

# Who learns from the carrot, and who from the stick?

November 22 2013

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To flexibly deal with our ever-changing world, we need to learn from both the negative and positive consequences of our behaviour. In other words, from punishment and reward. Hanneke den Ouden from the Donders Institute in Nijmegen demonstrated that serotonin and dopamine related genes influence how we base our choices on past punishments or rewards. This influence depends on which gene variant you inherited from your parents. These results were published in *Neuron* on November 20.

The [brain chemicals](#) dopamine and [serotonin](#) partly determine our sensitivity to reward and punishment. At least, this was a common assumption. Hanneke den Ouden and Roshan Cools investigated this assumption together with colleagues from the Donders Institute and New York University. Den Ouden explains: "We used a simple computer game to test the genetic influence of the genes DAT1 and SERT, as these genes influence dopamine and serotonin. We discovered that the dopamine gene affects how we learn from the long-term consequences of our choices, while the serotonin gene affects our choices in the short term."

## Online game

"In nearly 700 people we analysed which variant of the SERT and the DAT1 genes they had," says den Ouden. "Using an [online game](#), we investigated how well people are able to adjust their choice strategy after

receiving a reward or a punishment." The players would repeatedly choose one of two symbols. Symbol A usually resulted in a reward whereas symbol B usually resulted in punishment. Halfway through the game, these rules were reversed. The game allowed the researchers to measure how flexible people are in adjusting their choices when the rules change. But it also showed whether people impulsively change their choice when the computer happened to give misleading feedback.

## Different genes, different strategies

Den Ouden: "Different players use different strategies, which depend on their genetic material. People's tendency to change their choice immediately after receiving a punishment depends on which serotonin [gene variant](#) they inherited from their parents. The dopamine gene variant, on the other hand, exerts influence on whether people can stop themselves making the choice that was previously rewarded, but no longer is."

This study shows that dopamine and serotonin are important for different forms of flexibility associated with receiving reward and [punishment](#). Many neuropsychiatric disorders caused by abnormal dopamine and/or [serotonin levels](#) are associated with forms of inflexibility, for example addiction, anxiety, or Parkinson's disease. So this study not only tells us more about the heritability of our choice behaviour; a better understanding of the relationship between brain chemicals and behaviour in healthy people will ultimately help to provide us with better insight into these [neuropsychiatric disorders](#).

**More information:** "Dissociable Effects of Dopamine and Serotonin on Reversal Learning." Hanneke E.M. den Ouden, Nathaniel D. Daw, Guillén Fernandez, Joris A. Elshout, Mark Rijpkema, Martine Hoogman, Barbara Franke, Roshan Cools *Neuron* 80, 1–11, November 20, 2013. [www.cell.com/neuron/abstract/S0896-6273\(13\)00789-7](http://www.cell.com/neuron/abstract/S0896-6273(13)00789-7)

Provided by Radboud University Nijmegen

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