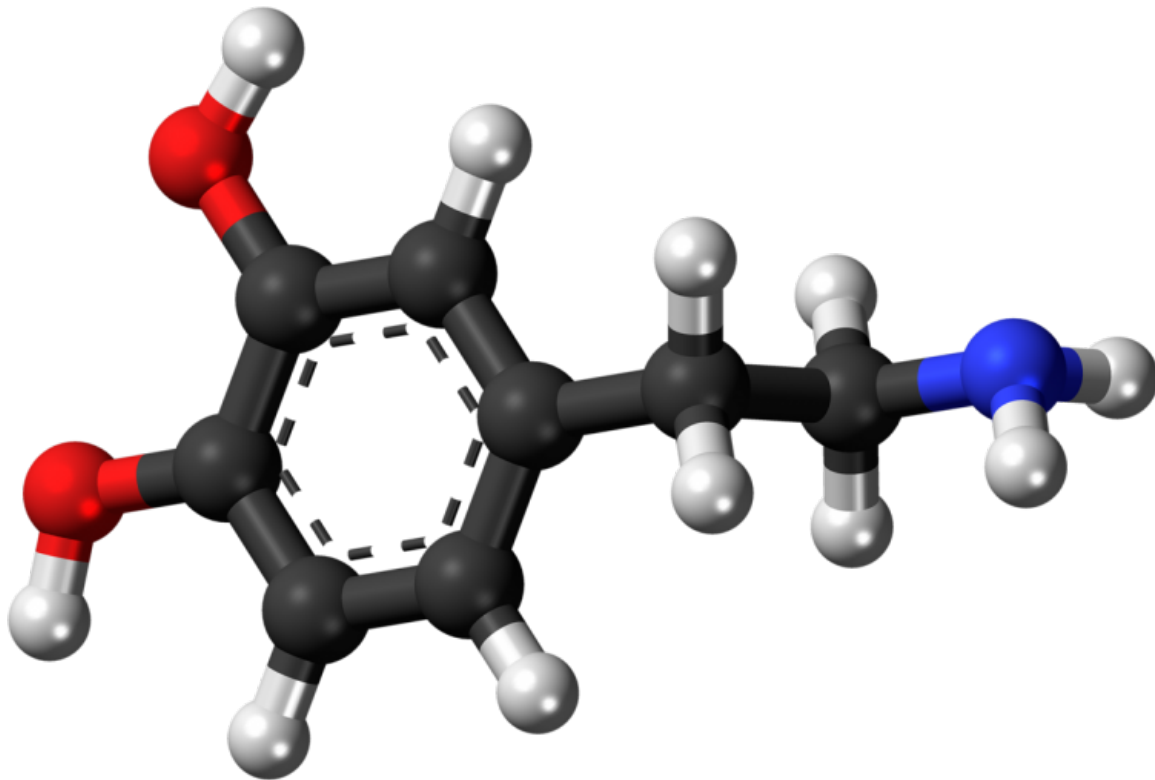


Novelty speeds up learning thanks to dopamine activation

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Ball-and-stick model of the dopamine molecule, a neurotransmitter that affects the brain's reward and pleasure centers. Credit: Jynto/Wikipedia

Brain scientists led by Sebastian Haesler (NERF, empowered by IMEC, KU Leuven and VIB) have identified a causal mechanism of how novel

stimuli promote learning. Novelty directly activates the dopamine system, which is responsible for associative learning. The findings have implications for improving learning strategies and for the design of machine learning algorithms.

Novelty and learning

A fundamental type of learning, known as [associative learning](#), is commonly observed in animals and humans. It involves the association of a stimulus or an action with a positive or negative outcome.

Associative learning underlies many of our every-day behaviors: we reward children for doing their homework, for example, or limit their TV time if they misbehave.

Scientists have known since the 1960's that novelty facilitates associative learning. However, the mechanisms behind this phenomenon remained unknown.

"Previous work suggested that novelty might activate the [dopamine system](#) in the brain. Therefore we thought that [dopamine](#) activation might also promote associative learning," says Prof. Sebastian Haesler, who led the study.

Sniffing out novelty

To demonstrate that novelty indeed activates dopamine neurons, the researchers exposed mice to both new and familiar smells.

"When mice smell a novel stimulus, they get very excited and start sniffing very rapidly. This natural, spontaneous behavior provides a great readout for novelty perception," explains Dr. Cagatay Aydin, postdoc in the group of Sebastian Haesler. With the mouse experiments, the team

confirmed dopamine neurons were activated by new smells, but not by familiar ones.

In a second step, the mice were trained to associate novel and familiar smells with reward.

"When we specifically blocked dopamine activation by novel [stimuli](#) in only a few trials, learning was slowed down. On the other hand, stimulating [dopamine neurons](#) during the presentation of familiar stimuli accelerated learning," says Joachim Morrens, Ph.D. student in the group.

The value of novelty

The findings demonstrate that dopamine activation by novel stimuli promotes learning. They further provide direct experimental support for a group of theoretical frameworks in computer science, which incorporate a 'novelty bonus' to account for the beneficial effect of novelty. Incorporating such a bonus can speed up machine learning algorithms and improve their efficiency.

From a very practical perspective, the results remind us to break our routine more often and seek out novel experiences to be better learners.

More information: Morrens et al. 2020. Cue-evoked dopamine promotes conditioned responding during learning. *Neuron*, 2020.

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