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Dopamine model could play role in treating schizophrenia and drug addiction

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In the brain, dopamine is involved in a number of processes that control the way we behave. If an action results in the substance being released, we are more likely to repeat the action. This applies to actions such as eating, sexual intercourse or winning a competition. However, the same also holds true when individuals take harmful narcotics. Scientists believe that mental illnesses such as schizophrenia can be linked to dopamine imbalances.

Learning signal

If an action leads to a better response than expected, the brain will temporarily release more dopamine. If the response is worse than expected, the brain momentarily stops releasing dopamine. This mechanism is responsible for our tendency to repeat actions that have given us a high level of dopamine, and to avoid those that result in lower dopamine levels.

"That's why many see dopamine as a learning signal," according to post doctorate Jakob Kisbye Dreyer of the Department of Neuroscience and Pharmacology, University of Copenhagen, who was involved with the module's creation.

"Others have argued that it is impossible for the dopamine system to react quickly enough to be a part of our learning process. It can take a split second to learn something, but a cell that releases dopamine works slowly. If you look at a lighthouse that flashes at a slow frequency, you might not notice right away that the light was turned off. Likewise, the arguments against dopamine as an aid to learning have focused on the slow feedback time when you experience something bad, and that it is too slow for the brain to make a connection. Our model shows that the collective signal from many cells provides a rapid enough reaction to influence learning."

Mathematic approach to the brain

One of the biggest challenges faced by neurologists is that it is difficult to study active brains in living humans.

"Theoretical neuroscience can easily become very complicated," Dreyer says. "If we try to come up with complete explanations of the way the brain works, we get models that are so complex that they are difficult to test."

The dopamine model's predictions, created as part of a unique collaborative effort among physicists, mathematicians and neurobiologists, are supported by observations made in animal models.

"Different branches of natural science have surprisingly different ways of thinking," Dreyer says. "Our work – and our model – is only possible because even though I am a physicist, I have been able to conduct research at the Department of Neuroscience and Pharmacology at the Faculty of Health Sciences. As soon as we are certain that the model is correct, we can begin applying it to dopamine-related illnesses such as drug addiction and schizophrenia."

The team's dopamine model will be described in the cover article of the next issue of *Journal of Neuroscience*, to be released at on 20 October. The article was written by Jakob Dreyer, Rune Berg and Jørn Hounsgaard, all of the Department of Neuroscience and Pharmacology, together with Kjartan Herrik of Lundbeck's Department of Neurophysiology.

Provided by University of Copenhagen