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Scientists afflict computers with schizophrenia to better understand the human brain

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Computer networks that can't forget fast enough can show symptoms of a kind of virtual schizophrenia, giving researchers further clues to the inner workings of schizophrenic brains, researchers at The University of Texas at Austin and Yale University have found.

The researchers used a virtual computer model, or "neural network," to simulate the excessive release of dopamine in the brain. They found that the network recalled memories in a distinctly schizophrenic-like fashion.

Their results were published in April in Biological Psychiatry.

"The hypothesis is that dopamine encodes the importance-the salience-of experience," says Uli Grasemann, a graduate student in the Department of Computer Science at The University of Texas at Austin. "When there's too much dopamine, it leads to exaggerated salience, and the brain ends up learning from things that it shouldn't be learning from."

The results bolster a hypothesis known in schizophrenia circles as the hyperlearning hypothesis, which posits that people suffering from schizophrenia have brains that lose the ability to forget or ignore as much as they normally would. Without forgetting, they lose the ability to extract what's meaningful out of the immensity of stimuli the brain encounters. They start making connections that aren't real, or drowning in a sea of so many connections they lose the ability to stitch together

any kind of coherent story.

The neural network used by Grasemann and his adviser, Professor Risto Miikkulainen, is called DISCERN. Designed by Miikkulainen, DISCERN is able to learn natural language. In this study it was used to simulate what happens to language as the result of eight different types of neurological dysfunction. The results of the simulations were compared by Ralph Hoffman, professor of psychiatry at the Yale School of Medicine, to what he saw when studying human schizophrenics.

In order to model the process, Grasemann and Miikkulainen began by teaching a series of simple stories to DISCERN. The stories were assimilated into DISCERN's memory in much the way the human brain stores information-not as distinct units, but as statistical relationships of words, sentences, scripts and stories.

"With neural networks, you basically train them by showing them examples, over and over and over again," says Grasemann. "Every time you show it an example, you say, if this is the input, then this should be your output, and if this is the input, then that should be your output. You do it again and again thousands of times, and every time it adjusts a little bit more towards doing what you want. In the end, if you do it enough, the network has learned."

In order to model hyperlearning, Grasemann and Miikkulainen ran the system through its paces again, but with one key parameter altered. They simulated an excessive release of dopamine by increasing the system's learning rate-essentially telling it to stop forgetting so much.

"It's an important mechanism to be able to ignore things," says Grasemann. "What we found is that if you crank up the learning rate in DISCERN high enough, it produces language abnormalities that suggest schizophrenia."

After being re-trained with the elevated learning rate, DISCERN began putting itself at the center of fantastical, delusional stories that incorporated elements from other stories it had been told to recall. In one answer, for instance, DISCERN claimed responsibility for a terrorist bombing.

In another instance, DISCERN began showing evidence of "derailment"-replying to requests for a specific memory with a jumble of dissociated sentences, abrupt digressions and constant leaps from the first- to the third-person and back again.

"Information processing in neural networks tends to be like information processing in the human brain in many ways," says Grasemann. "So the hope was that it would also break down in similar ways. And it did."

The parallel between their modified neural network and human schizophrenia isn't absolute proof the hyperlearning hypothesis is correct, says Grasemann. It is, however, support for the hypothesis, and also evidence of how useful neural networks can be in understanding the human brain.

"We have so much more control over neural networks than we could ever have over human subjects," he says. "The hope is that this kind of modeling will help clinical research."

Provided by University of Texas at Austin