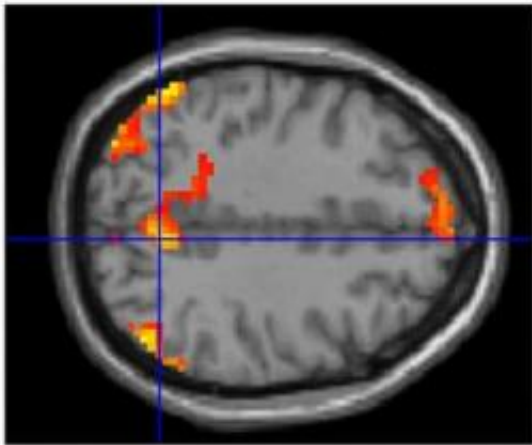


Brain scans show children with ADHD have faulty off-switch for mind-wandering

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The image represents the areas that the children with ADHD failed to deactivate during the low incentive condition, as compared with the control children (who showed no difference between incentive conditions). Credit: Dr. Elizabeth Liddle, The University of Nottingham

(PhysOrg.com) -- Brain scans of children with attention-deficit/hyperactivity disorder (ADHD) have shown for the first time why people affected by the condition sometimes have such difficulty in concentrating. The study, funded by the Wellcome Trust, may explain why parents often say that their child can maintain concentration when they are doing something that interests them, but struggles with boring tasks.

Using a 'Whac-a-Mole' style game, researchers from the Motivation, Inhibition and Development in [ADHD](#) Study (MIDAS) group at the University of Nottingham found evidence that children with ADHD require either much greater incentives – or their usual stimulant medication – to focus on a task. When the incentive was low, the children with ADHD failed to "switch off" brain regions involved in mind-wandering. When the incentive was high, however, or they were taking their medication, their [brain activity](#) was indistinguishable from a typically-developing non-ADHD child.

ADHD is the most common mental health disorder in childhood, affecting around one in 50 children in the UK. Children with ADHD are excessively restless, impulsive and distractible, and experience difficulties at home and in school. Although no cure exists for the condition, symptoms can be reduced by medication and/or behavioural therapy. The drug methylphenidate (more often known by the brand name Ritalin) is commonly used to treat the condition.

Previous studies have shown that children with ADHD have difficulty in 'switching-off' the default mode network (DMN) in their brains. This network is usually active when we are doing nothing, giving rise to spontaneous thoughts or 'daydreams', but is suppressed when we are focused on the task before us. In children with ADHD, however, it is thought that the DMN may be insufficiently suppressed on 'boring' tasks that require focused attention.

The MIDAS group researchers compared [brain scans](#) of eighteen children with ADHD, aged between nine and fifteen years old, against scans of a similar group of children without the condition as both groups took part in a task designed to test how well they were able to control their behaviour. The children with ADHD were tested when they were taking their methylphenidate and when they were off their medication. The findings are published in the *Journal of Child Psychology and*

Psychiatry.

Whilst lying in a magnetic resonance imaging (MRI) scanner, which can be used to measure activity in the brain, the children played a computer game in which green aliens were randomly interspersed with less frequent black aliens, each appearing for a short interval. Their task was to 'catch' as many green aliens as possible, while avoiding catching black aliens. For each slow or missed response, they would lose one point; they would gain one point for each timely response.

To study the effect of incentives, the reward for avoiding catching the black alien was then increased to five points, with a five-point penalty incurred for catching the wrong alien.

By studying the brain scans, the researchers were able to show that typically developing children switched off their DMN network whenever they saw an item requiring their attention. However, unless the incentive was high, or they had taken their medication, the children with ADHD would fail to switch off the DMN and would perform poorly. This effect of incentives was not seen in children without ADHD – activity in their DMN was switched off by items requiring their attention regardless of the incentive on offer.

Professor Chris Hollis, who led the study, says: "The results are exciting because for the first time we are beginning to understand how in children with ADHD incentives and stimulant medication work in a similar way to alter patterns of brain activity and enable them to concentrate and focus better. It also explains why in children with ADHD their performance is often so variable and inconsistent, depending as it does on their interest in a particular task."

Dr Martin Batty, co-author of the study, adds: "Using brain imaging, we have been able to see inside the children's heads and observe what it is

about ADHD that is stopping them concentrating. Most people are able to control their 'daydreaming' state and focus on the task at hand. This is not the case with children with ADHD. If a task is not sufficiently interesting, they cannot switch off their background [brain](#) activity and they are easily distracted. Making a task more interesting – or providing methylphenidate – turns down the volume and allows them to concentrate."

Dr Elizabeth Liddle, first author of the study, says that these findings help explain one of the interesting characteristics of ADHD – that children with the condition appear able to control themselves much better when motivated to do so.

"The common complaint about children with ADHD is that 'he can concentrate and control himself fine when he wants to', so some people just think the child is being naughty when he misbehaves," says Dr Liddle. "We have shown that this may be a very real difficulty for them. The off-switch for their 'internal world' seems to need a greater incentive to function properly and allow them to attend to their task."

Provided by Wellcome Trust

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