

# Scientists discover beliefs can be just as powerful as nicotine

February 26 2015, by Ashley Wennersherron

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Two identical cigarettes led to a discovery by scientists at the Virginia Tech Carilion Research Institute. Study participants inhaled nicotine, yet they showed significantly different brain activity. Why the difference? Some subjects were told their cigarettes were nicotine free.

"Our research group has begun to show that beliefs are as powerful a physical influence on the [brain](#) as neuroactive drugs," said Read Montague, director of the Computational Psychiatry Unit at the Virginia Tech Carilion Research Institute and lead author of a study published this week in the *Proceedings of the National Academy of Sciences*.

Nicotine has formidable effects throughout the brain, especially in the reward-based learning pathways. Nicotine teaches the brain that smoking leads to reward. Once the brain learns that correlation, the addictive chemical cycle is difficult to break. In this study, scientists tracked the brain responses using functional magnetic resonance imaging.

"We suspected that we would be able to see [neural signals](#) based on the subjects' belief rather than their actual nicotine intake," said Montague, who is also a professor of physics in Virginia Tech's College of Science.

After smoking cigarettes, volunteers played a reward-based learning game while their brains were scanned. The subjects viewed a historical stock price graph, made an investment, and repeated the cycle multiple times.

Researchers used computational models of learning signals thought to be generated by the brain during these kinds of tasks. In each subject, the individually tracked signals were specifically influenced by beliefs about nicotine.

Montague and his team found that the people who believed they had smoked nicotine cigarettes made different choices and had different neural signals than the other participants, despite the fact that both groups had consumed the same substance.

The scientists also found people who believed they had smoked nicotine had significantly higher activity in their reward-learning pathways. Those who did not believe they had smoked nicotine did not exhibit those same signals.

"It was the belief alone that modulated activity in the learning pathway," Montague said. "This goes beyond the placebo effect."

Multiple studies support the placebo effect, showing sham treatments can improve a patient's condition simply because the person believed it would be helpful.

In the current study, however, researchers found belief alone could actually erase or enhance the effects of nicotine in participants who were under the influence of the active drug.

The study was featured in an editorial commentary by Nora Volkow, director of the National Institute on Drug Abuse, in the Proceedings of the National Academy of Sciences.

"The current findings extend the relevance of dopamine-guided learning processes to the experience of how drug intoxication influences the way the human brain works and orchestrates our behaviors," Volkow wrote in

the commentary.

Volkow suggested previously shrouded mechanisms behind beliefs and learned responses could be manipulated as a target for new addiction treatments.

"Nothing is more convincing than how a drug can make you feel differently," Montague said. "A drug can induce a belief state, which itself causes the change."

Scientists might be able to harness this belief system, capable of inducing physiological changes, to reverse-engineer addiction.

"Just as drugs micromanage the belief state," Montague said, "maybe we can micromanage beliefs to better effect behavior change in addiction."

**More information:** The complete study is available online:  
[www.pnas.org/content/112/8/2539.full.pdf+html](http://www.pnas.org/content/112/8/2539.full.pdf+html)

Provided by Virginia Tech

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