Can You Read My Mind?

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The W.M. Keck Foundation has awarded Carnegie Mellon University a $750,000 grant to support research into how the human brain deciphers language, which could one day yield advances in the treatment of neurological disorders such as autism and dyslexia.
This multidisciplinary research is being conducted by Marcel Just, the D.O. Hebb Professor of Psychology, and Tom Mitchell, the Edward Fredkin Professor of Artificial Intelligence and Learning in the School of Computer Science. Using computer models to interpret the results of functional Magnetic Resonance Imaging (fMRI) brain scans, the researchers plan to develop a computational theory that describes the changes in brain activity over time during language comprehension and makes predictions about the subprocesses involved in word and sentence comprehension.

They also will demonstrate how reading different words and sentences will produce variations in brain activity and how dysfunctions in specific brain regions influence the function of the entire brain system.

In addition to this Keck Foundation grant, Mitchell and Just have received funding from the National Science Foundation for related studies, for a total of $1 million.

"If successful, our research will result in a significant advance in the scientific understanding of brain function during language processing. Such an understanding will have a major impact on the study of brain disorders involving language comprehension," Just said.

An fMRI study measures brain activity in each part of the brain over a specific duration of time. The process generates a massive amount of data—a single scan measures the activity level in about 20,000 voxels (3-D pixels) once every second. Each voxel is about the size of a peppercorn. So Just and Mitchell use data mining and statistical machine software to detect subtle patterns. They already have developed computer algorithms for analyzing fMRI scans that can distinguish which category of words a person is reading about (for example, a list of buildings versus a list of tools) by detecting subtle variations in brain activity. They also have created a computational model that can predict what brain activity will occur when a person reads a sentence.

"We can train our machine learning programs by showing them activity from one person's brain. It looks at other activity from the same brain and it can tell with 90 percent accuracy whether it's looking at a picture or reading a sentence. It can discriminate between words about different semantic and grammatical content, such as buildings versus tools, nouns versus verbs," Mitchell said.

While they trained their software, the researchers had focused on nouns. They now will turn their attention to nouns and verbs in combination to determine how different parts of the brain are activated to comprehend verb phrases and sentences.