FAST MOVING FRONTS - 2009

November 2009

PDF

Christian C. Ruff talks with *ScienceWatch.com* and answers a few questions about this month's Fast Moving Front in the field of Neuroscience & Behavior.

Article: Concurrent TMS-fMRI and psychophysics reveal frontal influences on human retinotopic visual cortex
Authors: Ruff, CC;Blankenburg, F;Bjoertomt, O;Bestmann, S;Freeman, E;Haynes, JD;Rees, G;Josephs, O;Deichmann, R;Driver, J
Journal: CURR BIOL, 16 (15): 1479-1488 AUG 8 2006
Addresses: Univ Coll London, Inst Cognit Neurosci, 17 Queen Sq, London WC1N 3AR, England.
Univ Coll London, Inst Cognit Neurosci, London WC1N 3AR, England.
Univ Coll London, Dept Psychol, London WC1H 0AP, England.
Univ Coll London, Wellcome Dept Imaging Neurosci, London WC1N 3BG, England.
Univ Coll London, Sobell Dept Motor Neurosci & Movement Disorders, London WC1N 3BG, England.
Max Planck Inst Human Cognit & Brain Sci, D-04103 Leipzig, Germany.

SW: Why do you think your paper is highly cited?

I work in the field of human cognitive neuroscience, the discipline that studies how brain processes give rise to what we see, think, feel, and do. Many studies in this field have focused on the function of single brain areas, by studying regionally specific brain activity changes while participants engage in a cognitive task. Our paper extended this general approach in two ways.

First, our study demonstrated that it is not just activation of one area, but rather communication between different areas of the human brain that can bring about a specific mental state—in our case, visual perception. This general notion has always been discussed in the literature, but had rarely been shown directly before.

Second, our study may have gathered interest because it brought causality into human neuroimaging research. Many previous studies demonstrated that particular forms of brain activity correlate with a mental function, but could not show that such activity is indeed causally necessary.

In our study, we combined neuroimaging with a method to stimulate neurons in the human brain. This strategy enabled us to show directly that (stimulation-induced) neural activity in a region in the frontal part of the human brain can change visual processing in interconnected posterior visual brain regions, and influence the associated visual percept. I think our study is highly cited as many readers recognize the explanatory power of this causal approach to brain-behavior relationships.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

It both describes a new discovery and illustrates a novel methodology. Conceptually, our main question was whether visual cortex function can be influenced by regions outside the parts of the brain traditionally thought to be "visual." To show this, we had to devise a way to induce neural activity in such regions while simultaneously measuring the impact of this on neural activity in remote but interconnected visual cortex.

"Our ultimate aim is to understand how brain processes support thought and behavior."

The appropriate technique turned out to be transcranial magnetic stimulation (TMS, a non-invasive method to stimulate circumscribed brain areas, which is often used therapeutically) combined concurrently with functional magnetic resonance imaging (fMRI, which can measure neural activity via oxygen consumption).

This methodical combination is quite complicated and had not been used before for the same purpose, so our paper described and discussed both our specific experimental findings as well as the necessary methodical developments. I think our paper was thus received by the field not only as a new finding on brain function, but also as a "proof-of-concept" for the general experimental approach.

SW: Would you summarize the significance of your paper in layman's terms?

Neuroscientists usually study human brain function by measuring neural activity while participants perform experimental tasks. This approach has identified many brain areas that seem to specifically activate during different aspects of perception, thought, or behavior. However, what is unclear from such findings is whether the observed neural activity is causally responsible for the mental state, and to what degree the activated brain regions interact.

In our study, we were interested in whether visual perception may involve communication between a specific region in the frontal part of the brain—called the frontal eye fields—and posterior brain regions involved in processing visual input. We addressed this question by stimulating the frontal eye fields while simultaneously measuring the activity in the posterior visual brain regions.

We found that frontal stimulation indeed changed neural activity in visual cortex and the associated perception. This finding is important, as it demonstrates directly that functional interactions between different areas of an interconnected brain network can cause a specific mental state. Our study also generally outlines how the combination of brain stimulation and brain imaging can allow neuroscientists to investigate functional interactions in the human brain and their relation to cognition and behavior.

SW: How did you become involved in this research and were any particular problems encountered along the way?

"In our study, we combined neuroimaging with a method to stimulate neurons in the human brain."

I started this research in London in 2003, when working in Jon Driver's laboratory on the neural processes underlying the control of visual attention—Jon Driver is Director of the Institute of Cognitive Neuroscience at UCL.

At that time, many people proposed that attention involves influences of frontal and parietal brain regions on visual cortex, but direct empirical demonstrations for this were lacking for the human brain. So I decided to work on this general topic with a combination of brain stimulation and neuroimaging.

In the beginning, I sometimes cursed myself for having chosen this path, as the technical complications of concurrent TMS-fMRI were tremendous, and many datasets turned out to be unusable due to artifacts or other technical problems. Fortunately Jon Driver was always very supportive and encouraging, and I am very grateful to him for that.

Moreover, I was lucky that there were other people (the co-authors on my studies) in the lab and at UCL's Functional Imaging Laboratory who were also interested in setting up this technique, although for somewhat different purposes. We could tackle many problems together; this made life easier and more fun, for which I also want to thank them.

In the end, the risk and effort paid off, and based on our initial work, we continue to acquire new datasets on causal functional interactions in the human brain.

SW: Where do you see your research leading in the future?

Our ultimate aim is to understand how brain processes support thought and behavior. The approach of combined brain stimulation and imaging allows direct study of a new aspect of this relationship, namely the functional contributions of communication between remote but interconnected brain areas.

I hope we can use this approach to characterize the communication in brain networks underlying many other aspects of human mental activity—such as decision-making. It would also be interesting to see how these functional brain interactions may account for individual differences, and possibly for pathological disorders of thought and behavior—such as depression.

SW: Do you foresee any social or political implications for your research?

Many people advocate that a better understanding of the neurobiological basis of cognition and behavior will be essential for improving many aspects of our society, including the legal system, education, the structure of financial markets, and so forth. I would generally agree with this position, but I do not think that we are already at a stage where we can give specific recommendations that could be put into practice.

The one domain where I already see clear implications of our research is for medical purposes. Brain stimulation methods are being increasingly used for treating depression, stroke, and other brain disorders, and the combination with neuroimaging, as implemented in our studies, can help clinicians to devise effective treatment protocols for their patients.

Christian C. Ruff, Ph.D.
Assistant Professor
Laboratory for Social and Neural Systems Research
University of Zurich
Zurich, Switzerland
and
Honorary Senior Lecturer
Institute of Neurology
University College London
London, UK

KEYWORDS: TRANSCRANIAL MAGNETIC STIMULATION; EYE FIELDS; FUNCTIONAL MRI; SPATIAL ATTENTION; DIRECTED ATTENTION; PREFRONTAL CORTEX; NEURAL MECHANISMS; BRAIN ACTIVITY; MOTOR CORTEX; SIGNALS.

PDF

back to top

2009 : November 2009 - Fast Moving Fronts : Christian Ruff on Transcranial Magnetic Stimulation

Science Home | About Thomson Reuters | Site Search