

# Derailed train of thought? Brain's stopping system may be at fault

18 April 2016



The study analyzes signals from the scalp in healthy volunteers as well as signals from electrode implants in the brains of people with Parkinson's disease. Credit: Nathalie Belanger.

Have you had the experience of being just on the verge of saying something when the phone rang? Did you then forget what it is you were going to say? A study of the brain's electrical activity offers a new explanation of how that happens.

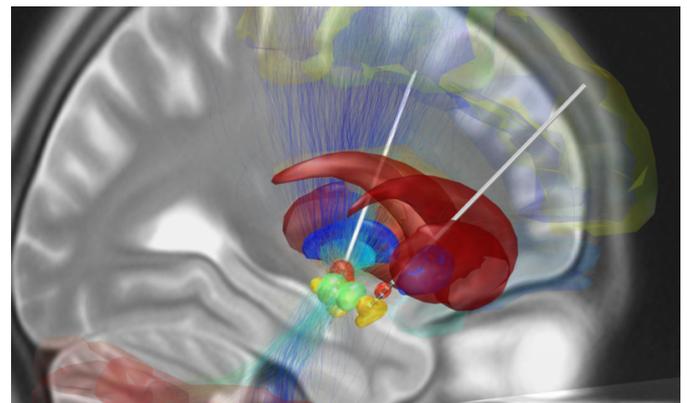
Published in *Nature Communications*, the study comes from the lab of neuroscientist Adam Aron at the University of California San Diego, together with collaborators at Oxford University in the UK, and was led by first author Jan Wessel, while a post-doctoral scholar in the Aron Lab. The researchers suggest that the same [brain](#) system that is involved in interrupting, or stopping, movement in our bodies also interrupts cognition—which, in the example of the phone ringing, derails your train of thought.

The findings may give insights into Parkinson's disease, said Aron, a professor of psychology in the UC San Diego Division of Social Sciences, and Wessel, now an assistant professor of psychology and neurology at the University of Iowa. The

disease can cause muscle tremors as well as slowed-down movement and facial expression. Parkinson's patients may also present as the "opposite of distractible," often with a thought stream so stable that it can seem hard to interrupt. The same [brain system](#) that is implicated in "over-stopping" motor activity in these patients, Aron said, might be also be keeping them over-focused.

The current study focuses particularly on one part of the brain's stopping system—the subthalamic nucleus (STN). This is a small lens-shaped cluster of densely packed neurons in the midbrain and is part of the basal ganglia system.

Earlier research by Aron and colleagues had shown that the STN is engaged when action stopping is required. Specifically, it may be important, Aron said, for a "broad stop." A broad stop is the sort of whole-body jolt we experience when, for example, we're just about to exit an elevator and suddenly see that there's another person standing right there on the other side of the doors.



A reconstruction of deep brain stimulation electrodes that have been surgically placed into the most common target structure for treatment of Parkinson's disease, the subthalamic nucleus (orange). The STN is part of the brain's stopping system and is a particular focus of this study. Credit: By Andreashorn - Own work, CC BY-SA

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The study analyzes signals from the scalp in 20 healthy subjects as well as signals from electrode implants in the STN of seven people with Parkinson's disease. (The STN is the main target for therapeutic [deep brain stimulation](#) in Parkinson's disease.)

All the volunteers were given a working memory task. On each trial, they were asked to hold in mind a string of letters, and then tested for recall. Most of the time, while they were maintaining the letters in mind, and before the recall test, they were played a simple, single-frequency tone. On a minority of trials, this sound was replaced by a birdsong segment - which is not startling like a "bang!" but is unexpected and surprising, like a cell phone chirping suddenly. The volunteers' brain activity was recorded, as well as their accuracy in recalling the letters they'd been shown.

The results show, the researchers write, that unexpected events manifest the same brain signature as outright stopping of the body. They also recruit the STN. And the more the STN was engaged - or the more that part of the brain responded to the unexpected sound - the more it affected the subjects' working memory and the more they lost hold of what they were trying to keep in mind.

"For now," said Wessel, "we've shown that unexpected, or surprising, events recruit the same brain system we use to actively stop our actions, which, in turn, appears to influence the degree to which such surprising events affect our ongoing trains of thought."

A role for the STN in stopping the body and interrupting working memory does fit anatomical models of how the nucleus is situated within circuitry in the brain. Yet more research is needed, the researchers write, to determine if there's a causal link between the activity observed in the STN and the loss in [working memory](#).

"An unexpected event appears to clear out what

you were thinking," Aron said. "The radically new idea is that just as the brain's stopping mechanism is involved in stopping what we're doing with our bodies it might also be responsible for interrupting and flushing out our thoughts."

A possible future line of investigation, Aron said, is to see if the STN and associated circuitry plays a role in conditions characterized by distractibility, like Attention Deficit Hyperactivity Disorder. "This is highly speculative," he said, "but it could be fruitful to explore if the STN is more readily triggered in ADHD."

Wessel added: "It might also be potentially interesting to see if this system could be engaged deliberately - and actively used to interrupt intrusive thoughts or unwanted memories."

If further research bears out the connection suggested by the current study, between the STN and losing your train of thought following an [unexpected event](#), the researchers say it might be that it is an adaptive feature of the brain, something we evolved long ago as a way to clear our cognition and re-focus on something new. Aron suggests this example: You're walking along one morning on the African Savannah, going to gather firewood. You're daydreaming about the meal you're going to prepare when you hear a rustle in the grass. You make a sudden stop - and all thoughts of dinner are gone as you shift your focus to figure out what might be in the grass. In this case, it's a good thing to forget what you had been thinking about.

**More information:** *Nature Communications*, [dx.doi.org/10.1038/NCOMMS11195](https://doi.org/10.1038/NCOMMS11195)

Provided by University of California - San Diego

APA citation: Derailed train of thought? Brain's stopping system may be at fault (2016, April 18) retrieved 18 April 2016 from <http://medicalxpress.com/news/2016-04-derailed-thought-brain-fault.html>

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