Researchers develop new software to advance brain image research

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A University of Colorado Boulder research team has developed a new software program allowing neuroscientists to produce single brain images pulled from hundreds of individual studies, trimming weeks and even months from what can be a tedious, time-consuming research process.

The development of noninvasive neuroimaging techniques such as functional magnetic resonance imaging, or fMRI, spurred a huge amount of scientific research and led to substantial advances in the understanding of the human brain and cognitive function. However, instead of having too little data, researchers are besieged with too much, according to Tal Yarkoni, a postdoctoral fellow in CU-Boulder's psychology and neuroscience department.

The new software developed by Yarkoni and his colleagues can be programmed to comb scientific literature for published articles relevant to a particular topic, and then to extract all of the brain scan images from those articles. Using a statistical process called "meta-analysis," researchers are then able to produce a consensus "brain activation image" reflecting hundreds of studies at a time.

"Because the new approach is entirely automated, it can analyze hundreds of different experimental tasks or mental states nearly instantaneously instead of requiring researchers to spend weeks or months conducting just one analysis," said Yarkoni.

Yarkoni is the lead author on a paper introducing the new approach to analyzing brain imaging data that appears in the June 26 edition of the journal *Nature Methods*. Russell Poldrack of the University of Texas at Austin, Thomas Nichols of the University of Warwick in England, David Van Essen of Washington University in St. Louis and Tor Wager of CU-Boulder contributed to the paper.

Brain scanning techniques such as fMRI have revolutionized scientists' understanding of the human mind by allowing researchers to peer deep into people's brains as they engage in mental activities as diverse as reciting numbers, making financial decisions or simply daydreaming. But interpreting the results of brain imaging studies is often more difficult, according to Yarkoni.

"There's often the perception that what we're doing when we scan someone's brain is literally seeing their thoughts and feelings in action, but it's actually much more complicated," Yarkoni said. "The colorful images we see are really just estimates, because each study gives us a somewhat different picture. It's only by combining the results of many different studies that we get a really clear picture of what's going on."

The ability to look at many different mental states simultaneously allows researchers to ask interesting new questions. For instance, researchers can pick out a specific brain region they're interested in and determine which mental states are most likely to produce activation in that region, he said. Or they can calculate how likely a person is to be performing a particular task given their pattern of brain activity.

In their study, the research team was able to distinguish people who were experiencing physical pain during brain scanning from people who were performing a difficult memory task or viewing emotional pictures with nearly 80 percent accuracy. The team expects performance levels to improve as their software develops, and believes their tools will improve

researchers' ability to decode mental states from brain activity.

"We don't expect to be able to tell what people are thinking or feeling at a very detailed level," Yarkoni said. "But we think we'll be able to distinguish relatively broad mental states from one another. And we're hopeful that might even eventually extend to mental health disorders, so that these tools will be useful for clinical diagnosis."

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