

Penn Fellowships in Neuroscience & Society



Neurolaw Afternoon



Center for Neuroscience & Society
UNIVERSITY of PENNSYLVANIA

fMRI Lie Detection



Lie detection 101

- Two main approaches
 - Comparison question method
 - Guilty knowledge method



Lie detection 101

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 - Comparison question method
 - Guilty knowledge method
- Did you kill a man in Reno?
 - If subject lies, expect greater physio response to this question than to other emotional questions (eg, Have you ever stolen?)



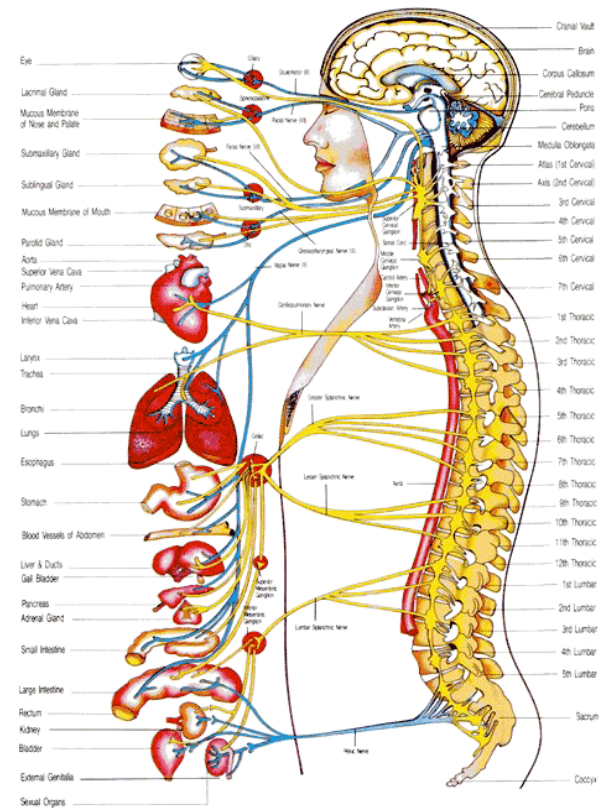
Lie detection 101

- Two main approaches
 - Comparison question method
 - Guilty knowledge method
- Did you kill a man in Reno?
 - If subject lies, expect greater physio response to this question than to other emotional questions (eg, Have you ever stolen?)
- Did the knife have a wooden handle?
 - If the subject knows about the murder weapon, the correct description will “ring a bell” / “click” and this will be reflected in physiology



Lie detection 101, continued

- How to measure the physiological impact of giving a deceitful answer or recognizing features of the crime?
- Deception increases autonomic nervous system arousal
 - Sympathetic division activates during arousal, emotion



Measuring sympathetic nervous system activity for lie detection

- Ancient China:
 - Interrogate with dry rice in mouth
- 20th Century, US and elsewhere, “polygraph”
 - Blood pressure
 - Respiration
 - Heart rate
 - Sweat

Autonomic nervous system controls physiological arousal		
Sympathetic division (arousing)		Parasympathetic division (calming)
Pupils dilate	EYES	Pupils contract
Decreases	SALIVATION	Increases
Perspires	SKIN	Dries
Increases	RESPIRATION	Decreases
Accelerates	HEART	Slows
Inhibits	DIGESTION	Activates
Secrete stress hormones	ADRENAL GLANDS	Decrease secretion of stress hormones



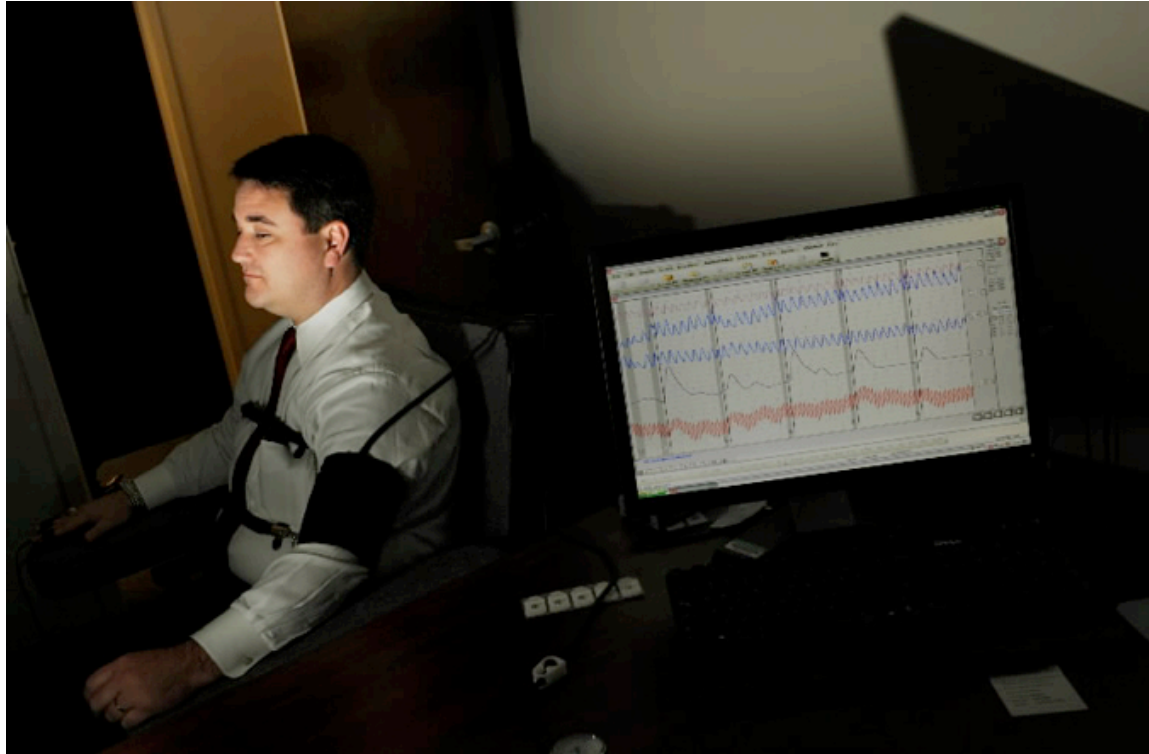
History of the polygraph



- William Moulton Marston's undergraduate research project at Harvard
 - Blood pressure goes up when lying (Comparison Question) or hearing relevant crime facts (Guilty Knowledge)
- Later workers added respiration, HR and GSR



Polygraph

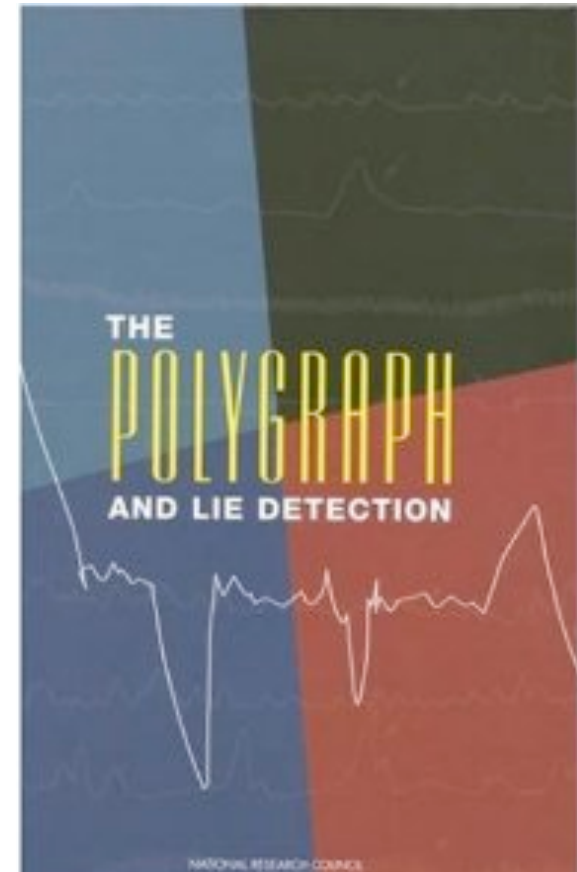


Note aura of science (= objectivity, certainty, authority)

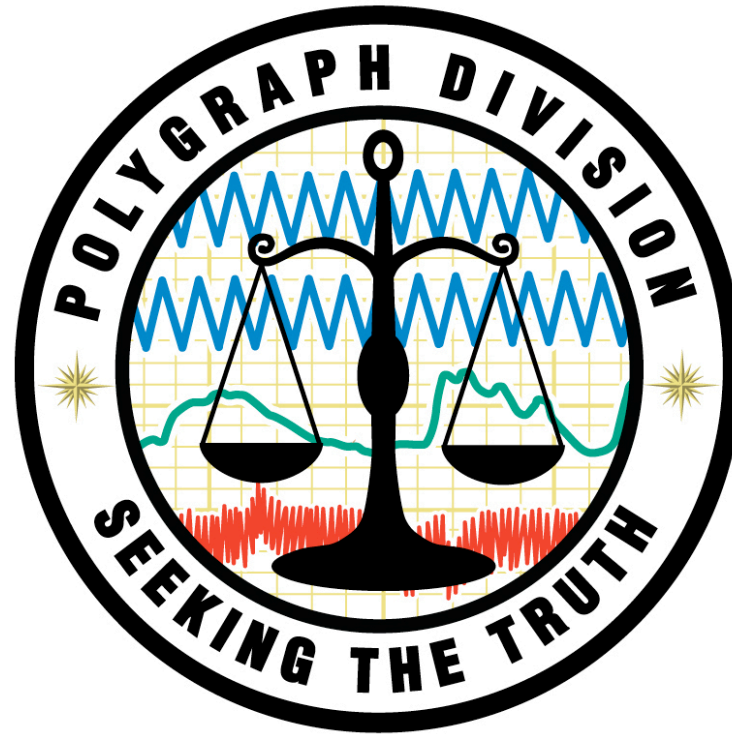


Does it work?

- Yes and no (mainly no).
 - Accuracy depends on who's measuring
 - Hard to measure accuracy in real world situations
 - Does “work” mean better than guessing? 75%? 99%?
 - Especially bad for screening (low base rate)
- Despite this...



Intelligence



Use in criminal investigation

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Boards & Commissions: D - M

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Police Polygraph



Frequently Asked Questions about Polygraphs

Q. When are Polygraphs used?

A: The Santa Barbara Police Department conducts pre-employment polygraph examinations for most positions at the police department. They are conducted to verify information, qualifications, past criminal or drug history, if any.

The Santa Barbara Police Department also conducts criminal polygraphs on suspects or persons to find out if they committed a particular crime or to exonerate them from suspicion of criminal activity.



Polygraph and the law

- Employee Polygraph Protection Act of 1988
- Criteria for admissibility of scientific evidence
 - Frye (1923 – actually concerned polygraph)
 - Has the new method “gained general acceptance in the particular field in which it belongs”
 - Daubert (1993 – concerning drug and birth defects)
 - More flexibility



What's past is prologue



ERP and fMRIrain-based lie detection:

Even more scientific impressiveness

Even less empirical validation



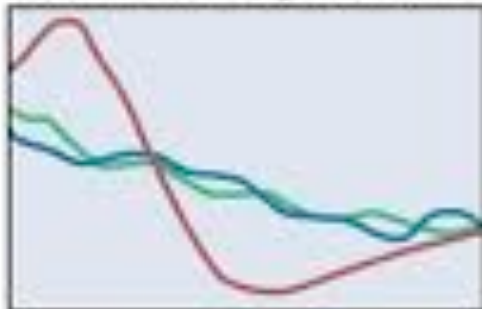
ERP markers of guilty knowledge

- “Brain Finger-Printing”

- Red: Information the suspect is expected to know.
- Green: Information not known to suspect.
- Blue: Information of the crime that only perpetrator would

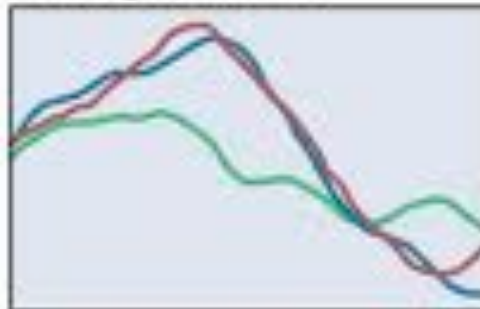
NOT GUILTY

Because the blue and green lines closely correlate, suspect does not have critical knowledge of the crime.

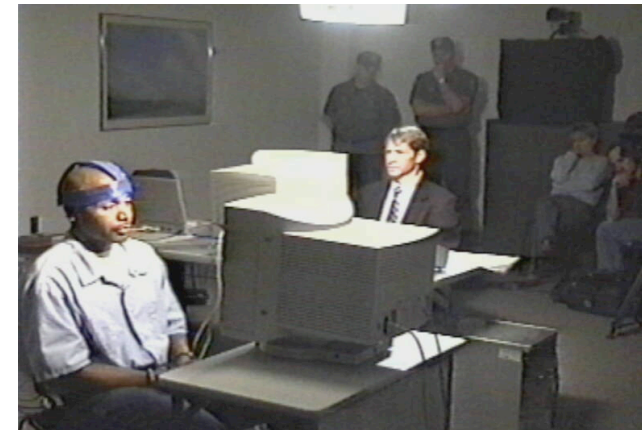


GUILTY

Because the blue and red lines closely correlate, suspect has critical knowledge of the crime.



For more information see: www.brainwavescience.com.



- Admitted for reversal of Terry Harrington's murder conviction



ERP markers of guilty knowledge

- Brain Electrical Oscillations Signature (BEOS)



- Used to convict Aditi Sharma of murder
- As of 2009 over 300 suspects or witnesses have taken the BEOS test



fMRI lie detection

- Starting in 2002, studies of the neural bases of deception
 - Basic research with simple tasks, eg Langleben's playing card task: subject gets a card, must conceal its identity while being shown many cards and asked, for each one, "is this your card?"
 - How does this differ from real world deception?

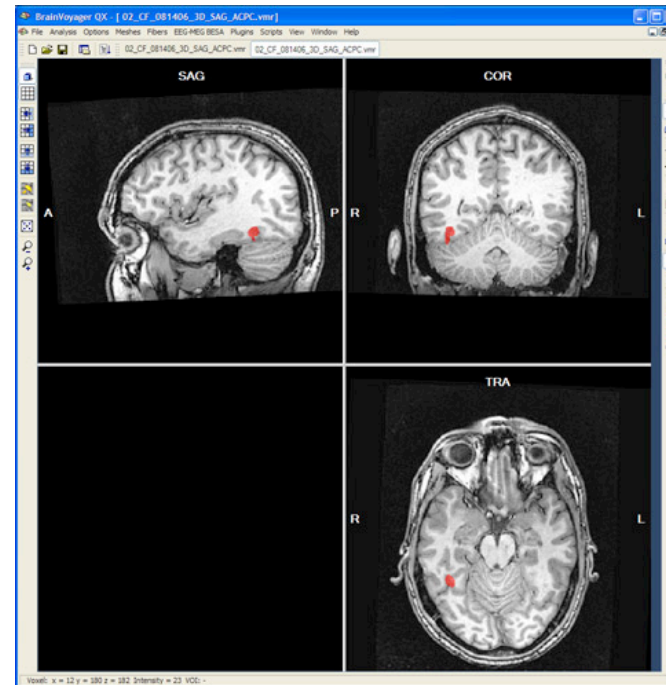


Activation associated with deception

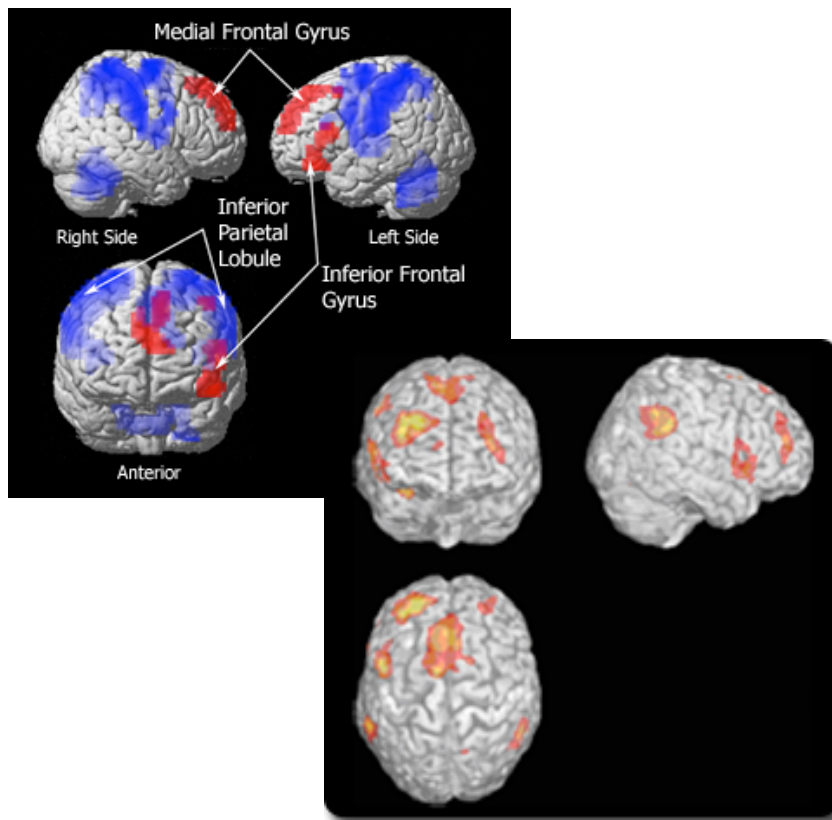
- Is there a “brain signature” of deception?

Is it possible that lying is like face perception?

Is there a “Prefrontal Prevarication (lying) Area,” analogous to the Fusiform Face Area?



A constellation of areas typically, but not invariably, activated



- Across studies, dorsolateral PFC, ventrolateral PFC, posterior parietal, anterior insula, anterior cingulate
- Locations of lie-truth difference vary
- *Regions associated with effort and cognitive control*
- *le not specific to lying*



Multivariate techniques



- How well can we discriminate lies from truth using all the (inconsistent and nonspecific) information?



Major outstanding problems

- In the lab, confounds: deception trials also more familiar, different response demands
- Outside the lab, no relevant evidence





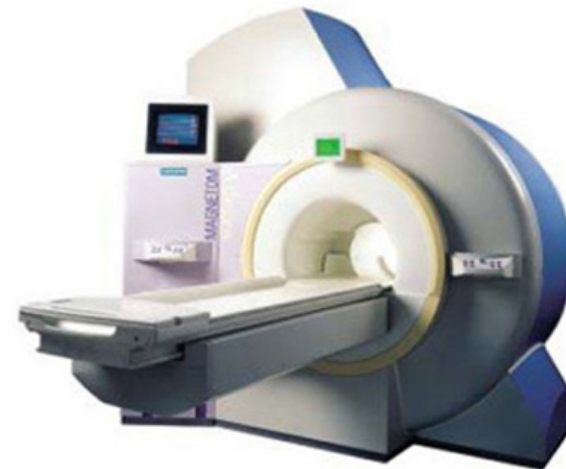
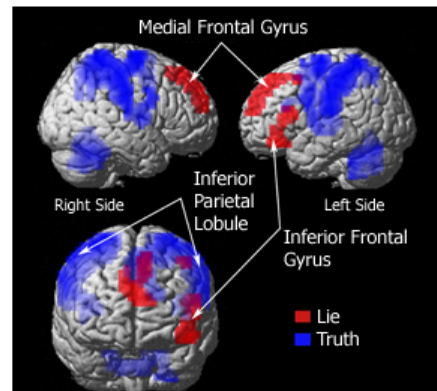
New Truth Verification Technology

No Lie MRI, Inc. provides unbiased methods for the detection of deception and other information stored in the brain.

The technology used by No Lie MRI represents the first and only direct measure of truth verification and lie detection in human history!

No Lie MRI uses techniques that:

- Bypass conscious cognitive processing
- Measure the activity of the central nervous system (brain and spinal cord) rather than the peripheral nervous system (as polygraph testing does).



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CEPHOS CORPORATION uses the latest advances in medical imaging to peer inside the inner workings of the brain during deception. Our goal is to develop accurate tools to detect lying.

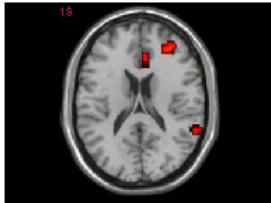
Lying is shown to activate specific, discrete parts of the brain. We can use these regions to determine if a person is lying with a high degree of accuracy. No activation is seen when telling the truth.

Standard magnetic resonance imaging (MRI) technology is used to detect brain activations. This technique is referred to as functional magnetic resonance imaging (fMRI).

Over the last six years, this technology has been used in a series of studies to detect the neuronal basis of deception. fMRI has numerous advantages over standard "lie detectors" including:

- o **Accurate - currently 90% accuracy in clinical testing.**
- o **Machine-based - all analysis performed using automated computer analysis.**
- o **Non-subjective - humans do not ask the questions or examine the scans.**
- o **Validated algorithms - uses algorithms used and developed in thousands of clinical studies.**

CEPHOS continues to test and validate the technology with the goal of achieving 95% accuracy. Based on valid clinical results in 2006, the company intends to offer this service in the first half of this year.




Areas appearing in red represent activated regions of the brain when telling a lie.



Original message
From: Martha Farah [mfarah@psych.upenn.edu]
Received: 2/6/10 4:35 PM
To: Steven J. Laken, Ph.D. [slaken@CEPHOSCORP.COM]

Subject: From Steven J. Laken, Ph.D. ★

 Reply  Forward  Archive  Junk  Delete

Subject RE: seeking reference citation

2/6/10 5:45 PM

Dear I **To:** Martha Farah ★

Other Action

I'm pu The references are on the website. The 97% is documented and has not been subjected to peer review however it has been
publis reviewed by our scientific panel.

Cephx Steven J. Laken, Ph.D.
than 3 President and CEO
Cephos Corp.
Thank P.O. Box 45
Tyngsboro, MA 01879
Marth Direct: 978.319.4542
Fax: 978.856.3350
Marth Main: 978.703.4725

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Daubert hearing 2010



Daubert hearing on fMRI lie detection in Memphis Federal Court, 2010



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Evidence in science and law

- Truth.
- Truth, as best we can determine it, for practical purposes
 - The jury, not a lie detector, decides what is true... Lie detector evidence may help the jury decide



Not admitted, but...

- Judge Tu Pham:

“in the future, should fMRI-based lie detection undergo further testing, development and peer review, improve upon standards controlling the technique’s operation, and gain acceptance by the scientific community for use in the real world, this methodology may be found to be admissible even if the error rate is not found to be quantified in a real world setting.”



Roles of neuroscience in law

1. Ammunition for attack on very idea of legal or moral responsibility and implications for punishment
2. Handmaiden to psychology
 - NGRI
 - Adolescent culpability
 - Mitigation at sentencing
3. Other
 - Detection of deception
 - Also: Screening and prediction, Therapeutic sentencing, Memory dampening, Pain detection...



Thank you!



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How can we determine real-world validity?

- Peter Imrey (2010): a “clinical trial”
 - Cases selected prior to review of evidence
 - Scan defendants
 - Later, examine cases in which indisputable evidence came to light
- Cost estimated in the range of $\$10^8$

