

Behavioral incentives mimic effects of medication on brain systems in ADHD

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Medication and behavioural interventions help children with Attention Deficit Hyperactivity Disorder (ADHD) better maintain attention and self control by normalising activity in the same brain systems, according to research funded by the Wellcome Trust.

In a study published today in the journal *Biological Psychiatry*, researchers from the University of Nottingham, show that medication has the most significant effect on [brain function](#) in children with ADHD, but this effect can be boosted by complementary use of rewards and incentives which appear to mimic the effects of medication on brain systems.

ADHD is the most common [mental health disorder](#) in childhood, affecting around one in twenty 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 a combination of medication and behaviour therapy.

[Methylphenidate](#), a drug commonly used to treat ADHD, is believed to increase levels of dopamine in the brain. Dopamine is a [chemical messenger](#) associated with attention, learning and the brain's reward and pleasure systems. This change amplifies certain brain signals and can be measured using an [electroencephalogram](#) (EEG). Until now it has been unclear how rewards and incentives affect the brain, either with or without the additional use of medication.

To answer these questions, researchers at the university's 'Motivation, Inhibition and Development in ADHD Study' (MIDAS) used EEG to measure [brain activity](#) whilst children played a simple game. They compared two particular markers of brain activity that relate to attention and impulsivity and looked at how these were affected by medication and motivational incentives.

The team worked with two groups of children aged nine to fifteen years, one group of twenty-eight children with ADHD and a control group of twenty-eight children. 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.

In a test designed to study the effect of incentives, the reward for avoiding catching the black alien was increased to five points; a follow-up test replaced this reward with a five point penalty for catching the wrong alien.

The researchers found that when given their usual dose of methylphenidate, children with ADHD performed significantly better at the tasks than when given no medication, with better attention and reduced impulsivity. Their brain activity appeared to normalise, becoming similar to that of the control group.

Similarly, motivational incentives also helped normalise brain activity on the two EEG markers and improved attention and reduced impulsivity, though its effect was much smaller than that of medication.

"When the children were given rewards or penalties, their attention and self control was much improved," says Dr Maddie Groom, first author of

the study. "We suspect that both medication and motivational incentives work by making a task more appealing, capturing the child's attention and engaging his or her brain response control systems."

Professor Chris Hollis, who led the study, believes the findings may help reconcile the often-polarised debate between those who advocate either medication on the one hand, or psychological/behavioural therapy on the other.

"Although medication and behaviour therapy appear to be two very different approaches of treating ADHD, our study suggests that both types of intervention may have much in common in terms of their affect on the brain," he says. "Both help normalise similar components of brain function and improve performance. What's more, their effect is additive, meaning they can be more effective when used together."

The researchers believe that the results lend support from neuroscience to current treatment guidelines for ADHD as set out by the National Institute for Health and Clinical Excellence (NICE). These recommend that behavioural interventions, which have a smaller effect size, are appropriate for moderate ADHD while medication, with its larger effect size, is added for severe ADHD.

Although the findings suggest that a combination of incentives and medication might work most effectively, and potentially enable children to take lower doses of medication, Professor Hollis believes more work is needed before the results can be applied to everyday clinical practice or classroom situations.

"The incentives and rewards in our study were immediate and consistent, but we know that [children](#) with ADHD respond disproportionately less well to delayed rewards," he says. "This could mean that in the 'real world' of the classroom or home, the neural effects of behavioural

approaches using reinforcement and rewards may be less effective."

Provided by Wellcome Trust

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