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# Study provides new insights into brain organization

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Scientists have provided new insights into how and why the brain is organised - knowledge which could eventually inform diagnosis of and treatments for conditions like Alzheimer's disease and autism.

A study by Newcastle University, UK, and the International University Bremen, Germany, debunked a prevailing theory that the nervous system should have mainly very short nerve fibre connections between nerve cells, or neurons, to function at its most effective.

Instead the study, which carried out a sophisticated computer analysis of public databases containing detailed information of worldwide anatomical studies on primate and worm brains, found that long nerve fibre connections were just as vital to overall brain function as short ones.

Much of what we know about the human brain derives from neuroscience research on primates, which are used because they have have experienced similar evolutionary stages to humans.

Brain scans of Alzheimer's patients and people with autism have shown that they are lacking certain long-distance neural interactions, although experts have yet to discover their specific purpose.

The new study, published in the academic journal PLoS Computational Biology, found that long fibres are important because they can send messages quickly over a longer distance compared with if the same

message was sent over the same distance via lots of short fibres. It also found that long fibres are more reliable for transmission of messages over longer distances.

"You can draw parallels with a train journey from Newcastle to London," said lead researcher, Dr Marcus Kaiser, of Newcastle University's School of Computing Science and the University's Institute of Neuroscience.

"For example, you would get to London much more quickly and easily if you took a direct train there. However, if you had to make the journey via Durham, Leeds and Stevenage, changing trains each time, then it will take you longer to get there, and there is the possibility you would miss a connection at some point. It's the same in the human brain."

The computer programme, run over several days, took information about the length of nerve fibres in the primate brain and neuronal connections called axons in the brain of a species of worm known as Caenorhabditis elegans. It then tested if the total length of fibres could be reduced, by testing billions of different position arrangements. Indeed, wiring lengths could be reduced by up to 50% owing to the fact that neural systems have surprisingly many long-distance connections.

Co-researcher Dr Claus Hilgetag, an associate professor with International University Bremen's School of Engineering and Science, said: "Many people have suggested that the brain is like a computer and that for optimum effectiveness it should have mainly short connections between the nerve cells. Our research suggests that a combination of different lengths of neural projections is essential.

"It is particularly interesting that we made the same observations in both the primate and the worm as their brains are very different in terms of shape and size."

Although it is too early for the research to have direct clinical applications, the researchers suggest that it may eventually contribute towards insights into the diagnosis and possibly the treatment of patients with Alzheimer's and autism if more information about neural networks - and specifically what the long and short nerve fibres do in the brain - is garnered.

One potential development could be a predictive test for the conditions, which examines and analyses a patient's brain organisation, aiding diagnosis and possibly showing how the condition may develop over the coming years.

The study is the most comprehensive yet to look at the spatial organisation of the nervous system in primates and worms.

Source: University of Newcastle upon Tyne