Medical Xpress

Finding the seat of language? Researchers look into Broca's brain

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This sandwiched image of two X-rays shows electrodes that surgeons use to find and remove the source of seizures (to cure epilepsy), while sparing the source of mental functions like language. Composite illustration Ned T. Sahin/Department of Psychology

(PhysOrg.com) -- A team of Harvard and University of California, San Diego, researchers report having pinpointed an area of the brain where three essential components of language -- word identification, grammar, and word pronunciation -- are processed.

Ned T. Sahin, a postdoctoral fellow in both Harvard's Psychology

Department and UCSD's Radiology Department, and colleagues at both schools, have used a technique called intracranial electrophysiology (ICE) to gain access, with unprecedented precision, to Broca's area, a region of the cerebral cortex long-suspected to be the seat of language.

Their results are reported in the journal *Science*.

In the ICE method, "direct recordings of brain signals are made using electrodes placed inside the human brain, allowing extremely high spatial, temporal, and physiological resolution, concurrently," says Sahin. For years, neurobiologists had lacked the techniques to pinpoint the areas of the brain responsible for language processing.

Because there are no animal models for human language processing and because it would be ethically unacceptable to insert electrodes into the brains of healthy human subjects, scientists have up to now been stymied in their attempts to locate the precise area of the brain responsible for processing the various components of language.

Sahin and his colleagues have done their ICE studies using patient volunteers who were undergoing neurosurgery for epilepsy.

"What captures my interest is being able to record what sets of brain cells are saying to each other while the person [in whose brain the cells reside] is saying something to me. It's amazing," Sahin says. He points out, however, that it is not yet possible to interpret what the brain cells are saying. Sahin likens the difficulty to that of a French-speaking child listening to a conversation in Greek. "He knows something important is being communicated, but he just can't unlock it yet."

Sahin and his team listened to signals from the "forest of neurons" required to compute language as they came "yelling and screaming down" electrodes that passed through or near Broca's area of the brain.

Each electrode recorded input from a collection of about 10,000 cells. Careful analysis of the brain signals allows the researchers to determine which signals come from the local area as opposed to echoes from signals originating elsewhere.

With the electrodes in place, the researchers asked patients to read a word on a laptop computer screen while they are in their hospital beds and connected to the recording computers. Words like “come” are first read, then used to complete a sentence like “Yesterday they _____.” In this case, the participants would need to supply the word “came.” "Subjects do not speak out loud, but rather think the word to themselves, then press a button to signal completion," Sahin says.

Sahin’s task requires the patients to recognize both frequent and infrequent words, to find the appropriate tense of a verb or plural/singular form of a noun, and to change or retain the pronunciation of the base form of the word (as presented). Patients repeat the exercises in different combinations. "If the word is ‘house,’ for instance, and the sentence requires the plural form, a patient's brain must compute the abstract concept we call plural, and additionally must prepare and articulate the added syllable for the ‘-es’ ending," Sahin explains. The idea, he says, is to get a person to either repeat the words they see verbatim, or make a transformation to use them properly in context.

Within a fifth of a second, information about the word's identity arrives at the patient's Broca's area, Sahin and colleagues reported.

The experiment has yielded evidence that language processing takes place in a small part of Broca's area as a sequence of three different stages, each ending before the next one begins. All three are necessary in order to complete a simple task such as looking at a word and uttering it, though there may be other stages beyond these three. "We found a tightly timed sequence of brain activity associated with aspects of

identifying the word, grammatically transforming it into the right form for the context, and then preparing to pronounce the final sound form," Sahin explains.

Provided by Harvard University (news : web)