Impulsive, weak-willed or just too much dopamine?

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It's a common scenario: you're on a diet, determined to give up eating cakes, but as you pass the cake counter, all resolve disappears... Now, scientists at the Wellcome Trust Centre for Neuroimaging at UCL (University College London) have shed light on the brain processes that affect our will power and make us act impulsively.

In a study published today in the Journal of Neuroscience, funded mainly by the Wellcome Trust, researchers led by Professor Ray Dolan have shown that increased levels of dopamine - a chemical in the brain involved in mediating reward, motivation, and learning through reinforcement, - make us more likely to opt for instant gratification, rather than waiting for a more beneficial reward.

The research may help explain why people affected by conditions such as Attention Deficit/Hyperactivity Disorder (ADHD), characterised by high levels of dopamine in the brain, tend to show extremely impulsive behaviour. Similarly, it highlights why such behaviour can be a potential negative side-effect of L-dopa, a drug used to help alleviate the symptoms of Parkinson's disease.

To test the effect of dopamine on decision-making, Professor Ray Dolan and colleagues carried out a test with 14 healthy volunteers under two conditions: once when given a small (150mg) dose of L-dopa, once when given a placebo. Under each condition, the subjects were asked to make a number of choices consisting of either a 'smaller, sooner' option, for example receiving £15 in two weeks, or a 'larger, later' option, such as

receiving £57 in six months.

"Every day we are faced with decisions that offer either instant gratification or longer-term, but more significant reward," explains Dr Alex Pine, first author of the study. "Do you buy your new iPhone today or wait six months till the price comes down? Do you diet or eat that delicious-looking cake? Do you get out your books to study for a future exam or watch some more TV?"

The researchers found that every subject was more likely to behave more impulsively - choosing the 'smaller, sooner' option - when levels of dopamine in the brain were boosted. . On the whole, the number of sooner options chosen increased by almost a third, although each subject varied on this measure.

Dr Pine believes that this finding may also explain why we tend to behave more impulsively when influenced by external 'cues'.

"We know that sensory inputs - sights, sounds smells and anticipation of rewards, or even of neutral cues which have been associated with rewards - momentarily boost dopamine levels in our brains, and our research shows that higher dopamine levels make us act more impulsively," he says.

"But this research is important for more than just explaining our day to day lapses in self-control. It also helps us understand why disorders which are associated with abnormal dopamine functioning can also lead to extremely impulsive behaviour."

The researchers also tested the subjects under the influence of small doses of haloperidol, a dopamine suppressant; however, the results were inconclusive, showing little difference from the effect of the placebo. Dr Pine cautions against the idea that dopamine suppressants might be used

to help combat impulsivity and addiction.

"Dopamine plays a wide role in the brain, from movement through to cognition," he explains. "Lowering dopamine levels may be able to reduce impulsivity, but we need to be certain that this didn't come at the expense of other, important functions."

The test was conducted whilst the subjects were in a functional magnetic resonance imaging (fMRI) scanner, which looks at activity in the brain by measuring changes in blood flow. A network of brain regions, including the striatum and prefrontal cortex, tends to be more active when considering a sooner versus a more delayed reward. The researchers showed that this differential activity was more magnified after the subjects were given L-dopa.

They also found that greater individual susceptibility to the influence of the drug was associated with an increase in activity in the brain region known as the amygdala when volunteers made choices. The amygdala is known to play a role in processing emotions, which affects decision-making, though the mechanism of this influence it is not yet fully clear.

More information: Pine, A et al. Dopamine, Time, and Impulsivity in Humans. Journal of Neuroscience; e-pub 29 June 2010

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