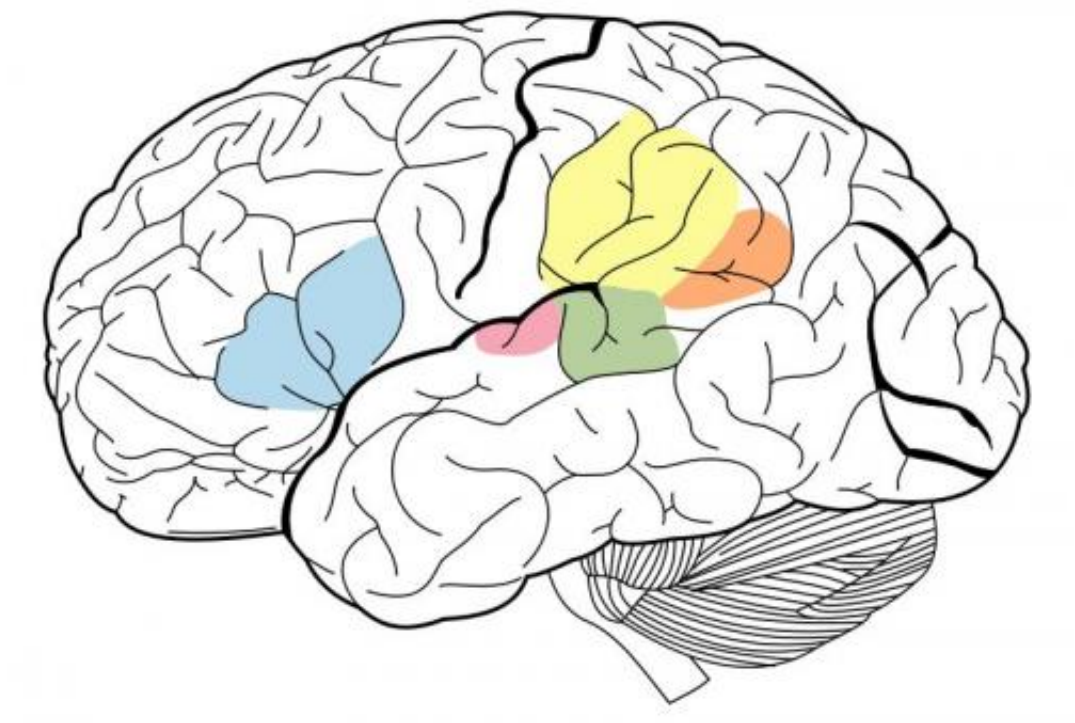
The brain predicts words before they are pronounced

September 18 2018



The Primary Auditory Cortex is highlighted in magenta, and has been known to interact with all areas highlighted on this neural map. Credit: Wikipedia.

The brain is not only able to finish the sentences of others: A study by the Basque research centre BCBL has shown for the first time that it can also anticipate an auditory stimulus and determine the phonemes and specific words the speaker is going to pronounce.

Prediction is one of the main neuro-cognitive mechanisms of the brain. Every millisecond, the brain tries to actively anticipate what will happen next depending on the knowledge it has of its environment.

In recent years, many research studies have been launched to understand the phenomenon of prediction in depth, but little was known until now about the role played by this phenomenon in the understanding of language.

Now, a study carried out by the Basque Center on Cognition, Brain and Language (BCBL), goes a step further in its knowledge. The results have recently been published in the journal *Scientific Reports*.

So far, multiple experiments have shown that the brain is able to anticipate the information it will hear and know exactly what the speaker is going to talk about.

However, this work describes for the first time that the complex machinery of the brain is able to estimate even what specific words it will hear before they are spoken.

The main target was to check how the auditory system acts in the phenomenon of prediction. Thus, the brain can estimate when a word is going to start, which phonemes will be the first ones to be heard and pre-activate the auditory system to actively anticipate the stimulus that will impact the ear.

The researchers from the centre in San Sebastian used magnetoencephalography (MEG) studies—a non-invasive method for recording brain activity—to detail what mechanisms the brain uses and what neural networks it activates in order to predict what it is going to hear.

"The perspective on how our brain works is changing; we are beginning to give much more weight to the predictive component. The brain is always trying to estimate what the future will be like, when the future has not yet arrived," explains Nicola Molinaro, researcher at the BCBL.

Forty-seven volunteers were shown images on a screen and then listened to the word associated with the photograph. Before the appearance of the auditory stimulus, the researchers identified brain activity in the primary auditory cortex, the region of the brain responsible for the processing of auditory information.

"This is more than clear evidence that the auditory regions do not passively respond to the stimulus that impacts on our ear, but actually predict something in advance," Molinaro says.

The experts could see that one second after seeing the image, the auditory regions began to exhibit brain activity in a different way depending on the physical properties of the words they were going to hear next.

According to the authors, the brain knows exactly what the physical form of the word it is going to hear will be like, even before it is pronounced. In the case of the occlusive phonemes, the brain oscillations began to work with much more energy approximately one second before listening to the auditory stimulus.

"We have found clear evidence that the neuronal system can predict the form of a word before it appears," says the expert.

Knowing better how the brain works in this sense could help to develop more effective treatments for certain disorders that are related to brain prediction. "Many disorders have to do with failures of the predictive system, such as autism, in which children have problems predicting the

future and, therefore, fail to extract regularities about how the environment is working," says Molinaro.

"In the case of linguistic disorders such as dyslexia, if the brain could synchronize better with the sound waves it hears, the phonological problem dyslexics suffer from could be alleviated," he concludes.

More information: Irene F. Monsalve et al. Theta oscillations mediate pre-activation of highly expected word initial phonemes, *Scientific Reports* (2018). DOI: 10.1038/s41598-018-27898-w

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