Juggling enhances connections in the brain

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Learning to juggle leads to changes in the white matter of the brain, an Oxford University study has shown. The research, funded by the Wellcome Trust and Medical Research Council and published in the journal Nature Neuroscience, appears to show improved connectivity in parts of the brain involved in making movements necessary to catch the balls. ‘We tend to think of the brain as being static, or even beginning to degenerate, once we reach adulthood,’ says Dr Heidi Johansen-Berg of the Department of Clinical Neurology, University of Oxford, who led the work. ‘In fact we find the structure of the brain is ripe for change. We’ve shown that it is possible for the brain to condition its own wiring system to operate more efficiently.’ The researchers at the Oxford Centre for Functional Magnetic Resonance Imaging of the Brain (FMRIB) set out to see if changes in the white matter of the brain could be seen in healthy adults on learning a new task or skill. White matter consists of the bundles of long nerve fibres that conduct electrical signals between nerve cells and connect different parts of the brain together, while the grey matter consists of the nerve cell bodies where the processing and computation in the brain is done. Changes in grey matter following new experiences and learning have been shown. But enhancements in white matter have not previously been demonstrated. Measuring changes in white matter relied on assessing diffusion MRI images using new methods pioneered by the FMRIB centre at Oxford. The methods are able to compare anatomical features of white matter between individuals or over time. ‘We have demonstrated that there are changes in the white matter of the brain – the bundles of nerve fibres that connect different parts of the brain – as a result of learning an entirely new skill,’ explains Dr Johansen-Berg. A group of young healthy adults, none of whom could juggle, was divided into two groups each of 24 people. One of the groups was given weekly training sessions in juggling for six weeks and asked to practice 30 minutes every day. Both groups were scanned using diffusion MRI before and after the six-week period. Juggler, postgraduate student at FMRIB, and first author on the paper, Jan Scholz (left), said: ‘We challenged half of the volunteers to learn to do something entirely new. After six weeks of juggling training, we saw changes in the white matter of this group compared to the others who had received no training. The changes were in regions of the brain which are involved in reaching and grasping in the periphery of vision, so that seems to make a lot of sense.’ After the training, there was a great variation in the ability of the volunteers to juggle. All could juggle three balls for at least two cascades, but some could juggle five balls and perform other tricks. All showed changes in white matter, however, suggesting this was down to the time spent training and practising rather than the level of skill attained. ‘This exciting new result raises a lot of questions,’ says Dr Johansen-Berg, ‘MRI is an indirect way to measure brain structure and so we cannot be sure exactly what is changing when these people learn. Future work should test whether these results reflect changes in the shape or number of nerve fibres, or growth of the insulating myelin sheath surrounding the fibres.’ Dr Johansen-Berg says: ‘Of course, this doesn’t mean that everyone should go out and start juggling to improve their brains. We chose juggling purely as a complex new skill for people to learn. But there is a ‘use it or lose it’ school of thought, in which any way of keeping the brain working is a good thing, such as going for a walk or doing a crossword.’ ‘There are potential clinical applications of this work, although they are a long way off,’ adds Dr Johansen-Berg. ‘Knowing that pathways in the brain can be enhanced may be significant in the long run in coming up with new treatments for neurological diseases, such as multiple sclerosis, where these pathways become degraded.’