

Neuroscience, Mental States, and the Law

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University of Glasgow
Dept. of Philosophy

August 11, 2017



Shen Neurolaw Lab

Every story is a brain story

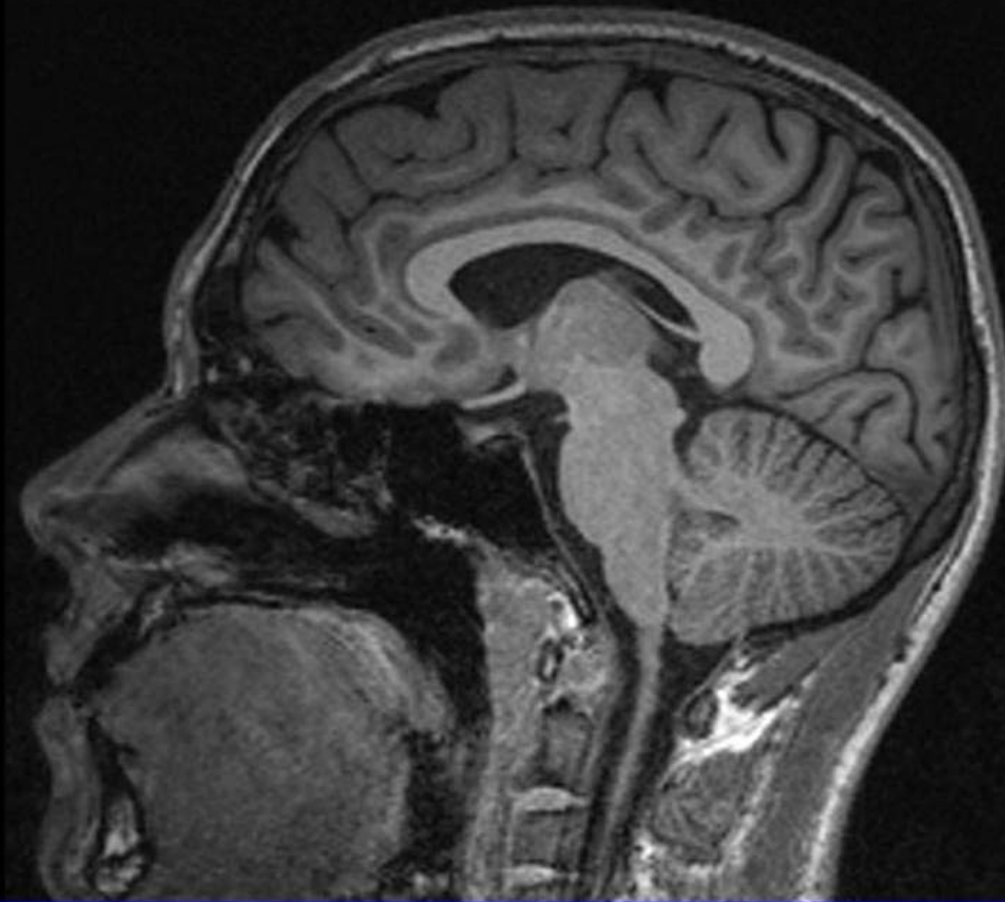
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UCSB Brain Imaging Center
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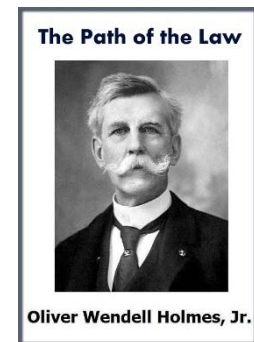
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Why
Neurolaw?

Because there
is **great**
possibility.

For the rational study of the law the blackletter man may be the man of the present, but **the man of the future is the man of statistics and the master of economics.** It is revolting to have no better reason for a rule of law than that so it was laid down in the time of Henry IV. It is still more revolting **if the grounds upon which it was laid down have vanished long since,** and the rule simply persists from blind imitation of the past. --Oliver Wendell Holmes (1897)



Why
Neurolaw?

Because brain science will become increasingly useful, but it will never be dispositive.

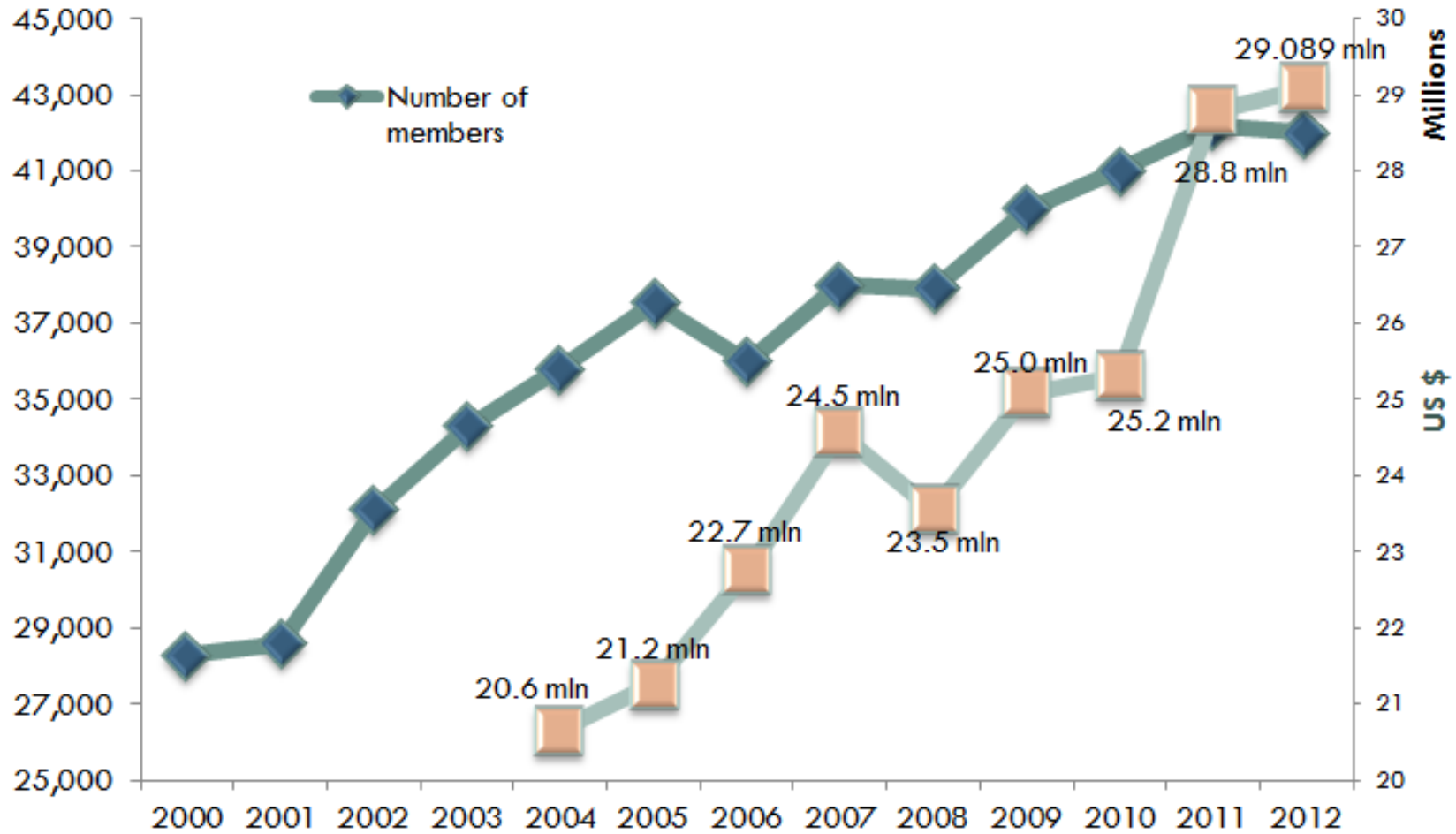
And that means we need to have **dialogue** about what to do with this new, but incomplete information.

Excitement

... but also

Caution

Excitement!



Source: Sfn annual reports, www.sfn.org

Caution!
State of the
clinical
science

OPINION

Can neuroscience be integrated into the DSM-V?

Steven E. Hyman

Abstract | To date, the diagnosis of mental disorders has been based on clinical observation, specifically: the identification of symptoms that tend to cluster together, the timing of the symptoms' appearance, and their tendency to resolve, recur or become chronic. The Diagnostic and Statistical Manual of Mental Disorders and the International Classification of Disease, the manuals that specify these diagnoses and the criteria for making them, are currently undergoing revision. It is thus timely to ask whether neuroscience has progressed to the point that the next editions of these manuals can usefully incorporate information about brain structure and function.

Not yet.

Mistreating Psychology in the Decades of the Brain

Gregory A. Miller

Department of Psychology, University of Illinois at Urbana-Champaign, Champaign, IL, and Zukunfts Kolleg,
University of Konstanz, Konstanz, Germany

“Intellectual
modesty is in
order.”



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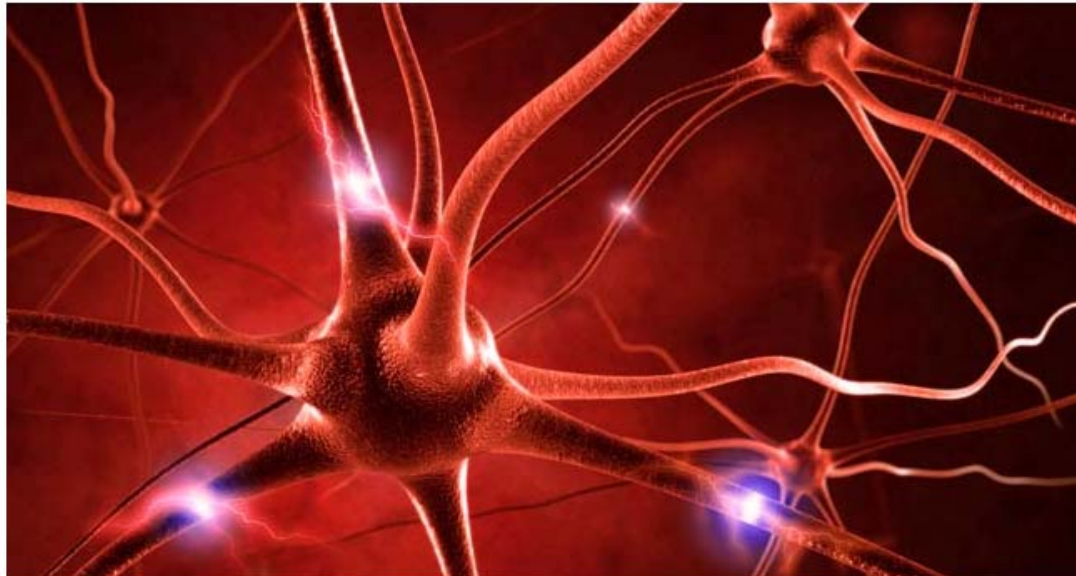
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The *Research Network on Law and Neuroscience*, supported by the [John D. and Catherine T. MacArthur Foundation](#), addresses a focused set of closely-related problems at the intersection of neuroscience and criminal justice: 1) determining the law-relevant mental states of defendants and witnesses; 2) assessing a

SEARCH

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**Colloquium on
 Law, Neuroscience,
 and Criminal Justice**

Stanford Law School
 Palo Alto, California
March 14–15, 2013

- Neuroscience for Judges
- Adolescent Decision Making and Legal Responsibility
- Neurobiology of Violence
- Addiction, Treatment, and Criminal Responsibility
- Formation and Detection of Memories
- Sentencing, Risk Assessment, and Re-offending

MacArthur Foundation Federal Judicial Center

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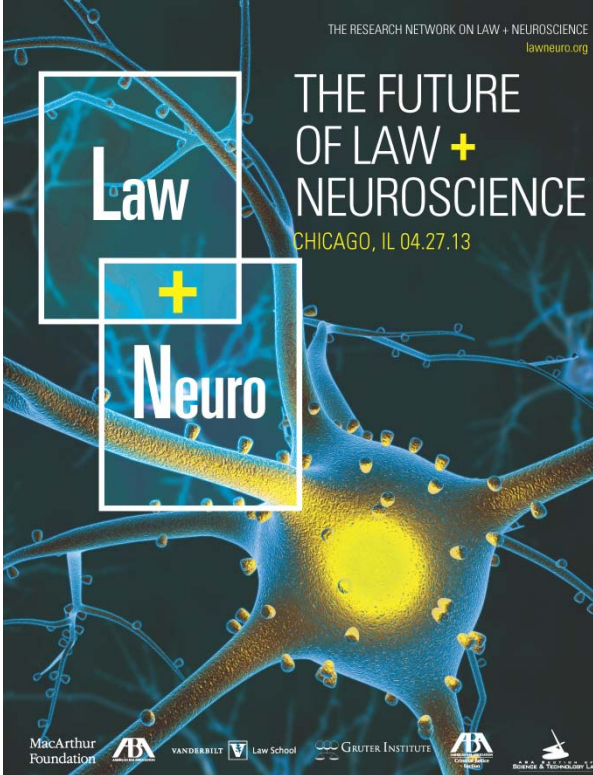
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CHICAGO, IL 04.27.13



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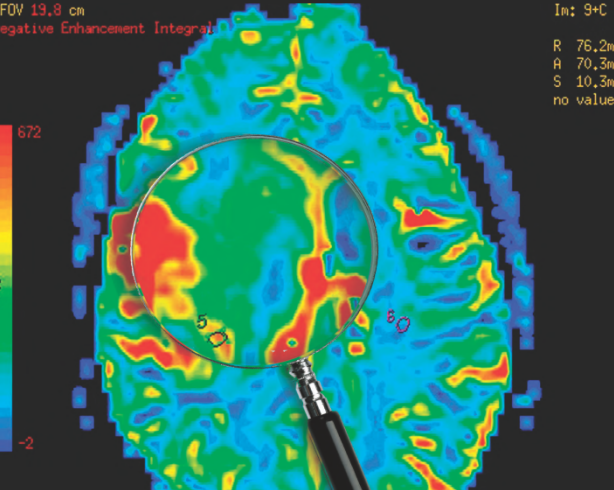
Law + Neuro

**COLLOQUIUM FOR
 FEDERAL JUDGES ON
 LAW, NEUROSCIENCE,
 + CRIMINAL JUSTICE**

VANDERBILT UNIVERSITY 02.06-07.2014

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 A 70.3mm
 S 10.3mm
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About the Center

Providing responsible, ethical and scientifically sound translation of neuroscience into the legal arena.



Mission

The speed of technology in neuroscience as it impacts ethical and just decisions in the legal system needs to be understood by lawyers, judges, public policy makers, and the general public. The Massachusetts General Hospital Center for Law, Brain, and Behavior is an academic and professional resource for the education, research, and understanding of neuroscience and the law. [Read more >](#)

clbb.mgh.harvard.edu



Shen Neurolaw Lab

Every story is a brain story

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Important Context:

**The Rapidly Expanding Neurolaw
Universe**

Lie Detection & Memory Detection in Court:

fMRI-based lie detection

EEG-based memory recognition

(and our recent research)

The Future of Memory Recognition in Law:

Excitement! *and* Caution



Shen Neurolaw Lab

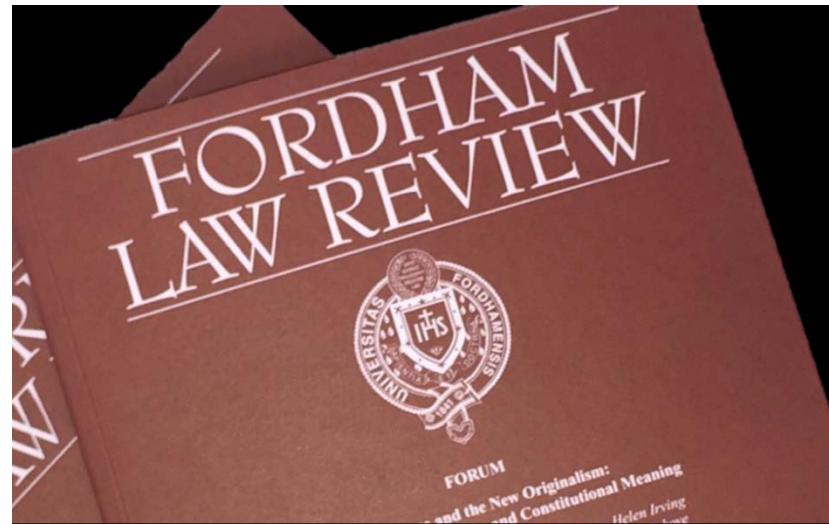
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EEG-based memory recognition
(and our recent research)

The Future of Memory Recognition in Law:
Excitement! *and* Caution



THE OVERLOOKED HISTORY OF NEUROLAW

*Francis X. Shen**

INTRODUCTION

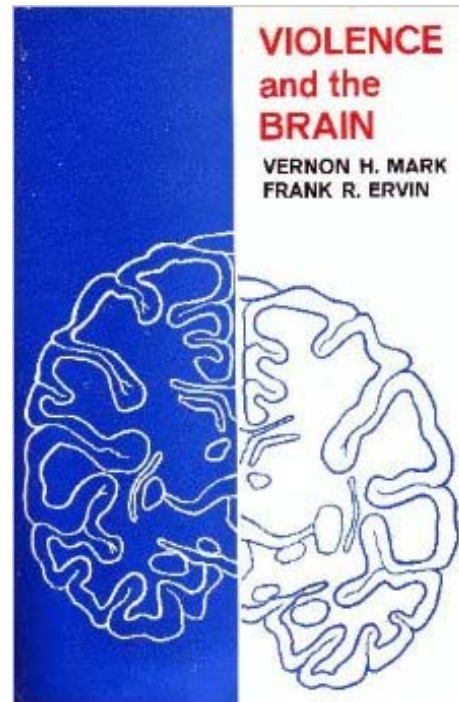
I often describe law and neuroscience as a “new” and “emerging” field.¹ This gives neurolaw a shiny gloss and attracts headlines. The claim also is true, in the sense that we are examining the legal implications of new neuroscientific technology and novel findings.

The (Overlooked) History of Neurolaw

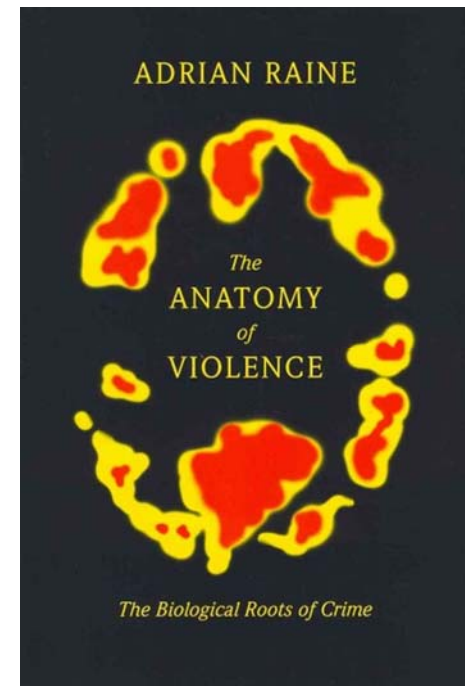
:: *Looking forward by looking back*



**1933
(1949)**



1973



2013

**Brain Science is
everywhere ...**

By what criteria do we evaluate (or promote or criticize) brain science in the public sphere?

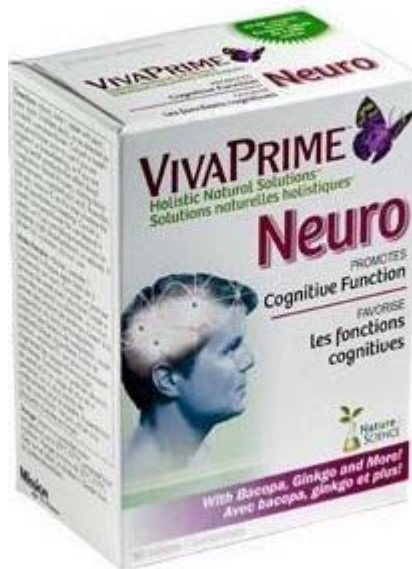
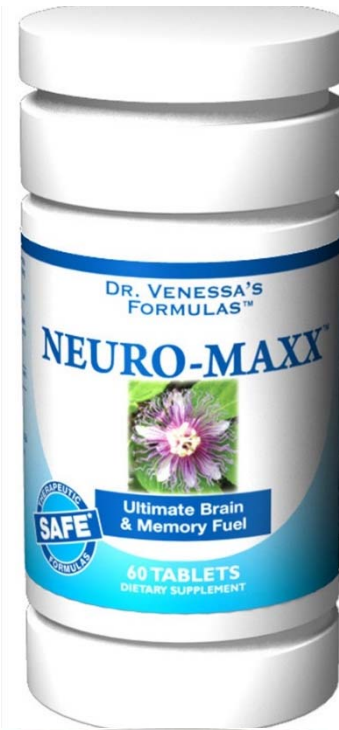
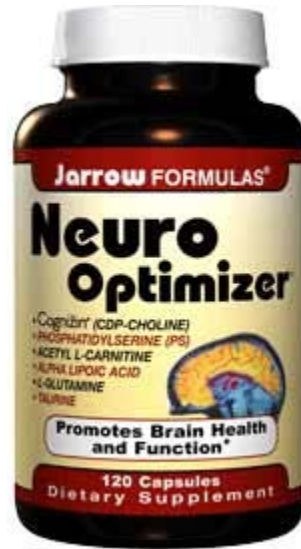
83 NEUROBIC EXERCISES
to help prevent memory loss and increase mental fitness

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AVAILABLE IN 22
LANGUAGES

by Lawrence C. Katz, Ph.D.
& Manning Rubin







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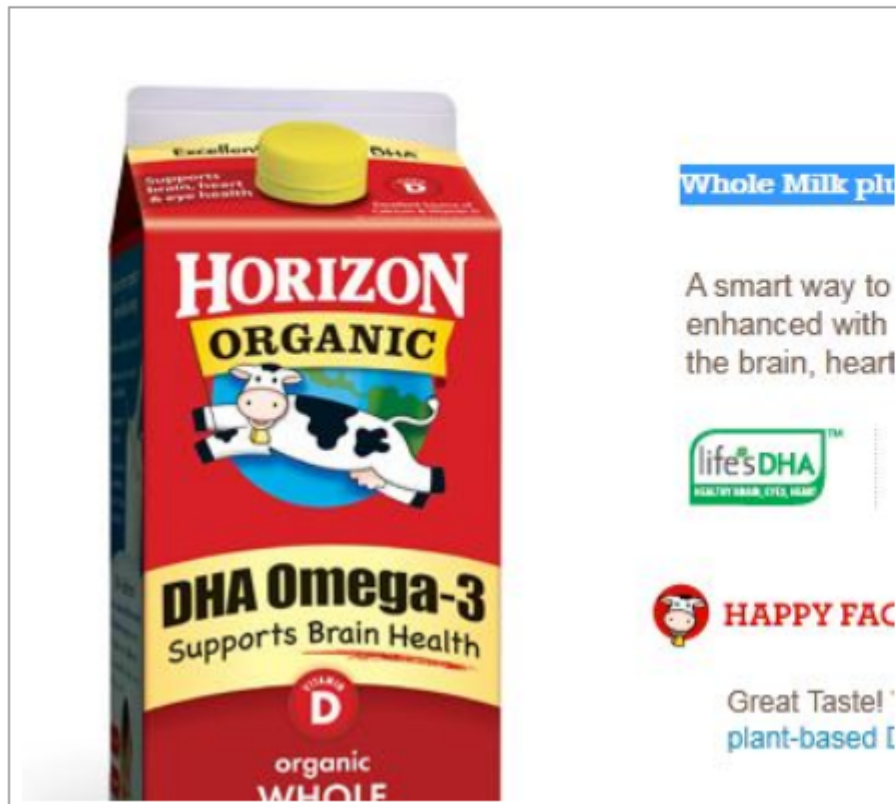
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BRAIN FOOD

Horizon Organic Sued Over Claims That Its Milk Is Good For Your Brain

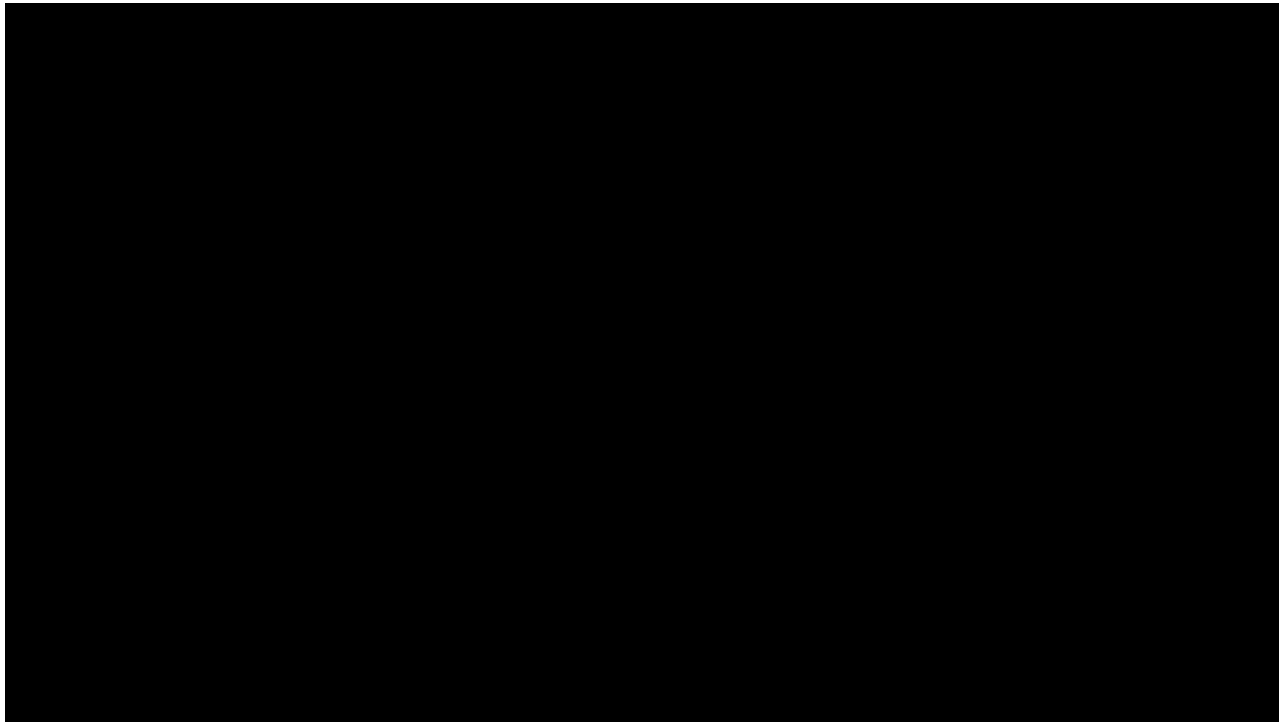
By [Chris Morran](#) on October 4, 2011 11:15 AM



We all know that milk does a body good — or at least that's what they say in the commercials — but a new lawsuit claims that one of the nation's largest producers of organic dairy products is greatly overstating the brain health benefits of some of its milk offerings.

In a class-action complaint filed in the U.S. District Court for the Northern District of Illinois, plaintiffs allege that Dean Foods, parent company of Horizon Organics, is misleading consumers by slapping a huge banner that reads "Supports Brain Health" on the cartons of Horizon's Milk plus DHA Omega-3 line.

From the Chicago Tribune:



“Brain Training” Company Pays \$2 Million Over Lack of Demonstrable Brain Training

By Lily Hay Newman



898



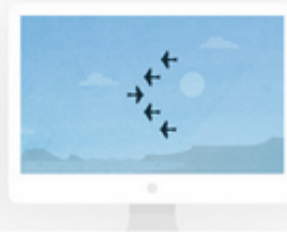
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We transform science into delightful games

For decades, researchers have created tasks that measure cognitive abilities. We've adapted some of these tasks and made some of our own, creating 50+ cognitive games.



Scientists delve into research



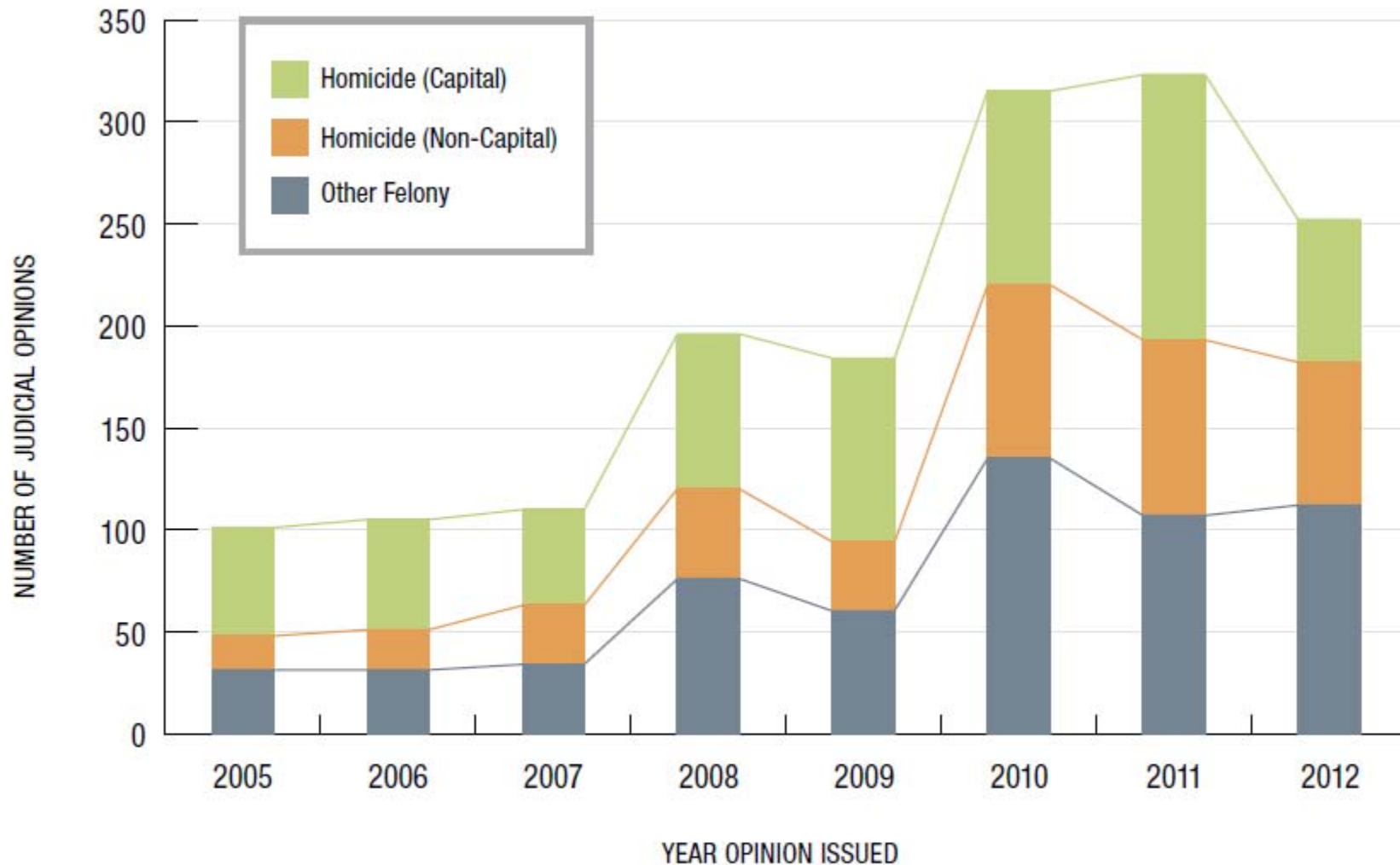
Game Designers bring to life

Brain Science is
everywhere ...

*including the
courts*

Neuroscientific Evidence In Court

:: More Cases



A total of 1800 judicial opinions (majority, plurality, concurrence, dissent) issued during 2005–2012 were included. Graph and analysis based on 1586 majority and plurality opinions only. Source: Farahany, N., Database 2014. On file at Duke University.



Neuroscientific evidence as instant replay

Francis X. Shen

Law School, University of Minnesota, Minneapolis, MN 55455, USA
Corresponding author. E-mail: fxshen@umn.edu

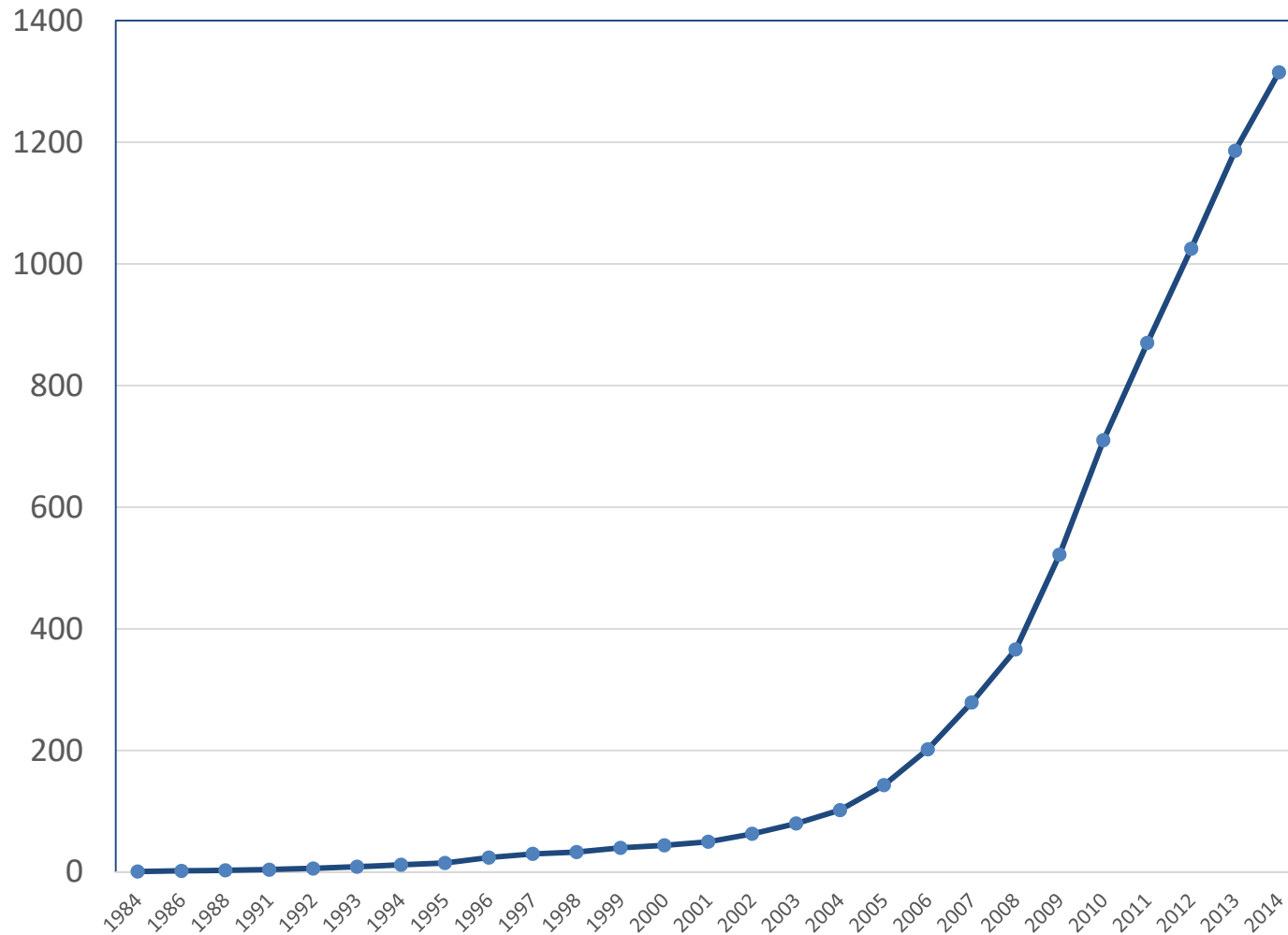



Brain Science is
everywhere ...

*including legal
scholarship*

:: Growth Of Neurolaw Scholarship

Number of Articles, Books, and Book Chapters published in Law and Neuroscience, by publication date, 1984-2014



I 

**MENS
REA.**



SORTING GUILTY MINDS

FRANCIS X. SHEN,^α MORRIS B. HOFFMAN,^β OWEN D. JONES,^χ
JOSHUA D. GREENE,^δ & RENÉ MAROIS^ε



The Language of Mens Rea

Matthew R. Ginther^a
Francis X. Shen^{β,γ}
Richard J. Bonnie^δ
Morris B. Hoffman^ε
Owen D. Jones^ζ
René Marois^η
Kenneth W. Simons^{θ,ι}

Decoding Guilty Minds: How Jurors Attribute Knowledge and Guilt

Matthew R. Ginther,¹ Francis X. Shen,² * Richard J. Bonnie,³
Morris B. Hoffman,⁴ Owen D. Jones,⁵ & Kenneth W. Simons^{6,7}



Parsing the Behavioral and Brain Mechanisms of Third-Party Punishment

Matthew R. Ginther,^{1,2} Richard J. Bonnie,³ Morris B. Hoffman,⁴ Francis X. Shen,⁵ Kenneth W. Simons,⁶
 Owen D. Jones,^{2,7,8,9} and René Marois^{9,10}



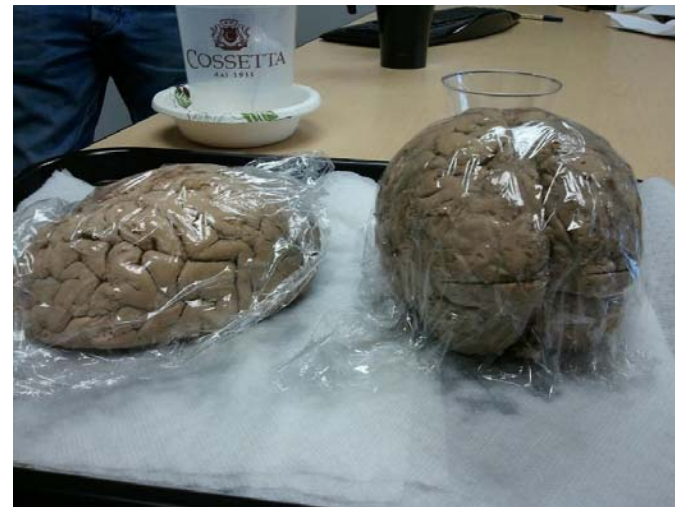
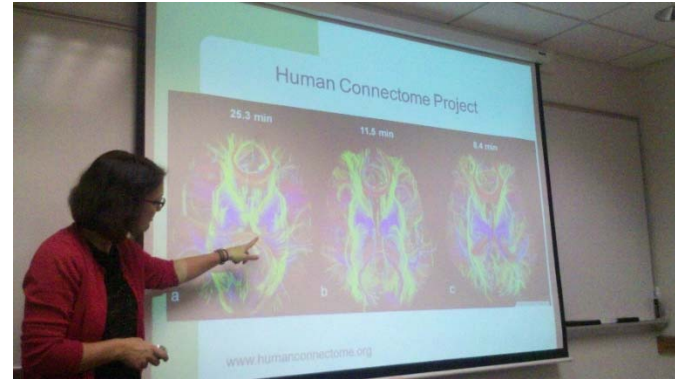
MINORITY MENS REA: RACIAL BIAS AND CRIMINAL MENTAL STATES

Francis X. Shen ^α

Brain Science is
everywhere ...

*including law
classrooms*

Law and Neuroscience course at UMN
Law School



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LAW AND NEUROSCIENCE

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Law & Business

CHAPTER 15

Lie Detection

Once you jump behind the skull, there's no hiding.

—Joel Huizenga, CEO of NoLieMRI (2007)[†]

A fundamental premise of our criminal trial system is that “the jury is the lie detector.”

—Justice Clarence Thomas^{††}

CHAPTER SUMMARY

This chapter:

- Discusses the historical roots of the polygraph, how a polygraph works, and the polygraph's legal standing in court and in other settings.
- Introduces the science of neuroscience-based lie detection techniques, including fMRI- and EEG-based techniques, as well as critiques of these methods and their potential applications to law.
- Presents recent cases involving neuroscience-based lie detection evidence.

Brain Science is
everywhere ...

*including
legislatures*

Number of Proposed Brain-Related Bills, by Year (All state legislatures, 1997-2009)

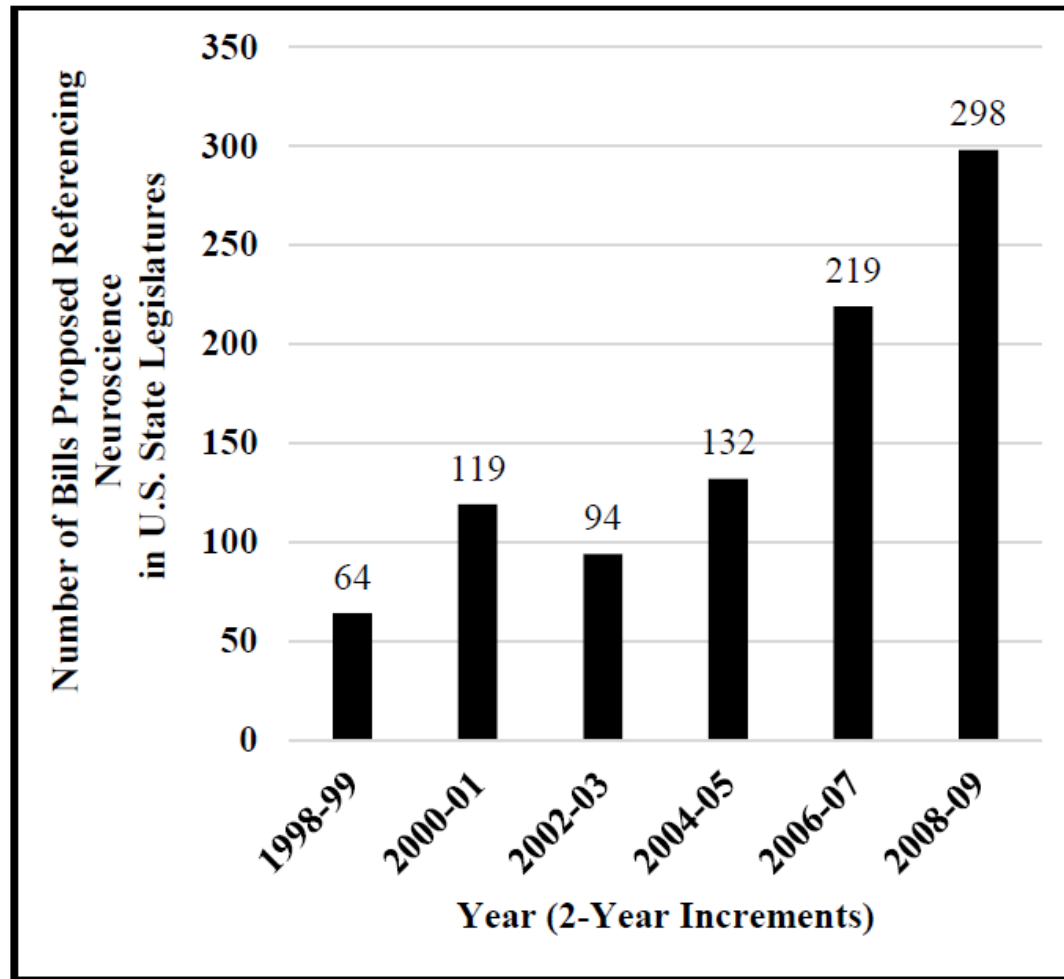


Figure 2: Number of Proposed Bills in U.S. State Legislatures That Reference Neuroscience, 1998–2009
(Summarized in Two-Year Increments)

Neuroscience Narratives

:: Topics covered by brain bills

Alzheimer's * Autism * Brain Death *
Brain Injury * Civil Commitment * Crime
Victims * Criminal Defense * **Early**
Childhood * Education * End of Life *
Foster Care * **Health Care** * **Juvenile**
Justice * **Mental Health** * Military
Veterans * Neonatal * Parkinson's * Parole *
Post Traumatic Stress Disorder * Privacy * Sex
Offenders * Shaken Baby Syndrome * Special
Education * **Sports Concussions** *
Toxins * Veterans Courts

**NEUROLEGISLATION:
HOW U.S. LEGISLATORS ARE USING BRAIN SCIENCE**

*Francis X. Shen**

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| <i>A. The Current Non-Revolution of Neurolegislation</i> | <i>520</i> |
| <i>B. The Possibility of Transformational Neurolegislation</i> | <i>522</i> |

Neuroscience is increasingly mentioned in proposed legislation, but at present neuroscience reaffirms rather than revolutionizes legislators' preexisting policy commitments.

Neurolaw is
much more
than just
criminal law.

Law and Neuroscience 2.0

1. Legal Implications of Pre-Onset Alzheimer's Detection
2. Preventing and Treating Concussions in Youth and Professional Sports
3. Regulating Mobile Consumer Neurotechnology
4. Brain biomarkers and brain-based prediction
5. Admissibility of Novel Neuroscientific Evidence
6. Juvenile Justice and Brain Science
7. Developing Brain-Based Memory Recognition Technology
8. Mind-Body Dualism in Legal Doctrine and Practice
9. Brain Death and Disorders of Consciousness
10. Cognitive Enhancement through Direct Brain Intervention
11. Governance of Induced Pluripotent Stem Cell Human Chimeras Research
12. Privacy and Brain Hacking
13. Artificial Intelligence
14. Virtual Reality and the Law
15. Non-Human Animal Brains and Non-Human Animal Rights
16. Global Neurolaw



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Important Context:

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Universe**

Lie Detection & Memory Detection in Court:
fMRI-based lie detection
EEG-based memory recognition
(and our recent research)

The Future of Memory Recognition in Law:
Excitement! *and* Caution

Lie

Detection

Two cases

Gary Smith

Public Safety

The long life of a MoCo homicide case: Two trials, two appeals, third trial on the horizon

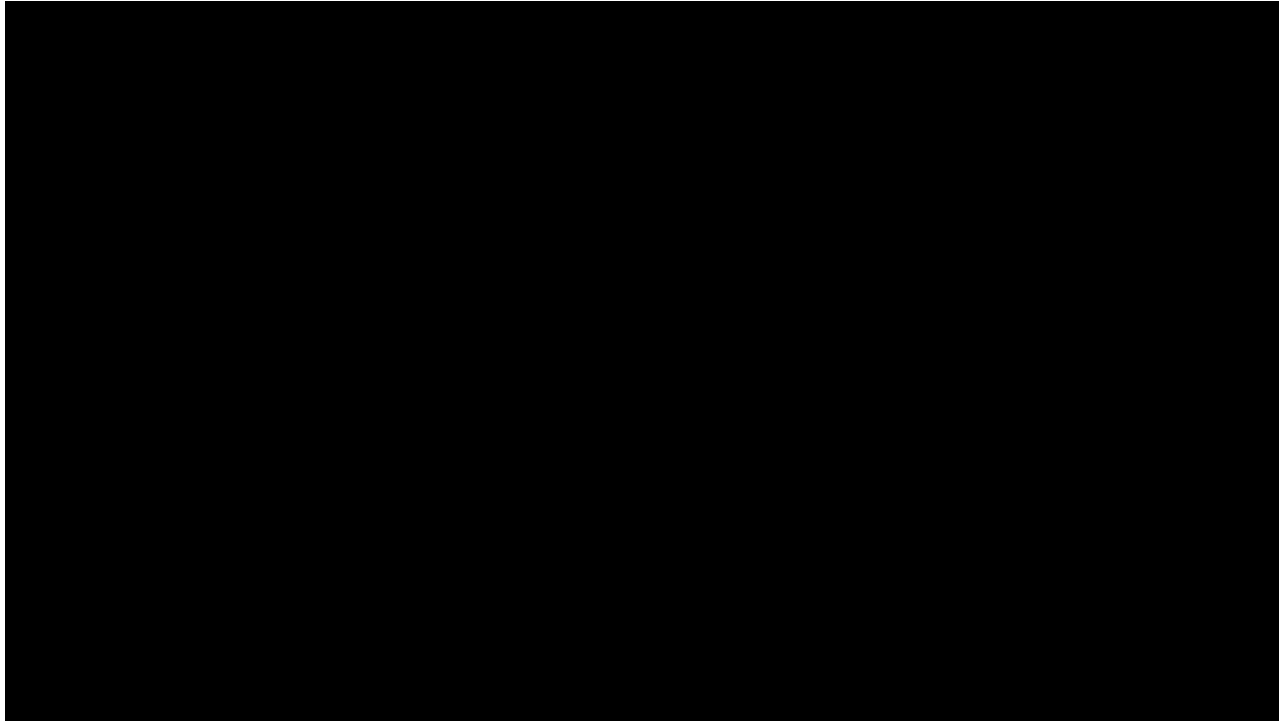
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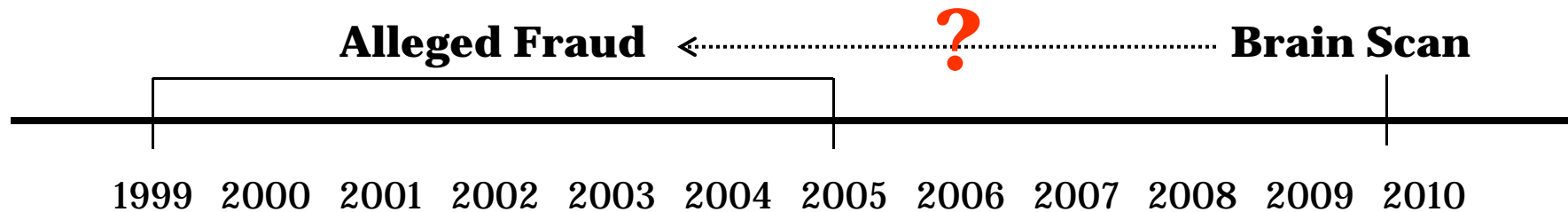
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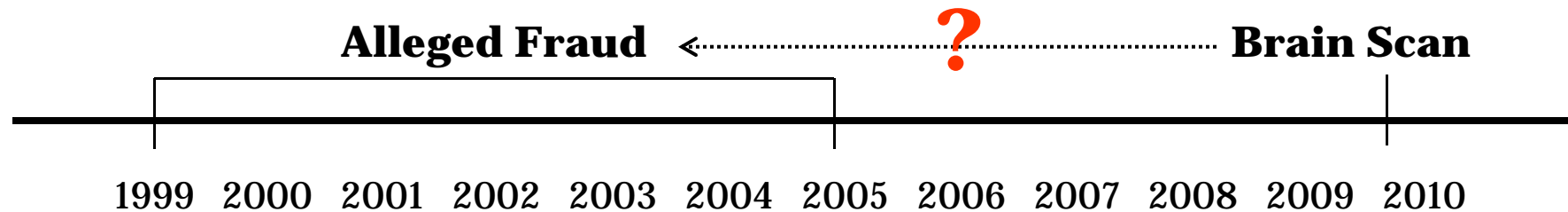
Gary Smith



:: Semrau: *Timeline of Fraud*



Between 1999 and 2005, did Dr. Semrau “knowingly** devise a scheme or artifice to defraud a health care benefit program in connection with the delivery of or payment for health care benefits, items, or services”?**



**“... the task at hand here is
the question of **what the
brain is doing.**”**

**:: Dr. Marcus Raichle
testifying in *U.S. v. Semrau***





Dr. Steven Laken

In my professional opinion, I, Dr. Steven Laken, conclude that ...

... Dr. Semrau's brain indicates he is telling the truth in regards to not cheating or defrauding the government.

The banner features the Cephos logo on the left, which consists of a stylized blue and orange circle with a white waveform. To the right of the logo is the word "Cephos" in a white, sans-serif font. Further right is a navigation menu with the following items: "About Us", "Lie Detection", "Forensic DNA", "Investigations", "News & Info", and "Contact Us". Below the navigation menu is the tagline "The Science Behind The Truth". The main body of the banner has a dark blue background with glowing blue and orange neural network patterns. On the left side, there is a text block: "Lie Detection Services" followed by "Using state-of-the-art functional magnetic resonance imaging (fMRI) technology, Cephos provides independent, peer-reviewed, published scientific validation for a range of situations. If your word, reputation or freedom is in dispute, contact the Cephos team today." At the bottom of the banner, there are three small, square inset images: the first shows a close-up of a brain scan, the second shows a fingerprint, and the third shows a DNA double helix structure.



Judge Pham:

Although Dr. Laken is qualified to offer an opinion, the court nevertheless concludes that his testimony should be excluded because, **at least at this early stage in its development, fMRI-based lie detection does not satisfy the requirements of Rule 702.**

Brain Scans as Evidence: Truths, Proofs, Lies, and Lessons

**by Francis X. Shen^{*}
and Owen D. Jones^{**}**

I. INTRODUCTION

This *Brain Sciences in the Courtroom Symposium* is both timely and important. Given recently developed and rapidly improving brain imaging techniques that enable non-invasive detection of brain activity, civil and criminal courts increasingly encounter attorneys proffering brain scans as evidence.¹ The reason is simple. In addition to caring about how people act—such as when they cause a person’s death or sign a will—the legal system’s inquiries frequently turn on determining what people were *thinking*, or were *capable* of thinking, when they acted.

Memory Detection

Your brain waves could reveal what you forgot (or lied about)

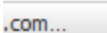
A study with implications for criminal investigations finds that looking at a particular brain wave could help recover buried or hidden information.

by **Anthony Domanico**  @ajdomanico / 25 September 2014, 2:30 am AEST



During interviews and interrogations, detectives often ask subjects whether they recall pieces of information pertaining to a crime or crime scene. Because our brains are constantly processing huge amounts of information, it can be difficult or even impossible to recall data that wasn't salient enough to notice, at least consciously. And if information is incriminating, we might resist voluntarily giving it up.

But what if such information could be extracted without relying on a subject's memory at all? According to **a new study** published in the journal *Psychological Science*, that could be possible via a particular brain wave known as P300, circumventing both **our fallible memory** and refusal to give up potentially incriminating evidence.

The study examined 24 subjects using the Concealed Information Test (CIT), a recognition test  examines whether a subject recognizes crime-



Could an EEG, like the one shown here, hold the key to better lie detection?

Video screenshot by Anthony Domanico/CNET

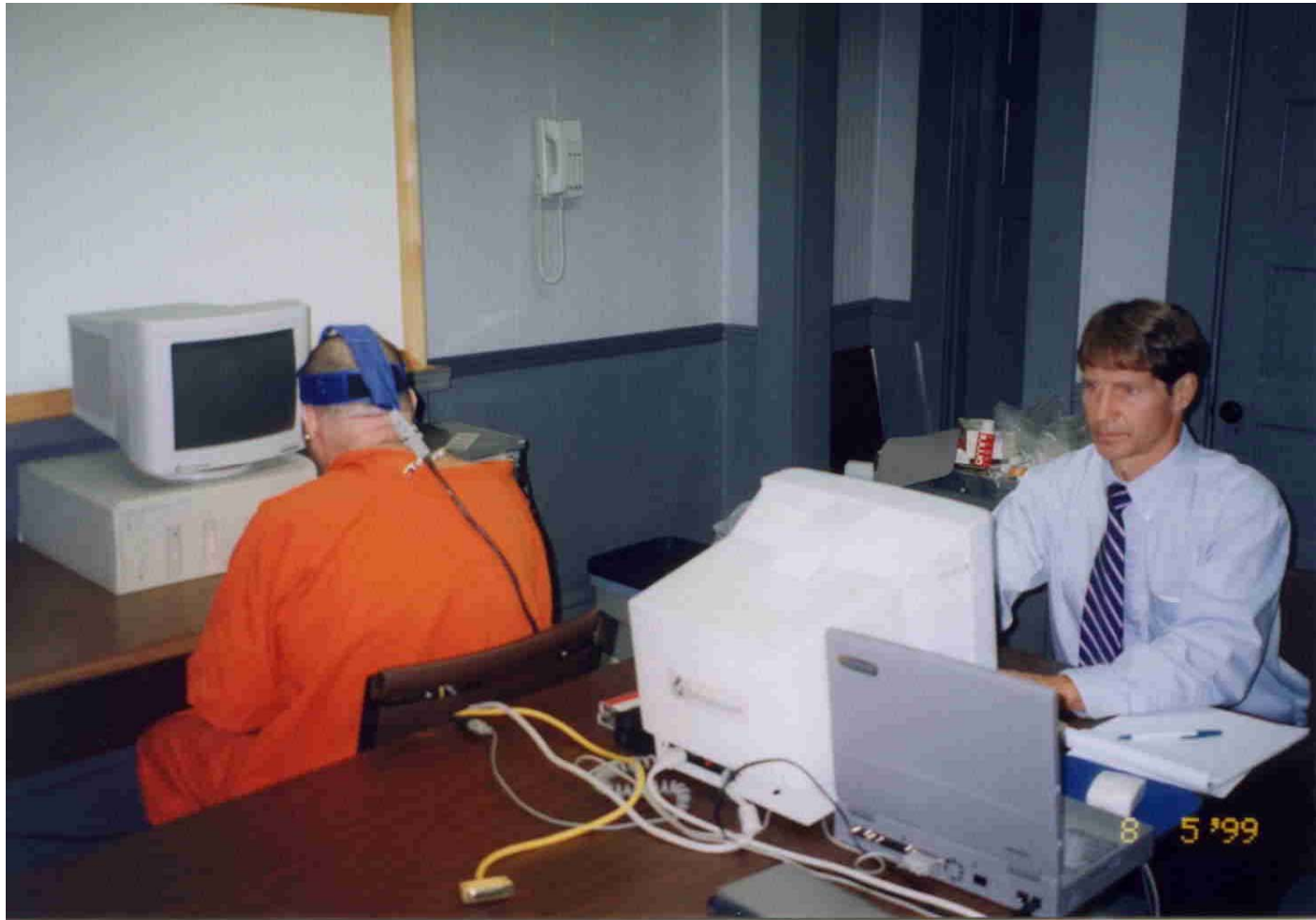


Figure 1: Dr. Lawrence Farwell administers his version of a brain-based memory test to serial killer JB Grinder in 1999.



The limited effect of electroencephalography memory recognition evidence on assessments of defendant credibility

Francis X. Shen^{*,†}, Emily Twedell[‡], Caitlin Opperman^{**},
Jordan Dean Scott Krieg^{††}, Mikaela Brandt-Fontaine^{††},
Joshua Preston^{***}, Jaleh McTeigue^{†††}, Alina Yasis^{††††}
and Morgan Carlson^{****}

* Corresponding author: E-mail: fxshen@umn.edu

Figure 1a. Design of Online Experiment

Fictional fact pattern:

- Stolen diamond necklace
- Insider trading

Randomly assigned to 1 of 15 unique scenarios:

Strength of case

- Strong
- Medium
- Weak

χ Evidence

- No expert evidence
- Polygraph dishonest
- Polygraph honest
- EEG, info present
- EEG, info not present

Assessment of Guilt:

- Yes, saw item
- No, did not

Reported Confidence:

- 0-100%

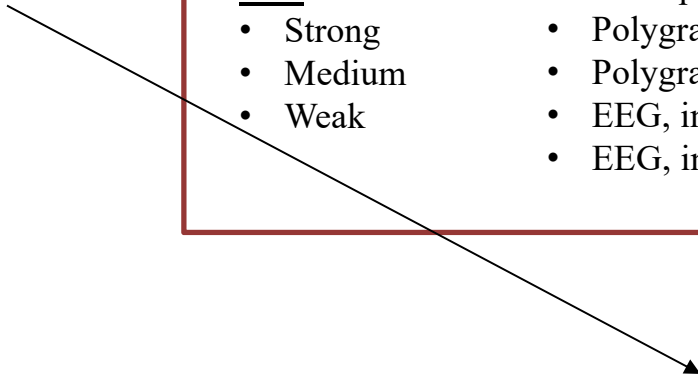


Figure 1b. Design of In-Person State Fair Experiment

Fictional fact pattern:

- Stolen diamond necklace
- Insider trading

Randomly assigned to 1 of 9 unique scenarios:

Strength of case

- Strong
- Medium
- Weak

χ Evidence

- No expert evidence
- EEG, info present
- EEG, info not present

Assessment of Guilt:

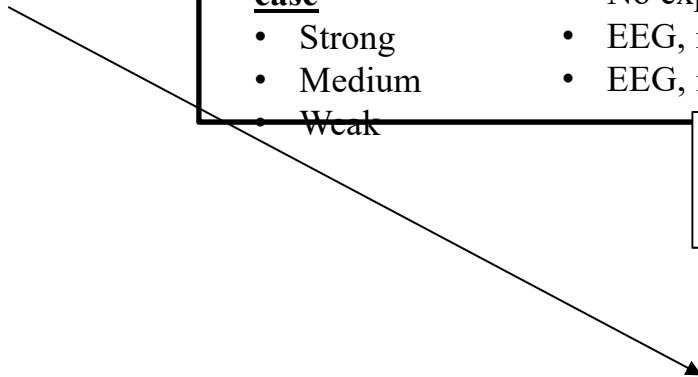
- Yes, saw item
- No, did not

Reported Confidence:

- 0-100%

Interview:

- Explanation of response



Strong: One of the store's employees, Greg, is a potential suspect. Greg was the only employee in the store the night the necklace went missing, Greg had the keys to the office and was the last one to leave, and Greg has previously been convicted of a theft at another place of employment. Greg's cell phone text message log from the night of the theft includes a message that reads 'Big time score'.

Medium: One of the store's employees, Greg, is a potential suspect. Greg worked in the store the day of the theft, and Greg has keys to the office. But surveillance video footage does not show him entering the office. Greg does have a juvenile charge for shoplifting candy, but he has never been fired from a job, and he has been working at the hardware store for 18 years without incident. Greg's cell phone text message log from the night of the theft shows no unusual messages.

Weak: One of the store's employees, Greg, is a potential suspect. Greg worked in the store the day of the theft, but Greg does not have keys to the back office and surveillance video footage does not show him entering the office. Greg has never had any criminal charges filed against him, has never been fired from a job, and has been working at the hardware store for 18 years without incident. Greg's cell phone text message log from the night of the theft shows no unusual messages.

EEG P300 with information present: Greg denies that he took the necklace and says, 'I've never seen it before in my life'. A search of his apartment turns up nothing. Greg takes a brain-based memory recognition test, which uses a particular electrical signature (the 'P300 wave') in Greg's brain to assess whether or not Greg's brain recognizes the necklace he claims never to have seen. The results of this P300 wave test suggest that Greg is not being honest when he says that he has never seen the necklace before in his life.

EEG P300 with information not present: Greg denies that he took the necklace and says, 'I've never seen it before in my life'. A search of his apartment turns up nothing. Greg takes a brain-based memory recognition test, which uses a particular electrical signature (the "P300 wave") in Greg's brain to assess whether or not Greg's brain recognizes the necklace he claims never to have seen. The results of this P300 wave test suggest that Greg is being honest when he says that he has never seen the necklace before in his life.

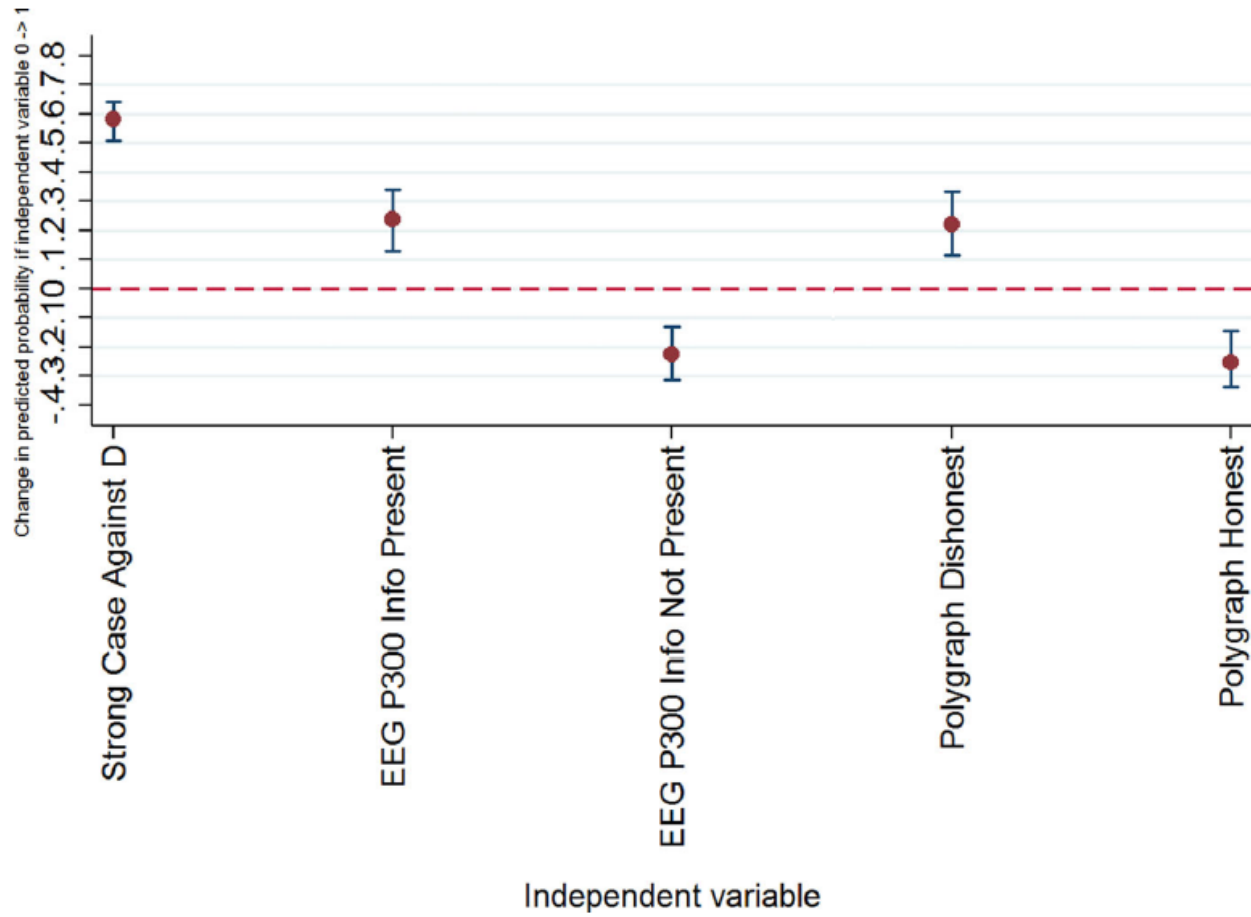


Figure 2: *Experiment 1 (online subjects): predicted change in likelihood of subject deciding that the protagonist saw the object.* The graph plots the change in predicted probability associated with each independent variable changing from 0 to 1. Predictions are based on the logistic regression model as described in the text, with results reported in Table 1. All other variables are held constant at their mean or medians. The dots are a point estimate, and the bars indicate 95% confidence intervals.

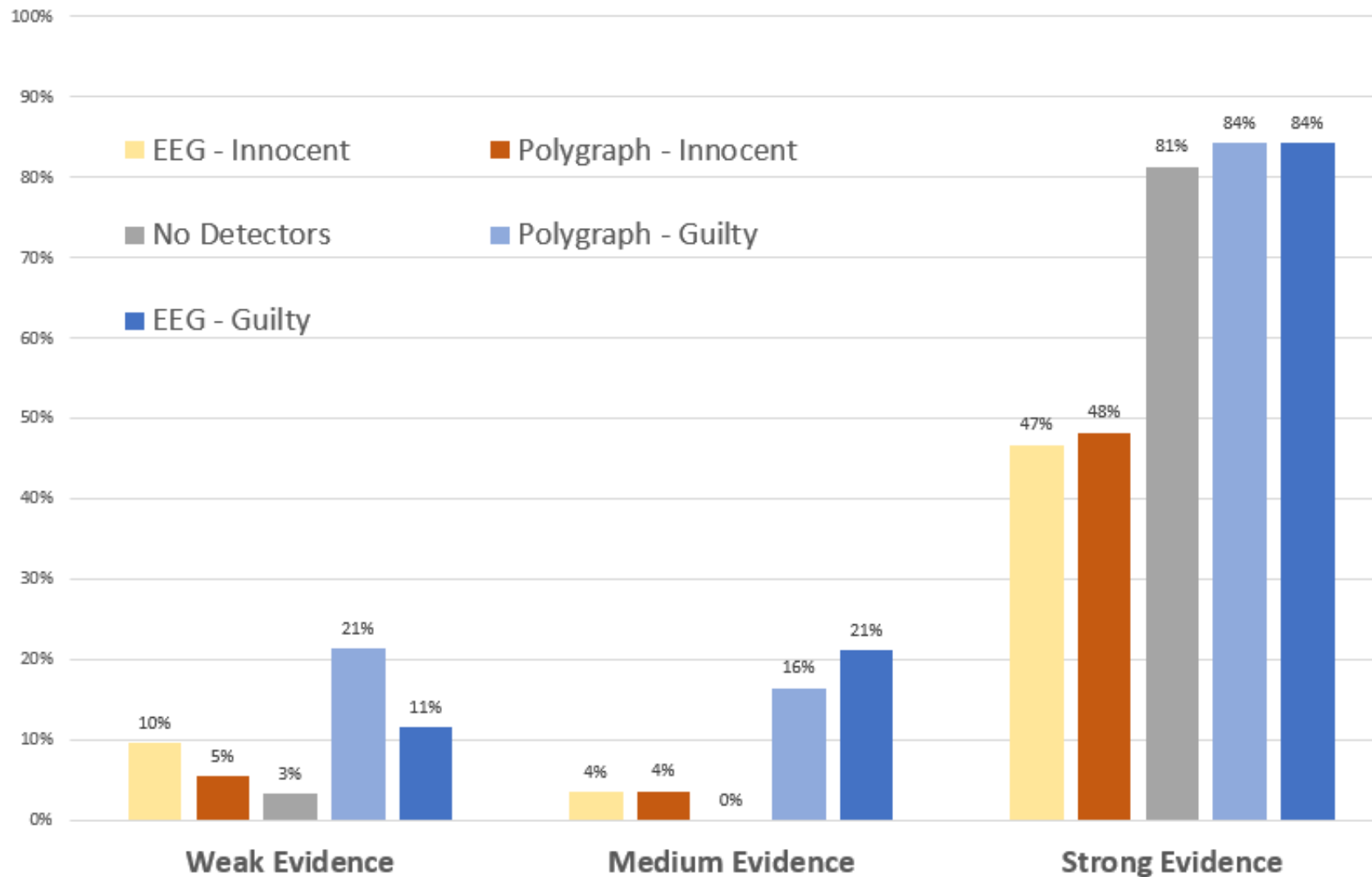


Figure 1. 870 ONLINE SUBJECTS: Stolen Diamond Fact Pattern: % Finding Guilty by Fact Pattern and Detector Results

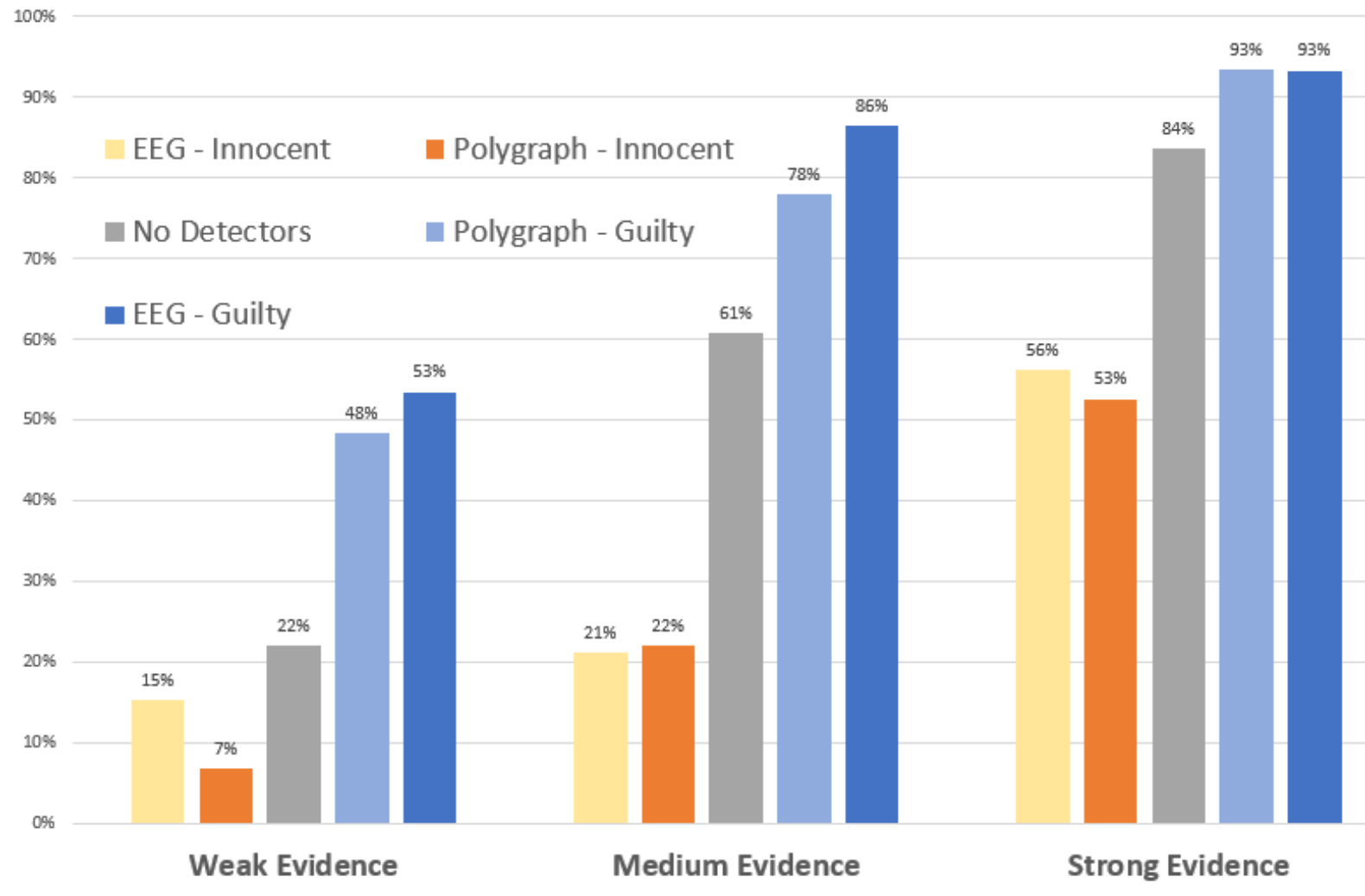


Figure 2. 870 ONLINE SUBJECTS: Insider Trading Fact Pattern: % Finding Guilty by Fact Pattern and Detector Results

Our Next Steps

- **NSF grant proposing real-world forensic application of the memory recognition technology**
- **Improved mock jury studies**
- **Form advisory group to comment upon development of this technology**



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Important Context:

**The Rapidly Expanding Neurolaw
Universe**

Lie Detection & Memory Detection in Court:

fMRI-based lie detection

EEG-based memory recognition

(and our recent research)

The Future of Memory Recognition in Law:

Excitement! *and* Caution