The use of “neuroscience” in the courtroom has had a lot of exposure recently. As reported in the last newsletter, a woman in India was convicted of a murder last year based on evidence obtained from a “Brain Electrical Oscillations Signature” (BEOS) test. This test claims to use patterns of brain activation to determine whether or not a person has experiential knowledge of a particular set of alleged facts or circumstances surrounding a crime. We also recently learned that neuroscience lie detection using fMRI is beginning to make its way into courtrooms in the United States. This past month (March 2009), No Lie MRI produced a report that, although eventually withdrawn, was offered as evidence in a court in Southern California. It is likely that increasingly more attorneys will be asking judges in the future to allow the introduction of neuroscience evidence into the courtroom. These examples indicate the timeliness of our work, and how critical it is in shaping, commenting upon, and analyzing these trends and future developments.

I am pleased to report that the co-directors of the Project have approved seventeen innovative research projects, and that they are currently underway. For example, one research group is conducting brain scans of individuals in the prison population to investigate the possible neural underpinnings of criminal behavior. Other group members have commenced an exciting project to validate whether new tools of brain imaging analysis may hold promise in accurate detection of brain states (relevant to the topic of lie detection). Other research teams are using fMRI to investigate the way judges make decisions about guilt (or innocence) and sentencing. We have projects examining implicit juror bias, the effects of early prefrontal cortex damage, and drug addiction and the law. Finally, we are in the process of collecting information about the use of neuroscience imaging evidence in California criminal trials in the last several years, and are building an online tool to examine the impact of neuroscience evidence on jurors. We hope to translate our research into these and other topics as we progress into papers and reports that will help inform the law and other researchers.

Also of note, the MacArthur Law and Neuroscience Project recently sponsored a two-day seminar entitled “Psychopathy and the Law,” which featured several prominent speakers who discussed intersections between legal issues and psychopathy (definitions and conceptualizations of psychopathy, causes, and neuroscience with implications for the law). The symposium, which was held immediately prior to the annual Society for the Scientific Study of Psychopathy, was extremely well-attended and received.

Other aspects of the Project continue to shape and inform public policy and the judicial system. In collaboration with the Gruter Institute, we have sponsored four highly successful educational outreach programs for judges and jurors, and plan to hold another one in June in Nashville, TN. Finally, we look forward to our annual meeting coming up in May, to be held in Santa Barbara. This meeting will provide an opportunity for us to learn from each other about the research now underway and to plan for further progress this summer and fall, about which we look forward to keeping you informed.

Michael Gazzaniga
Director
The notion of lie detection is by no means novel. For as long as humans have been able to obscure the truth, humans have been attempting to uncover it. Ancient methods of lie detection bring to mind hoary images of people being thrown into bodies of water, with a verdict of guilt or innocence assessed by whether the subject under interrogation sank or floated (an “innocent” person accepted by the sanctity of the waters was pulled down and drowned, leaving one to ponder the irony of this double-jeopardy situation).

As neuroscience techniques become more refined, it is likely that the neural correlates of complex behaviors will be uncovered, demystifying the inner workings of the brain and its functional output. Some of the largest strides in advancing our knowledge of human cognition and higher-order functions have been accomplished with functional magnetic resonance imaging (fMRI), a powerful brain imaging technique that enables inferences about brain activity based on blood flow to specific areas of the brain. Not yet two decades old, fMRI has come to dominate the field of functional brain mapping, and has been particularly useful for measuring cognitive function in humans due to its relatively good spatial resolution. In fact, a search for nearly any emotion or cognitive state yields at least one empirical study utilizing fMRI. From a legal perspective, if the technique were to pass standards of admissibility for use in the courtroom, it could conceivably be used to interrogate the brains of suspected criminals or witnesses for neural evidence that they recognize certain elements from a crime scene.

Although the idea of courtroom “brain evidence” might seem like a pilot episode of a show on primetime television, the idea is not without precedent. Currently, electroencephalography (EEG)-based methods of memory detection have created a controversy, particularly since less than a year ago, a court in India convicted a young husband and wife of murder based in large part on supposedly inculpating patterns of brain wave data from a test to which the wife submitted. Many experts in the field argue that EEG-based memory detection techniques lack the thorough empirical testing that is required for validation of any tool or measure used in the courtroom (discussed in the Winter 2009 issue of the Project’s newsletter). A growing group of veteran thinkers on topics of neuroscience and the law caution that although fMRI holds much promise, like its rough-hewn sibling, the technological advantages that it offers at this point are still too preliminary for courtroom introduction. In spite of these concerns, the prospect of using brain imaging technologies to identify a neural marker that reliably indicates whether or not an individual has previously encountered a particular stimulus has generated much interest in both neuroscientific and legal communities.

In anticipation of the emergence of fMRI memory detection as a method in need of critical scientific appraisal, Professors Anthony Wagner and Hank Greely of Stanford University have teamed up on a MacArthur Law and Neuroscience Project-funded proposal to empirically evaluate an fMRI-based approach to memory detection. Specifically, they aim (with Dr. Jesse Rissman, a post-doctoral researcher in Dr. Wagner’s lab) to test whether new advances in fMRI data analysis techniques (multivoxel pattern analysis, or MVPA) can reliably detect the presence or absence of memory traces for individual stimuli (in this case, human faces). Application of state-of-the-art fMRI pattern classification methods holds promise for memory detection. A well-trained classifier may be able to reliably differentiate between patterns of brain activation that are elicited when a person views stimuli that are either familiar or unfamiliar. A logical question is whether these classification tools may one day be admitted as evidence to be used in courtroom determinations by judges and juries. Professors Wagner and Greely weigh in:

Could you talk a bit about what it is that this project has been funded to investigate and your roles in this project?
A multi-phase study funded by the MacArthur Law and Neuroscience Project will dig deeper into the question of whether and to what extent functional brain imaging might impair jurors’ reasoning, such as by biasing them to give the functional image too much weight. This research project is being led by Legal Decision Making network member Michael Saks, with help from Nick Schweitzer, Emily Murphy, Walter Sinnott-Armstrong, Jay Hull, Adina Roskies, Teneille Brown and others.

While empirical data on any prejudicial effect will certainly be useful in informing the law and conducting the FRE 403 analysis, the law does not require that there be extensive empirical research on this topic before it can be decided. FRE 403 and its state counterparts merely require that the probative value be substantially outweighed by the potential for prejudice, potential that can be demonstrated by common sense arguments and analogy to other types of prejudicial evidence such as the polygraph or gruesome photos.

Scientific expert testimony and data are often excluded on FRE 403 grounds, as the jurors may over-value the evidence. One type of prejudice is encapsulated by what neuroscientist Dean Mobbs has called the “Christmas tree phenomenon,” where viewers are so in awe of the colorful brain images that they fail to properly scrutinize the expert’s interpretation of the image, or ignore the many discretionary steps that are required for it to be to be constructed. Other types of prejudice include wasting the court’s resources and encouraging what Criminal Responsibility and Prediction network co-director Stephen Morse has dubbed the “fundamental psycho-legal error,” where brain causation is improperly equated with mitigation. These dangers and others are explored in detail in an article accepted for publication in the Stanford Law Review, authored by Project fellows Teneille Brown and Emily Murphy.

Courts are facing these issues right now. On March 14th, Project fellow Emily Murphy broke the story of an attempt to introduce a report by No Lie MRI of its “truth verification” data in a juvenile dependency hearing.

Upcoming Events: 2009

May 18-22  Annual Conference of the Gruter Institute for Law and Behavioral Science  
Squaw Valley, CA  
http://www.gruterinstitute.org/

May 22-25  Association for Psychological Science (APS) Annual Meeting  
San Francisco, CA  
http://www.psychologicalscience.org/convention/

May 27-30  MacArthur Law and Neuroscience Project Annual Spring Meeting  
Santa Barbara, CA  
http://www.lawandneuroscienceproject.org

June 18-23  Human Brain Mapping  
San Francisco, CA  
http://www.humanbrainmapping.org/sanfrancisco2009/

July 6-7  UCL Law and Neuroscience Colloquium  
London, UK  
http://www.ucl.ac.uk/laws/events/docs/UCL_law_neuroscience.pdf

Aug 24-27  Moral Responsibility: Neuroscience, Organization & Engineering Conference  
Delft, Netherlands  
http://www.ethicsandtechnology.eu/index.php/subsite/moral

Sept 24-26  Brain Matters- New Directions in Neuroethics  
Halifax, Nova Scotia  
http://www.noveltechethics.ca/site_brainmatters.php#halifax
The Law and Neuroscience Project is composed of approximately 40 members, all of whom hold positions of distinction in their respective disciplines. One of those members, Dr. Silvia Bunge, is a neuroscientist at the University of California, Berkeley, where she holds joint appointments in Psychology and Neuroscience.

Dr. Bunge obtained her Ph.D. with Dr. John D. Gabrieli at Stanford University, after which she completed her post-doctoral work at M.I.T. with Dr. Anthony Wagner (who is also a member of the Project). Prior to her appointment at UC Berkeley, Dr. Bunge was an assistant professor at UC Davis. With solid training in the neurobiological mechanisms of the prefrontal cortex and cognitive control, Dr. Bunge now directs the Cognitive Control and Development Laboratory at UC Berkeley.

Dr. Bunge’s research focuses on the brain mechanisms that support goal-directed behavior in healthy children, adolescents, and adults, as well as in several patient populations. In addition to using multiple neuroscientific methods to elucidate the dynamic relationships between brain structure, brain function, and behavior, her team is also working to develop cognitive training tools for use in remediation and rehabilitation.

Says Dr. Bunge, “The neuroscientific approach to the problem of free will boils down to the study of cognitive control, or the ability to produce goal-directed behavior. Cognitive control functions include the ability to consider the potentially negative long-term consequences of an action, defer gratification, inhibit an inappropriate response, or curb an emotional outburst.”

Cognitive control emerges slowly over childhood and adolescence, and it is not fully mature until the early twenties. Individuals lie on a continuum with respect to their ability to control thoughts, actions, and emotions. Healthy, high-functioning young adults tend to be at the high end of the spectrum, and individuals who have incurred brain damage that includes prefrontal cortex tend to be at the very low end.

Importantly, recent neuroscience-based cognitive training studies indicate that it is possible to train cognitive control and even reasoning ability. “These findings have important implications for questions of sentencing, which is an important topic of discussion in the Project,” says Bunge. “Participating in the Project has been a tremendous learning experience for me, as well as an opportunity to voice my thoughts and concerns with legal experts about the uses and misuses of neuroscience in the law.”

- Teneille Brown, Project Fellow

Brain Images in Courts...continued from page 3

The report, based on fMRI-based lie detection, ostensibly claimed that the defendant told the truth when he said he did not sexually assault his dependent. In a Wired article discussing the case, Brooklyn Law School evidence scholar Ed Cheng said that “[i]t’s not clear whether or not a somewhat reliable but foolproof fMRI machine is any worse than having a jury look at a witness…. If you want the status quo, fine, but in this case, the status quo might not be all that good.” While visual inspection by the jury leaves a lot to be desired, functional brain imaging does not save us from the problem of human discretion, malingering, and distortion – and indeed, has not been demonstrated to be foolproof. What it does is present findings in a way that appear incredibly objective, infallible, and robust, without actually being any of these things. On the eve of the hearing that would have determined whether No Lie’s report would be admitted, the defendant withdrew his request to have it introduced.

We do not yet know how often fMRI-based evidence is being introduced in state trial courts, or for what set of purposes. To address this question, Legal Decision Making network co-director Hank Greely will be gathering data on the use of neuroimaging in California trial courts. While we get a handle on how this evidence is being used, we continue to work to determine the prejudicial effect of functional brain images in various contexts.

-Teneille Brown, Project Fellow

6 http://lawandneuroscienceproject.org/2009/03/14/no-lie-mri-being-offered-as-evidence-in-court/
as familiar and correctly rejects unstudied faces as novel. The trained classifier is then used to read out the mnemonic state of the subject on the trials on which the classifier was not trained. In this way, we can assess how well the classifier can detect whether a person is recognizing a face as familiar or as novel. Based on preliminary data, we find that the trained classifier is surprisingly accurate in distinguishing between brain patterns that mark successful recognition of encountered faces and rejection of unstudied faces as novel. This is particularly true when we restrict our attention to focus exclusively on those trials for which the classifier was most confident in its assessment of that the face was perceived as familiar versus novel. As a cognitive neuroscientist, our appreciation of the possible legal relevance of these findings, as well as the many ways in which ecological validity needs to be fully assessed, is greatly informed by our collaboration with Hank.

HG: As the legal voice, I have three roles in this study. First, I get the opportunity to learn more regarding this aspect of neuroscience, about which I’m very curious. Second, I can provide advice to the researchers on ways in which the experiment relates to the legal system. For example, if there are design applications or conclusions that are relevant to law, I can highlight these for Anthony and Jesse, in order to utilize any opportunities to make their work more useful to questions that arise from the legal system. And finally, I am a resource for them to answer any questions they may have.

AW: I was pretty skeptical on the front end with respect to using these tools to classify different mnemonic states. Having worked for a couple of months with Jesse Rissman on this project, I’ve been surprised by how well classifiers do under highly-controlled, non-ecologically valid conditions—classification performance is substantially higher than I would have expected. From a cognitive neuroscientist’s perspective, this is a pleasant surprise because this suggests that our fMRI data are rich with information, which we can exploit to address questions about the neurobiology of memory. Yet despite the surprising accuracy of the MVPA approach we’ve implemented to date, we have to keep in mind that the data can exploit to address questions about the neurobiology of memory. Yet despite the surprising accuracy of the MVPA approach we’ve implemented to date, we have to keep in mind that the data are highly controlled, and thus the power of neuroscience data, maybe having the data be a little less accessible to them will swing the pendulum back in the proper direction.

HG: From a legal perspective, I don’t envy the expert witness who will inevitably have to explain to judges or jurors how these pattern classifiers work. It will be a difficult process to explain the interpretations that are based on very complicated statistical analyses. Up to this point, an expert witness has had simply to infer and explain brain activation based on increases or decreases in blood flow to brain areas, with a correspondence between increased activation and important brain areas of interest. These “pictures” of the brain can then be colored, and it becomes very easy to illustrate how the brain was “active” to a juror. But the multi-voxel pattern analysis approaches will not be as easy to convey. But this might not necessarily be a bad thing; if we are worried (as we should be) that judges and jurors will over-rate the importance of the power of neuroscience data, maybe having the data be a little less accessible to them will swing the pendulum back in the proper direction.

AW: Or, it may have the undesirable effect of disproportionately empowering the expert witness. To revisit the BEOS court case in India, the judge’s written opinion clearly deferred to the forensic expert’s analysis and interpretation of the BEOS data [that was used as evidence to convict Aditi Sharma]. Advocates could capitalize on this, and use it to their advantage.

HG: Of course, the hope is not to have evidence be so complicated that it is not understood by the people deciding the outcome of a case. Rather, the hope is to have those people be aware of the strengths and weaknesses of the data so that they can weigh the evidence fairly. The work that Anthony and Jesse are doing should really help us all get a better sense of the potential benefits and risks of this approach. I think it is perfectly in keeping with the mission of the Law and Neuroscience Project – to help understand and deal well with the challenges neuroscience may hold for the legal system.

*Annabelle (Mimi) Belcher, Project Fellow*
Upcoming Events: 2009...continued from page 3

Oct 17-21  Society for Neuroscience annual meeting  
Chicago, IL  
http://www.sfn.org  

Oct 26-31  ESF-COST Law and Neuroscience Conference  
Acquafredda di Maratea, Italy  
http://www.esf.org/index.php?id=5679  

Nov 20-21  USC Conference on Empirical Legal Studies  
Los Angeles, CA  
http://law.usc.edu/cels/index.cfm  

For more information on these events, or to submit an event to be published in our tri-annual newsletter, please contact: info@lawandneuroscienceproject.org