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How are pronouns processed in the memory-region of our brain?

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Source: Netherlands Institute for Neuroscience - KNAW

Summary: A new study shows how individual brain cells in the hippocampus respond to pronouns. 'This may help us unravel how we remember what we read.'

FULL STORY

Read the following sentence: "Donald Trump and Kamala Harris walked into the bar, she sat down at a table." We all immediately know that it was Kamala who sat at the table, not Donald. Pronouns like "she" help us to understand language, but pronouns can have multiple meanings. Depending on the context, we understand who the pronoun is referring to. But how is it that we are so good at this, and how does our brain link pronouns with their nouns?

To answer this question, an international team of neuroscientists, neurosurgeons, and neurologists joined forces. Doris Dijksterhuis and Matthew Self from Pieter Roelfsema's group looked together with their colleagues at the brain activity of patients with epilepsy. As part of their treatment, these patients were implanted with depth electrodes in their hippocampus, a brain area involved in learning and memory. The research team took advantage of this and conducted additional tests with them.

"We can measure the activity of individual brain cells in the hippocampus while the patient performs a task," says Matthew Self. In the hippocampus, there are cells that respond to a specific person, so-called "concept cells." A well-known example is the "Jennifer Aniston cell," which becomes active when you see a photo of Jennifer Aniston, hear her name or read the words "Jennifer Aniston." We wondered if these cells also become active when you only read a pronoun, like 'he' or 'she'. Are these cells able to link the pronoun to the right person?

Shrek cell

Doris Dijksterhuis: "To test this, we first showed the patients many photos until we found a cell that responded to one particular image. For example, we found a cell that responded to an image of 'Shrek' but not to other images. We call this cell a 'Shrek concept cell'. When patients later read a sentence like: "Shrek and Fiona were having dinner. He poured out some wine." the 'Shrek' cell indeed responded to the word "Shrek," but also to the pronoun 'He.' This is interesting because such a pronoun can mean something entirely different in another sentence. For example, in the sentence 'Donald Trump and Kamala Harris were having dinner. He poured out some wine,' the same pronoun, 'He', refers to Donald Trump, and therefore the Shrek cell will not react. Individual hippocampal cells track who the pronoun refers to in a dynamic, flexible way."

Self: "We had the participants answer a question at the end of the sentences about who performed the action. We could predict whether the patients would give the correct answer based on the activity of the individual concept cells. To make it a bit more challenging, we also added some trick questions, with two people of the same gender: "Jennifer Aniston and Kamala Harris walked into a bar. She sat at the table." The patient had to decide themselves who performed the action. We observed that patients tended to choose the person that evoked the most activity in the hippocampus at the start of the sentence. This could be based on chance fluctuations in activity on a trial-by-trial basis or an internal preference for one of the two characters in the sentence."

The bigger picture

Dijksterhuis: "The hippocampus is important for learning and memory, but it remains unclear how the hippocampus is involved in the interaction between memory and language. How do we remember what we've read? When you think of something you've read, you have different concepts that together create the story. Pronouns help us to understand who did what in the story and cells in the hippocampus encode these actions into our memory. Ultimately, we want to know how an entire memory is formed and represented in the brain."

"It is of great value that this group of patients has given their permission to participate in our research. We can only very rarely measure the activity of single brain cells in people who are reading and it is impossible to study these processes in animals. When we get the chance, we try to get as much out of it as possible."

Source: *Science*

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Materials provided by **Netherlands Institute for Neuroscience - KNAW**. *Note: Content may be edited for style and length.*

Journal Reference:

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