Celebrity photos helped to uncover how memories are formed in the brain

July 2 2015, by Rodrigo Quian Quiroga

Memorable man. Josh Brolin has done his bit for science. Credit: Siebbi/wikimedia, CC BY-SA

In the science fiction movie Inception, Leonardo Di Caprio and his gang

set out to implant specific memories into individuals' brains in order to pull off the perfect crime. But in the real world of science implanting memories is actually quite easy – the challenge is tracking the brain cells involved in the process. Our research has now started to unveil some of the basic mechanisms of how new memories are encoded in the brain, simply using selfies to implant the memories.

Obstacles to reading the mind

For centuries, philosopher Rene Descartes inspired other thinkers with his famous thesis that mind and body are two separate entities. Today, however, most neuroscientists hold a "materialistic" view of the mind in relationship to the brain: the "mind" is the activity of neurons, as electricity is the movement of electrons or temperature the kinetic energy of molecules.

So, if the mind is nothing more than the firing of neurons, we should be able to alter their activity to influence behaviour. Or conversely, we should be able to alter behaviour – like implanting a memory or a thought – and track down how this is matched by changes in the firing of neurons.

So how do we go about implanting a memory? We just need to give subjects some new, memorable information, like telling them, for example, that a specific person has been seen at a specific place. The more salient and relevant the memory, the more it will be rehearsed and consolidated, and the longer it will last. However, incepting memories is one thing, tracking the firing of the neurons encoding them is another. In fact, it involves implanting electrodes in the brain, something that is in principle out of the question for humans.

There are, however, very special occasions when this procedure is done. One example is in patients suffering from epilepsy that cannot be

controlled with medication. These patients have electrodes implanted in the brain that can record information to delineate the area starting the epileptic seizures to eventually be taken out surgically. This procedure is quite successful – in many cases stopping or largely reducing the number of seizures – and it gives neuroscientists the incredible opportunity to study the firing of neurons in awake humans.

Known to get some brain cells firing. Credit: Andres Useche/wikimedia, CC BY

The Jennifer Aniston neuron

Using these type of recordings, we have previously shown that there are

neurons in the human brain that represent specific concepts, like a person, an animal or a place. Researchers in the field sometimes refer to these as Jennifer Aniston neurons, because the first of these neurons we identified fired to seven different pictures of Jennifer Aniston but not to any other pictures of actors, persons or places. Later on we found another one that fired only to different pictures of Halle Berry and even to her name written in the computer screen, and yet another one that fired selectively to different pictures of Oprah Winfrey and her name on the screen, and so on.

In the last few years, we have shown different aspects of how these neurons encode information in a very abstract, conceptual way. The cells are located in the hippocampus and its surrounding cortex, an area that has been linked to memory processes – patients with hippocampal lesions lose their ability to form new memories (as Leonard, the main character in the film Memento).

It makes sense that we have neurons encoding concepts in the memory-related areas of the brain, given that we tend to remember specific concepts and links between them. For example, if you remember meeting a friend at the pub, you probably forget myriads of irrelevant details like the clothes your friend was wearing and the exact time he or she showed up. This is because remembering too many details would distract us from processing the essential information to elaborate thoughts.

However, you are likely to remember the concept of meeting your friend X and talking about Y. For these reasons, we view these neurons as the "building blocks of memory". They are a representation of concepts that we link to each other in specific ways to form and recall memories. But how this is done?

The selfie solution

Who could ever forget seeing this image? Credit: Matias Ison, University of Leicester

The experiment started with the assumption that some of the neurons initially firing to a certain concept would also start firing to a related one, once the subject had made an association between the two.

To test this, we started by creating composite images resembling a "selfie" of a specific person in a specific place. The person/place pairs were carefully chosen so that the studied neurons initially fired either to the person or the place but not to both.

The striking result was that, seeing these images, the neurons started firing to the associated concepts at the exact moment the subjects learned the associations. For example, a neuron that originally fired to actor Josh Brolin but not to the Eiffel Tower, started firing to the Eiffel Tower from the moment the subject remembered that Josh Brolin was there.

These types of associations are the skeletons of how we construct our memories – meeting a person in a place, having a chat about a specific topic, drinking a glass of red wine, and so on. Our team has now shown how these memories, these specific associations, are encoded by neurons in memory-related areas. In humans, we still can't selectively activate sets of neurons to incept specific memories, but we are starting to disclose the basic mechanisms of how new memories are encoded.

Source: The Conversation