchers to link active genes to regions of the brain. The 20,000 genes are visualized in a point cloud; the tissue samples from different brain regions are in another cloud. Using statistical techniques, genes in the cloud are mapped close to each other if they are expressed in the same regions of the brain. Similarly, tissue samples are grouped according to their gene activity profiles. Next to the two clouds, the portal includes brain images to show where genes are active in an anatomical context.

Using his mouse, Baldur van Lew (LUMC, Radiology), who built BrainScope, draws a circle on the gene cloud. "I have now selected a set of genes in this circle. I will send it to a website that knows the function of thousands of genes; look, it turns out most of these genes are involved in the immune system. Genes that are expressed together – and thus are close to each other in the cloud – often have a similar function." Simultaneously, the areas of the brain light up, in which the selected genes are collectively active. Lelieveldt says: "In this case, the brain images show that the area where these genes are active is the white matter. This is where glial cells are located that play a role in immunity. Consequently, you can easily track down links between gene activity, function and brain anatomy. This enables you to come up with new research topics or hypotheses."

Tissue samples collected from brains spanning eight different age groups were also analysed using BrainScope. Huisman and colleagues created a gene cloud for each age group. This allows researchers to study changes in gene activity throughout brain development.

More information: BrainScope is public and can be accessed at www.brainscope.nl

Sjoerd M.H. Huisman et al. BrainScope: interactive visual exploration of the spatial and temporal human brain transcriptome, *Nucleic Acids*

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