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New brain atlas opens up alternative means for studying brain disorders

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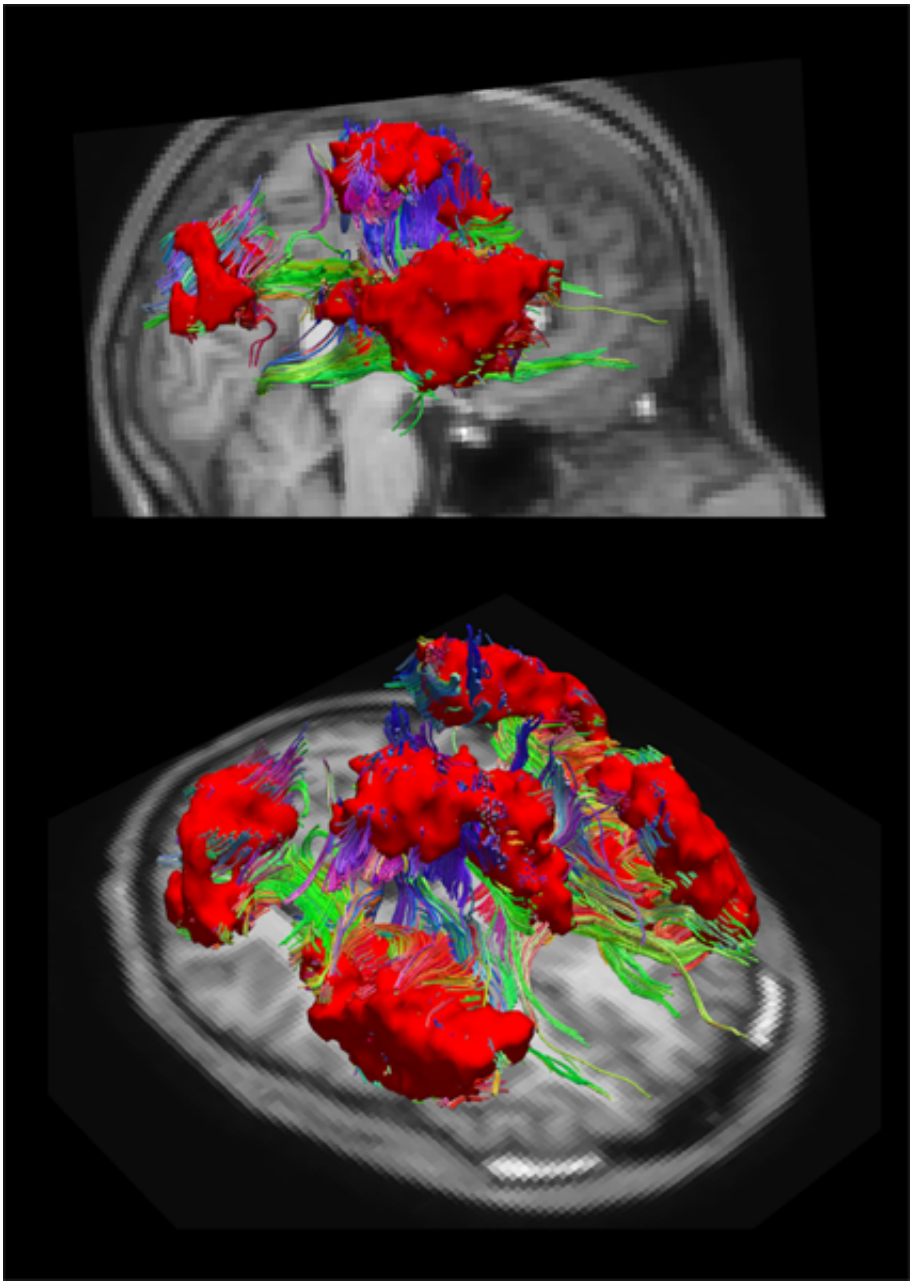

In red are two views of the same region in the new atlas. Credit: BioCruces

A new study, led by Jesús M. Cortés, an Ikerbasque lecturer at the Biocruces Institute for Healthcare Research and an academic collaborator in the Department of Cell Biology and Histology of the UPV/EHU-University of the Basque Country, has shed some light on the brain's organization and functions.

The brain is a highly complex, dynamic system. It is made up of grey and white matter. The grey matter contains the neurons which are responsible for processing the information received from the sensory area and other parts of the brain. The white matter makes use of fibres and is responsible for connecting the various regions of grey matter of the brain so that they can communicate with each other efficiently and collaborate in complex, cognitive tasks (this map of fibres is like the brain's highways). The functional interaction between the various regions of the brain is essential for it to function properly: it is reckoned that 20% of the energy consumed by a person is used by the brain to establish and maintain these connections.

Many studies have been carried out until now to understand how the brain functions and how it is organised structurally, but we still have much more to learn.

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techniques at the cutting edge of three disciplines: neuroscience, image processing and network theory. In particular, the brain's structural (fibres) and functional data (the brain's functional activity) have been merged on a large scale to analyse how the brain is organised. This analysis has resulted in the "partitioning" of the brain into an atlas that follows a common functional and structural pattern. This is the first time that a brain atlas has been produced by combining structural and functional data; until now, the atlases used were purely structural ones (anatomical ones) or purely functional ones.

Thanks to this new partition of the brain, the heavy dependence that exists between structural connectivity and the functional connectivity networks has been revealed for the first time. The atlas is robust and consistent across different individuals (it has been validated using data from other subjects and in different magnetic resonance imaging equipment).

Many neurological disorders affect the central nervous system. A considerable number are of a structural origin, such as head injuries or neurodegenerative diseases such as Alzhiemer's or Parkinson's (which originate as a result of a significant loss of fibres). Others may have a functional origin, such as a simple headache, a migraine or even an epileptic fit. Structural damage is known to lead to a functional alteration (the loss of fibres in Alzheimer's causes memory loss, etc.) or the other way round (there are people who display neuronal loss in specific zones after numerous epileptic fits). So the structure-function relationship is closely related as alterations in one of them affect the other.

The new atlas has been produced using data from healthy subjects Right now, alterations in each of these regions caused by aging or a moderate to severe head injury are being studied. So the study of the alterations in the different regions of the atlas may henceforth open up alternative avenues for understanding a range of disorders.

More information: I. Diez, P. Bonifazi, I. Escudero, B. Mateos, M.A. Munoz, S. Stramaglia and J.M. Cortes A novel brain partition highlights the modular skeleton shared by structure and function *Scientific Reports* (2015). DOI: 10.1038/srep10532