Memory, the adolescent brain and lying: The limits of neuroscientific evidence in the law

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Brain scans are increasingly able to reveal whether or not you believe you remember some person or event in your life. In a new study presented at a cognitive neuroscience meeting today, researchers used fMRI brain scans to detect whether a person recognized scenes from their own lives, as captured in some 45,000 images by digital cameras. The study is seeking to test the capabilities and limits of brain-based technology for detecting memories, a technique being considered for use in legal settings.

"The advancement and falling costs of fMRI, EEG, and other techniques will one day make it more practical for this type of evidence to show up in court," says Francis Shen of the University of Minnesota Law School, who is chairing a session on neuroscience and the law at a meeting of the Cognitive Neuroscience Society (CNS) in San Francisco this week. "But technological advancement on its own doesn't necessarily lead to use in the law." But as the technology has advanced and as the legal system desires to use more empirical evidence, neuroscience and the law are intersecting more often than in previous decades.

In U.S. courts, neuroscientific evidence has been used largely in cases involving brain injury litigation or questions of impaired ability. In some cases outside the United States, however, courts have used brain-based evidence to check whether a person has memories of legally relevant events, such as a crime. New companies also are claiming to use brain scans to detect lies – although judges have not yet admitted this evidence in U.S. courts. These developments have rallied some in the neuroscience community to take a critical look at the promise and perils of such technology in addressing legal questions – working in partnership with legal scholars through efforts such as the MacArthur Foundation Research Network on Law and Neuroscience.

Recognizing your own memories

What inspired Anthony Wagner, a cognitive neuroscientist at Stanford University, to test fMRI uses for memory detection was a case in June 2008 in Mumbai, India, in which a judge cited EEG evidence as indicating that a murder suspect held knowledge about the crime that only the killer could possess. "It appeared that the brain data held considerable sway," says Wagner, who points out that the methods used in that case have not been subject to extensive peer review.

Since then, Wagner and colleagues have conducted a number of experiments to test whether brain scans can be used to discriminate between stimuli that people perceive as old or new, as well as more objectively, whether or not they have previously encountered a particular person, place, or thing. To date, Wagner and colleagues have had success in the lab using fMRI-based analyses to determine whether someone recognizes a person or perceives them as unfamiliar, but not in determining whether in fact they have actually seen them before.

In a new study presented today, his team sought to take the experiments out of the lab and into the real world by outfitting participants with digital cameras around their necks that automatically took photos of the participants' everyday experiences. Over a multi-week period, the cameras yielded 45,000 photos per participant.

Wagner's team then took brief photo sequences of individual events from the participants' lives and showed them to the participants in the fMRI scanner, along with photo sequences from other subjects as the control stimuli. The researchers analyzed their brain patterns to determine whether or not the participants were recognizing the sequences as their own. "We did quite well with most subjects, with a mean accuracy of 91% in discriminating between event sequences that the participant recognized as old and those that the participant perceived as unfamiliar, " Wagner says. "These findings indicate that distributed patterns of brain activity, as measured with fMRI, carry considerable information about an individual's subjective memory experience – that is, whether or not they are remembering the event."

In another new study, Wagner and colleagues tested whether people can "beat the technology" by using countermeasures to alter their brain patterns. Back in the lab, the researchers showed participants individual faces and later asked them whether the faces were old or new. "Halfway through the memory test, we stopped and told them 'What we are actually trying to do is read out from your brain patterns whether or not you are recognizing the face or perceiving it as novel, and we've been successful with other subjects in doing this in the past. Now we want you to try to beat the system by altering your neural responses.'" The researchers instructed the participants to think about a familiar person or experience when presented with a new face, and to focus on a novel feature of the face when presented a previously encountered face.

"In the first half of the test, during which participants were just making memory decisions, we were well above chance in decoding from brain patterns whether they recognized face or perceived it as novel. However, in the second half of the test, we were unable to classify whether or not they recognized the face nor whether the face was objectively old or new," Wagner says. Within a forensic setting, Wagner says, it is conceivable that a suspect could use such measures to try to mask the brain patterns associated with memory.

Wagner says that his work to date suggests that the technology may have some utility in reading out brain patterns in cooperative individuals but that the uses are much more uncertain with uncooperative individuals. However, Wagner stresses that the method currently does not distinguish well between whether a person's memory reflects true or false recognition. He says that it is premature to consider such evidence in the courts because many additional factors await future testing, including the effects of stress, practice, and time between the experience and the memory test.

Overgeneralizing the adolescent brain

A general challenge to the use of neuroscientific evidence in legal settings, Wagner says, is that most studies are at the group rather than the individual level. "The law cares about a particular individual in a particular situation right in front of them," he says, and the science often cannot speak to that specificity.

Shen cites the challenge of making individualized inference from group-based data as one of the major ones facing use of neuroscience evidence in the court. "This issue has come up in the context of juvenile justice, where the adolescent brain development data confirms behavioral data that on average 17-year-olds are more impulsive than adults, but does not tell us whether a particular 17-year-old, namely the one on trial, was less able to control his/her actions on the day and in the manner in question," he says.

Indeed, B.J. Casey of the Weill Medical College of Cornell University says that too often we overgeneralize the lack of self control among adolescents. Although adolescents do show poor self control as a group, some situations and individuals are more prone to this breakdown than others.

"It is not that teens can't make decisions, they can and they can do so efficiently," Casey says. "It is when they must make decisions in the heat of the moment – in presence of potential or perceived threats, among peers – that the court should consider diminished responsibility of teens while still holding them accountable for their behavior." Research suggests that this diminished ability is due to the immature development of circuitry involved in processing of negative or positive cues in the environment in the subcortical limbic regions and then in regulating responses to those cues in the prefrontal cortex.

The body of research to date is at the group-level, however, and is not yet able to comment on the neurobiological maturity of an individual adolescent. To help provide more guidance on this issue in legal settings, Casey and colleagues are working alongside legal scholars on a developmental imaging study, funded by the MacArthur Foundation, that is examining behaviors relevant to juvenile criminal behavior, including impulsivity and peer influence.

Making real-world connections

The same type of work – to connect brain imaging to particular behaviors in the real-world – is ongoing in a number of other areas, including fMRI-based lie detection and linking negligence to specific mental states. "It's a big leap to go from a laboratory setting, in which impulse control may be measured by one's ability to not press a button in response to a stimulus, to the real-world, where the question is whether someone had requisite self-control not to tie up an innocent person and throw them off a bridge." Shen says. "I don't see neuroscience solving these big problems anytime soon, and so the question for law becomes: What do we do with this uncertainty? I think this is where we're at right now, and where we'll be for some time."

"With a few notable exceptions such as death penalty cases, cases where a juvenile is facing a very stiff sentence, and litigating brain injury claims, 'law and neuroscience' is not familiar to most lawyers," Shen says. "But this might change – and soon." The ongoing work is vital, he says, for laying a foundation for a future that's yet to come, and he hopes that more neuroscientists will increasingly collaborate with legal scholars.

The symposium "Neuroscience and Law: Promise and Perils" takes place on April 16, 2013, at the 20th annual meeting of the Cognitive Neuroscience Society (CNS). More than 1,400 scientists are attending the meeting in San Francisco, CA, from April 13 to April 16, 2013.

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