Decoding touch

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With their whiskers rats can detect the texture of objects in the same way as humans do using their fingertips. A study, in which some scientists of SISSA have taken part, shows that it is possible to understand what specific object has been touched by a rat by observing the activation of brain neurons. A further step towards understanding how the brain, also in humans, represents the outside world.

We know the world through the sensory representations within our brain.

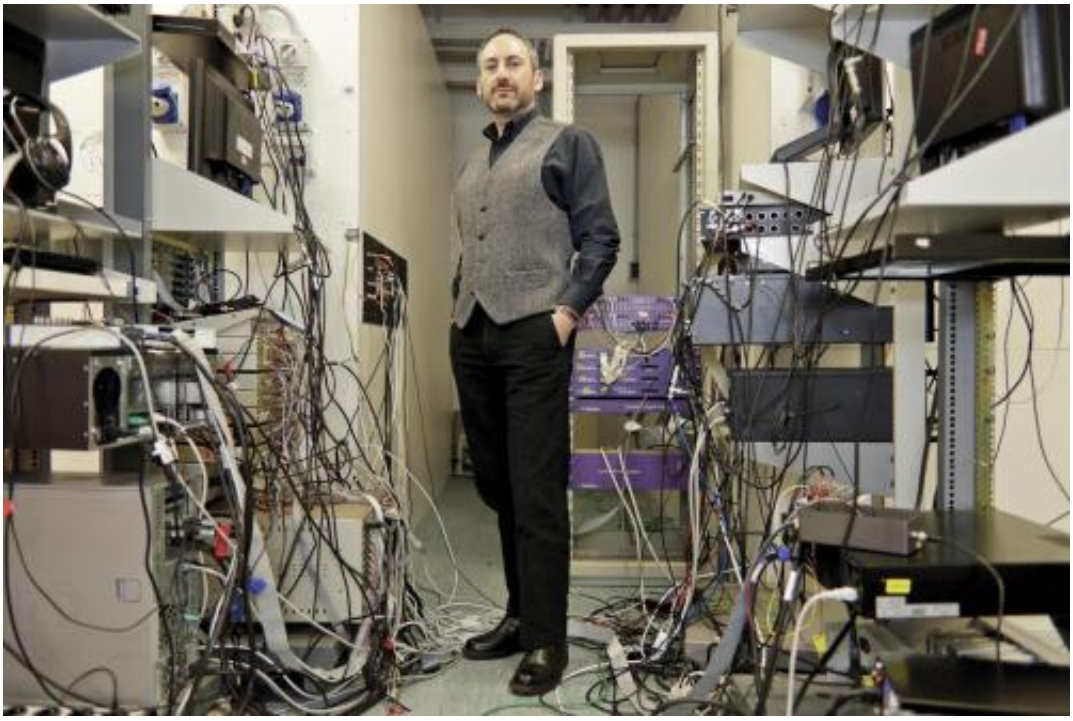
Such "reconstruction" is performed through the electrical activation of neural cells, the code that contains the information that is constantly processed by the brain. If we wish to understand what are the rules followed by the representation of the world inside the brain we have to comprehend how electrical activation is linked to the sensory experience. For this reason, a team of researchers including Mathew Diamond, Houman Safaai and Moritz von Heimendahl of the International School for Advanced Studies (SISSA) of Trieste have analyzed the behavior and the activation of neural networks in rats while they were carrying out tactile object recognition tests.

During the experiments researchers observed the performance of rats – the animals were discriminating one texture from another – along with the activation of a group of sensory neurons. "For the first time the study has monitored the activity of multiple neurons, while until now, due to technical limitations, researchers had examined only individual neurons," explains Diamond, who heads up the Tactile Perception and Learning Lab at SISSA. "The activity of such groups of neurons is represented in our model as multi-dimensional clouds, comprising as many dimensions as the number of cells under examination (up to ten). We have observed a different cloud for the contact with each different texture."

By analyzing the "clouds", Diamond and his colleagues were able to successfully decode the object contacted by the rodent. "Our method is so accurate that when the rat would mistake one object for another, the decoding would also indicate a different object from the one actually touched. And this happened because the representation made by the brain – and, as a consequence, our decoding – appeared like that of a different object. Hence the error."

Diamond's team has no intention of stopping here. "In real life, we generally recognize objects using more senses all together, in an integrated manner. We use touch and sight at the same time, for

instance," explains Diamond. "For this reason we are now working on new experiments employing more neurons, with more complicated stimuli, and more senses, to build 'multimodal' representations of objects."



Mathew Diamond.

More in detail...

This kind of "mind reading" carried out on rats' brain by Diamond and his colleagues is important to understand how the brain forms a representation of the world. "Each one of us perceives a physical world outside ourselves, yet actually all we have at our disposal to create an experience of the world is the representation that our brain makes of it through the input of sensory organs" says Diamond.

To understand that such a representation is at the very least partial it is enough to think of all the information about the world that escapes us all the time: for instance, we are blind to infrared and ultraviolet rays, we are unable to hear certain sound frequencies or smell some chemical substances or others. Some details pertaining to the physical world are completely invisible or, to put it better, imperceptible (others are interpreted incorrectly, like visual illusions, for example.)

This is a further demonstration that what we perceive is not the physical world in itself, but the neuronal activation the world evokes inside our brain.

More information: Houman Safaai, Moritz von Heimendahl, Jose M. Sorando, Mathew E. Diamond, and Miguel Maravall, Coordinated Population Activity Underlying Texture Discrimination in Rat Barrel Cortex, *The Journal of Neuroscience*, 27 March 2013, 33(13): 5843-5855; doi: 10.1523/JNEUROSCI.3486-12.2013