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Cognitive neuroscience and the law

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Advances in cognitive neuroscience now allow us to use physiological techniques to measure and assess mental states under a growing set of circumstances. The implication of this growing ability has not been lost on the western legal community. If biologists can accurately measure mental state, then legal conflicts that turn on the true mental states of individuals might well be resolvable with techniques ranging from electroencephalography to functional magnetic resonance imaging. Therefore, legal practitioners have increasingly sought to employ cognitive neuroscientific methods and data as evidence to influence legal proceedings. This poses a risk, because these scientific methodologies have largely been designed and validated for experimental use only. Their subsequent use in legal proceedings is an application for which they were not intended, and for which those methods are inadequately tested. We propose that neurobiologists, who might inadvertently contribute to this situation, should be aware of how their papers will be read by the legal community and should play a more active role in educating and engaging with that community.

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Introduction

During the past two decades, neuroscientific studies have begun to meet the challenge of understanding of cognitive function. As the many articles in this themed issue testify, we now have preliminary biological explanations for everything from the control of movements to social cognition. These physiological insights will challenge, in turn, legal systems that rest on conceptual bases that are often hundreds of years old. A reliable neurobiological test for willful deception, for example, would indisputably influence our current legal process. Would brain scans that measure a brain feature that correlated, even weakly, with a propensity for violence influence how a court sentences a convicted felon? Could a more complete understanding of the neural mechanism for voluntary decision-making be used to undermine the notions of accountability that are used in criminal convictions? Although most neurobiologists agree that these are interesting questions for the future, neuroscientific evidence is rapidly entering Western legal systems (in this article we focus on the US legal system, with which we are most familiar) in ways that would probably surprise and concern many scientists. The result is that the work of neuroscientists is being increasingly deployed in various legal contexts, whether the neuroscientists are aware of it or not. In this commentary we argue that the neurobiological community must become more aware of how their work is already beginning to influence the decisions made by judges, lawyers and legislators. Biologists must become more proactive in their interactions with the legal community. However, to explain why we (a lawyer and a neuroscientist) believe this, we have to begin by presenting a few key legal concepts with which we believe all cognitive neurobiologists should become familiar.

Use of scientific evidence by the legal system

First, scientists must understand how and where neuroscience can be used in legal settings. Many scientists are familiar with the jury trial and with the idea of expert testimony in that setting (see, for example, FED. R. EVID. 702.). In such cases, if an expert possesses specialized knowledge that would assist the judge or jury in understanding the evidence or determining the facts of a case, then parties may seek to have the expert offer an opinion into evidence. This formal introduction of expert opinion is governed by the rules of evidence. For the purposes of this article, we talk generally about the law, speaking to general trends and principles, and talking mostly about United States federal law as relates to admissibility of evidence. However, scientists should be aware that in the United States (as in many other countries), the law is structured such that there are two separate bodies of law — the federal law and the state law. Although federal law is generally uniform in its nationwide application, the differences between state laws vary more widely. The state and federal courts are separate systems with separate jurisdictions that apply separate (and sometimes quite different) standards to scientific evidence.

The rules of evidence serve as a way of determining what evidence should be used in considering the case before the court. The rules governing expert testimony fall roughly into two approaches in the US — the *Frye* approach (after *Frye v. U.S.*, 54 App. D.C. 46 (1923)) and the *Daubert* approach (*Daubert v. Merrell Dow Pharmaceuticals*, 509 U.S. 579 (1993)). In *Frye*, the Supreme Court of the District of Columbia (a non-federal court) held that judges, in determining whether to admit scientific evidence, should look to whether the science upon which it is based has "gained general acceptance in the particular field in which it belongs". Variations of this 'general acceptance' rule became widely adopted in the US by other state and federal courts. Seventy years later, the Supreme Court of the United States set a different standard in *Daubert*, putting forward a set of four elements that judges should consider when evaluating expert scientific testimony for admission. That is, whether the underlying theory or technique is testable (and whether it has been tested), whether it has been subjected to peer review and publication, its known or potential error rate, and its general acceptance in the relevant scientific community.

The result of these two rulings is that the individual judge in charge of each case, who might have limited (or no) scientific training, is placed in the difficult position of serving as the 'gatekeeper', evaluating the underlying science by *Daubert* or *Frye* standards, before deciding what to admit into evidence at a particular trial. One can see how this could rapidly become very confusing when scientific evidence conflicts. Which peer reviewed article should a judge with no scientific training consider more seriously, a three page paper published in *Nature*, a 25 page paper published in the *Journal of Neuroscience*, or a 50 page paper published in a 'peer-reviewed' book published by a vanity press?

Although this alone might raise serious concerns, scientific knowledge can come into play at several other points in the legal process at which even the weak and broadly interpretable protections of *Daubert* and *Frye* might not apply. This could occur, for example, during a sentencing hearing. This is a type of formal hearing that is held before a judge and that occurs after the guilt of an accused person has been established. In such hearings, evidence that does not have to meet the *Frye* or *Daubert* standards for admissibility can be presented to argue for tougher sentencing or for mercy, with evaluations and predictions being made about such issues as future dangerousness, or the likelihood of recidivism (the likelihood that a crime will be committed again by the same individual).

In this light, consider recent work on the prefrontal cortex by neuroscientist Richard Davidson, who in his published presidential address to the Society for Psychophysiological Research [1] concluded that: "individuals with hypoactivation of certain regions of the prefrontal cortex may be deficient in the instantiation of goal directed behavior and in the overriding of more automatic responses". "In particular. . .a lateral right-sided region (of the orbitalfrontal cortex) appears particularly responsive to punishments [2] (in normal subjects)". Although these statements and studies are, of course, directed at a scientific audience and without a doubt reflect our current understanding of brain function, under current rules of evidence a judge could easily permit these findings to influence sentencing phase deliberations. Functional magnetic resonance imaging (fMRI) data on the hypo- or hyperactivity of this punishment-sensitive area in a convicted individual could, as a result, be used at a sentencing hearing to argue that a convicted criminal was either more or less likely to repeat his or her offence.

An even lower standard of evidence is applied in what are known as 'pre-formal' processes. Defense counsel or prosecutors can, for example, use neurobiological test results in a dialogue with an individual who has been arrested but not yet charged with any crime — as leverage in arguing for a guilty plea, for a reduction in charges, or for a dismissal of the charge. These pre-formal usages typically occur outside of a courtroom setting, and this is problematic because it makes them difficult to review and places them almost completely beyond the bounds of traditional scientific dialogue.

As we hope the preceding paragraphs make clear, the legal tradition differs from the process with which scientists are familiar in two ways. First, scientists are accustomed to the validation of fact by peer review, a slow and incremental process that seeks to establish ground truth as a consensus, often during decades of debate. As is clear from the *Frye* and *Daubert* cases, this is simply not the case in the legal world — courts must resolve cases when they are presented with the tools available to them, and cannot wait for the development of a scientific consensus. Of course this then raises a series of crucial real-world problems. For example, would a neurobiological test for willful deception have to perform within a scientist's 95% confidence interval before it is applied in a jury trial? The answer is no, the rules of evidence do not require perfection — only relevance, defined as having "any tendency to make the existence of any fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence" (FED. R. EVID. 401 and 402). Or to take another example, if one could demonstrate that the neural architecture for decision-making was atypical in an individual, even though scientists might disagree about what typical meant, evidence of this type might well influence the sentencing component of a murder trial today. The second way in which the legal tradition differs from academic approaches is that most neuroscientists develop experimental tests for hypotheses in a way that is really quite limited. Might the locally tested 'facts' neurobiologists describe in peer reviewed papers be applied globally in the real world of law? The answer appears to be yes.

How will neuroscience influence the law?

Although we have focused on local legal situations up until this point, the impact of neuroscience research will not be felt solely at the local trial level. For example, in a recent US Supreme Court case, *Roper v. Simmons* (*Roper v. Simmons*, 125 S. Ct. 1183 (2005)), the court ruled to prohibit capital punishment for juvenile offenders under the age of 18. The opinion of the Supreme Court referred specifically to ''the scientific and sociological studies'' cited by the respondent and *amici* (legal opinions submitted to the court by third parties who have an interest in the outcome of the case) as confirming a ''lack of maturity and an underdeveloped sense of responsibility'' in the young. Tellingly, several of these *amici* specifically employed neurobiological evidence to support their arguments. Although one should not conclude that neuroscience was controlling of the decision of the Court in *Roper*, it is an example of how lawyers are already attempting to use neuroscience to persuade, even at the highest levels of the courts.

The implication of this disconnection between the world of neuroscience and the world of law is profound. As neuroscience advances, the need to consider the legal implications arising from our growing understanding of the brain — particularly as it relates to behavior — is increasingly apparent. However, there is no obvious forum in which this dialogue can advance. No single organization or collaborative body exists that can foster communication between the legal and the neuroscience communities. This could be problematic because the stakes will be high (liberty, freedom, maybe even life) and the needs will be immediate. As a group, the neurobiologists whose work is directly relevant to legal concepts are almost entirely unaware of the potential legal impact of their research.

To illustrate the collision of our legal and scientific systems that is already underway, we turn now to a brief examination of one particular issue, the neuroscience of lie-detection. This is an example of a situation in which the potential yield for the law would be great, at which lawyers are already focusing their attention, in which the services of physiologists are already being marketed to the legal community, and in which there have already been attempts to use such technology in criminal proceedings.

Lie-detection: a case study

Neuroscience-based lie detection, or more precisely neuroscientific techniques aimed at identifying intentional deception, is an area of strong research interest that is growing increasingly sophisticated. Although there is reason to be cautious in our predictions of future scientific accomplishments, there is also reason to believe that brain scanners will be able to determine accurately whether a human subject is engaged in willful deception at some point in the future. Indeed, many neurobiologists believe that this is a pending advance, and it is certainly one that raises serious legal and ethical issues. For example, do brain scans that are conducted against the wishes of the subject being scanned violate the protections against self-incrimination guaranteed by the Fifth Amendment to the U.S. constitution, or are they merely another form of physical evidence, similar to the subject's DNA, or their fingerprints? And to be used in a legal setting how accurate do such techniques have to be [3–6]? To understand how these issues will enter, and are entering, the legal arena, one has to understand the pre-existing use of polygraph-based lie detection in current legal practice in the US.

The US Supreme Court illuminated these issues in *U.S. v. Scheffer* (*U.S. v. Scheffer* 523 U.S. 303 (1998)), the case in which use of polygraph-based lie detection was barred in court-martial proceedings (most states, but not all, also bar or restrict use of polygraph evidence in court proceedings). In *Scheffer*, the court upheld a total bar on the introduction of polygraph evidence as constitutional. In *Scheffer*, a defendant sought to introduce polygraph evidence in his defense. The court ruled that a complete bar on polygraph (under court-martial rules of evidence) did not violate the defendant's Sixth Amendment rights to present an adequate defense, in part because the court concluded there were concerns about the reliability of the technology in the scientific community. As the opinion noted, ''the scientific community remains extremely polarized about the reliability of polygraph techniques'' (see decision in *Scheffer*, page 309). Under the earlier standard of *Frye*, many states barred or restricted the use of polygraph evidence, but the different standard provided subsequently in *Daubert* meant courts might look to the *Daubert* factors and reconsider the use of polygraphic evidence. *Scheffer* stands, in some sense, as a strong statement about the value of the scientific peer-review process within the legal arena. This shows that when scientists work with lawyers such victories are possible, and it demonstrates unequivocally the clear value in having scientists engaged in the discussion of how and whether their work is sufficiently reliable to be used in court settings — a factor courts could consider under *Daubert*. But it is important to remember that simply because polygraphic results cannot be admitted into evidence in court does not mean that they are not used in ways that have significant legal impact, including pre-formal use by police, prosecutors and defense counsel, use in the sentencing phases of trials, and use in criminal and intelligence investigations.

Today, new and more sophisticated forms of 'lie-detection' are being injected into this set of complicated precedents. The first of these new techniques to influence the legal system is an electroencephalographic (EEG)-based technique that is starting to be known in the legal community as 'brain fingerprinting' (http://www.brainwavescience.com/). This technique rests on the observation that an EEG electrode placed over the parietal cortex can detect a negative voltage potential when subjects view (or hear) novel stimuli, a phenomenon known as the P300 wave [7–9]. Interestingly, the magnitude of this P300 wave is inversely proportional to the likelihood of a particular stimulus appearing in a repeated series [10]. Thus, low probability stimulus subsets embedded in a larger stimulus series provoke larger P300 waves than the more common stimuli that make up the bulk of the series.

Building on this work with the P300 wave, Farwell and Donchin [11] demonstrated that under laboratory conditions some classes of hidden information could be detected with the P300 measure. In their first published report on this subject (which was funded at least in part by the US Central Intelligence Agency), these authors had subjects participate in a mock espionage scenario that required that they memorize six key phrases (such as the name of their 'secret contact'). A group of words was then presented to them that consisted of, effectively, three categories of words: first, the six key phrases, second, a large number of closely related but irrelevant phrases, and third, a small number of arbitrarily selected 'target' phrases that the subjects were asked to memorize in advance. Subjects were instructed to press a key identifying the pre-specified 'target' phrases whenever they were presented in the ongoing series. These target phrases elicited a stronger than average response in the P300 wave because of their low probability. But to a subject who also recognized the key phrases, these six additional phrases would also constitute a low probability set that might also be expected to elicit a P300 response. Of course this would only be the case for subjects familiar with the key phrases as distinct from the irrelevant phrases. In fact, Farwell and Donchin found that this was the case. In their laboratory study, P300 waves could be used to identify subjects that had participated in a mock espionage event with remarkable accuracy, accuracy that far exceeded that of traditional polygraphy [12].

Farwell, having subsequently published a second paper in a forensics journal [13], formed a US company that has been offering a patented version of this technique that incorporates the P300 wave measure along with other measures. This brain fingerprinting service is being marketed to law enforcement and legal practitioners, and there have been attempts to offer brain fingerprinting into evidence for post-conviction hearings in Iowa. Legal scholars, in fact, have already begun to consider the implications of this new neurobiological form of lie-detection [14], but the scientific community has only recently begun to critically examine what such technologies might mean in a legal setting [6]. The situation for a traditional assessment of this particular technique by the scientific community is complicated by the fact that Farwell has patented his process, thus limiting other scientists' ability to use and evaluate it. But clearly the time is ripe for scientists to discuss the potential of brain fingerprinting and other technologies. Will there be sufficient will to do so? In the absence of this dialogue, how will the legal community accurately evaluate lie-detection technologies such as brain fingerprinting or the much more complicated and potentially accurate methodologies based on brain scanners that are already beginning to be developed [15,16]?

Given that the future is upon us in this regard, and that neuroscientific data are already beginning to enter the legal domain, how should the scientific community proceed? The Dana Foundation and the American Association for the Advancement of Science have begun to sponsor meetings on these issues [17], as has the American Civil Liberties Union [18], but discussion is all too rare and almost no-one has suggested a systematic approach. One legal scholar, however, has suggested that regulatory systems be put into place to evaluate and regulate the safety and effectiveness of lie-detection technologies, much like medical devices, an approach that would require the passage of new laws [19]. Another approach would be for the scientific community to prepare for future legal dialogues similar to the one that occurred in *Scheffer* by working to educate lawyers and jurists about science, and by considering how science is or may be used in court proceedings. For example, explicit and open scientific debate on the reliability, applicability and value of neuroscience to various legal proceedings forms a sort of 'public record' that lawyers can turn to when a developing discovery or immature science is introduced in court. Regardless of what approach the scientific community adopts, it seems clear that some approach must be undertaken soon.

Conclusions

If anything, this article should encourage scientists to reflect on who will probably join the dialogue about the science of the brain as it gets introduced into legal settings that rest on an analysis of the mind. It should also give cognitive neuroscientists a reason to weight their words carefully when writing scientific papers that might have unanticipated legal ramifications. Lawyers and judges will also weigh in, but we must all be aware that policy makers might also turn their attention to the use of neuroscience in the courts. As one of us has noted previously "Policy makers add a third approach to the mix — one that is driven by political concerns and that is much less constrained in what can be considered in formulating positions. Lawyers and scientists are somewhat constrained by the rules of law and peer review, respectively. Policy makers, on the other hand, have broad, wide-sweeping powers and can seize on and implement policies with far-reaching impacts that, once in place, can be quite difficult to revise.'' [20].

If scientists do not participate in a dialogue with the legal community, then how neuroscience and neurobiology enters the courtroom will be a discussion largely left to lawyers, judges, legal scholars and policy makers. It seems clear that both scientists and lawyers could benefit by developing some mutual understanding of their respective disciplines (or at least, of the differences in intellectual culture and methods). Scientists could start by considering the potential effects and uses of their research, so as to better address the questions that are likely to be raised by lawyers and others in the legal community. This is not a cry to curtail or censor research, but rather to be sensitive to its potential and be ready to combat potential misuse and distortion (intentional or otherwise). Scientists are in the strongest position to speak to the strengths and weaknesses of advances in science, the meaning of a discovery, in context, and what it does — and does not — tell us. The time to start talking is now.

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