CROSS –EXAMINING THE BRAIN: A LEGAL ANALYSIS OF NEURAL IMAGING FOR CREDIBILITY IMPEACHMENT

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The last decade has seen remarkable process in understanding ongoing psychological processes at the neurobiological level, progress that has been driven technologically by the spread of functional neuroimaging devices, especially magnetic resonance imaging, that have become the research tools of a theoretically sophisticated cognitive neuroscience. As this research turns to specification of the mental processes involved in interpersonal deception, the potential evidentiary use of material produced by devices for detecting deception, long stymied by the conceptual and legal limitations of the polygraph, must be re-examined. Although studies in this area are preliminary, and I conclude they have not yet satisfied the foundational requirements for the admissibility of scientific evidence, the potential for use – particularly as a devastating impeachment threat to encourage factual veracity – is a real one that the legal profession should seek to foster through structuring the correct incentives and rules for admissibility. In particular, neuroscience has articulated basic memory processes to a sufficient degree that contemporaneously neuroimaged witnesses would be unable to feign ignorance of a familiar item (or to claim knowledge of something unfamiliar). The brain implementation of actual lies, and deceit more generally, is of greater complexity and variability. Nevertheless, the research project to elucidate them is conceptually sound, and the law cannot afford to stand apart from what may ultimately constitute profound progress in a fundamental problem of adjudication.

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I. Introduction

"But where are these practical psychological tests, which will detect specifically the memory failure and the lie on the witness stand? …If there is ever devised a psychological test for the valuation of witnesses, the law will run to meet it. … Whenever the Psychologist is really ready for the Courts, the Courts are ready for him."[*]

The premise of this Article is simple: "the Psychologist" is almost ready for "the Courts" several decades after Wigmore began waiting for him, but the Courts must be made ready, rather than be relied upon to "rush to embrace" any advances in detecting deception. Since technology now allows the observation of the internal neurological processes by which deceptive information is produced, an observer adjudicating credibility need no longer be limited to the psychosomatic responses measured by either demeanor observation or polygraph interpretation, which are poorly correlated in principle and practice to deceptive acts. In Part II I describe and evaluate the scientific changes that have created this potential for detecting deception, which is only just beginning to be exploited. A major element has been the expansion of cognitive neuroscience, a theoretical orientation toward mental phenomena that first characterizes with precision the information and processing steps needed to accomplish some mental task, and second, identifies within the brain those structures that actually perform the information processing steps involved. It is the recent technological changes in brain imaging, particularly the visualization of the brain while it is actively working – so called "functional imaging" – that have allowed cognitive neuroscience the potential to identify relatively subtle processes such as deception. Moreover, the ability to examine in real time the response of the subject brain during a question and answer session makes it feasible to use this technique forensically, so long as the pattern of brain activity corresponding to deception is sufficiently well-characterized.

In order to more precisely specify the research and evidentiary potential of this technique, I break down deception into three different types of mental operations, which show distinct patterns and differ in their practical or potential tractability to accurate measurement. Perhaps

[*] JOHN H. WIGMORE, WIGMORE ON EVIDENCE, 2nd Ed., § 875 (1935).

the most straightforward testing paradigm is *feigned ignorance*, sometimes called "guilty knowledge" in the polygraph literature,[†] or malingering.[‡] In this circumstance, it is relevant whether the subject knows X or not; the deceptive subject (falsely) denies knowledge of X, and the detection of deception device (DDD) attempts to accurately distinguish between the presence and absence of X, which, respectively would either bolster or contradict this denial. More problematic but potentially more valuable is the use of a DDD in the classic circumstances of *the lie*, wherein the subject is asked as to the fact of some matter and instead of responding sincerely with X, responds with Y, a falsehood about that state of affairs to which X also refers. The DDD in this context is required to accurately identify when the subject's brain is formulating a verbal response in conflict with a (different and presumably sincere) response evoked directly from the subject's memory. Most generally and most problematically, we would ideally like to detect deception when the subject is neither denying knowledge nor uttering falsehoods, but is simply misleading the questioner because they have a subjective *intent to deceive*. Note that it is only in this final paradigm that we are actually measuring "deception" per se, rather than mental operations that may distinguish deception from normal communication. Hypothetically, a DDD could be used to identify the presence of this intent in the subject.[§]

The goal and measure of a detection of deception device will be to demonstrate accuracy in terms of empirical sensitivity (picking up all instances of the deception type) and specificity (not picking up other phenomena not demonstrating deception). As statistical measures, sensitivity corresponds to a low rate of "Type II" errors, sometimes called "false negatives," while specificity is the inverse of "Type I" errors, or "false positives." Moreover, the test will

[†]Gershon Ben-Shakhar, Maya Bar-Hillel, and Mordechai Kremnitzer, *Trial by Polygraph: Reconsidering the Use of the Guilty Knowledge Technique in Court*, LAW AND HUM. BEH., 26: 527, 530 (2002).
[‡] *See* Douglas Mossman, Daubert*, Cognitive Malingering, and Test Accuracy*, L. & HUM. BEHAV. , 27: 229, 231
[§] This type of deception, of course, encompasses the preceding two kinds; that is, if there truly were a DDD capable of showing intent to deceive, a subject denying knowledge he possesses, or choosing to utter a lie, would be detected by the intent – more specifically, the hypothetical distinctive cognitive planning necessary to deceive – that necessarily preceded their deceptive behavior. It should be pointed out that none of these definitions precisely track the law of perjury, which would require a false material statement (and this can be a denial of knowledge), along with criminal intent. *See Bronston v. United States*, 409 U.S. 352 (1973) (disallowing prosecution for literally true but misleading statements); *United States v. O'Neill*, 116 F.3d 245, 247 (7th Cir. 1997) (successful perjury prosecution for false denial of knowing particular people in drug conspiracy).

also have to possess sufficient theoretical justification for what it measures in order to satisfy all the scientific criteria for admissibility. Along with discussing neuroimaging, and in particular, functional magnetic resonance imaging (fMRI), as the most promising techniques to lay the groundwork of this research, I also discuss in a more cursory fashion the use of electroencephalograms (EEGs). Instead of showing actual brain structures, these devices record electrical activity throughout the brain by the attachment of external electrodes, and have been promoted under the label "brain fingerprinting" as a DDD for denied knowledge; in addition, I will occasionally for purposes of contrast, discuss the polygraph research as it relates to the denied knowledge, the lie, or the intent to deceive paradigms.

Having reviewed the facts, I present in Part III a method of potentially integrating this research into the legal arena, beginning with an assessment under Federal Rule of Evidence 702, of its capacity to satisfy the scientific criteria of admissibility. In order to create a "virtuous cycle" of increasing accuracy and increasing court use, I propose a model that begins with limited admissibility in those contexts most likely to encourage increased rigor – namely, when the proponent is adverse to the witness tested, a circumstance that implies the use of fMRI initially for impeachment rather than substantive evidence. This is illustrated by a simple extensive form game of circumstances where there can be mutual benefit for civil plaintiffs and defendants to "cross-examine" the brain of a witness whose credibility has been put in doubt.

Historical Context

Dean Wigmore's confident prediction reflects the dubious quality of legal judgments of credibility, and the unfilled demand for any form of accurate assistance. The exclusion of DDDs from the trial setting is therefore no small part of the history of modern evidence. Until very recently, this interaction involved only a recapitulations of the perennial questions surrounding the polygraph, and proceeded according toward a continually repeated rejection modeled on the very *Frye*[**] decision which had made "the art of the lie detector" the gold (or perhaps pyrite)

[**] *Frye v. United States*, 293 F. 1013 (D.C. Cir. 1923)

standard of an unscientific means to ascertain the truth. Hypothetically, at least in the limited universe of civil cases where other evidence is quite equivocal, even a questionable instrument like the polygraph might be of value,[††] but an absolute bar rather than a conditional one has always been the rule.[‡‡] Or as Justice Thomas put it in conclusive terms: "A fundamental premise of our criminal trial system is that 'the *jury* is the lie detector.'"[§§]

This blanket exclusion of a method, of course, provides little incentive for its scientific improvement, and indeed the polygraph of today differs little in its essential features (and vices) from the earliest models.[***] Blaming *Frye* for this, or even the professional interest of the bar, would be excessive, as the primary culprit is the polygraph itself, whose theoretical and practical flaws are such that the debate has generally been whether it is "completely useless" or just "usually useless" (which transforms, of course, to "occasionally useful").[†††] The experience of Massachusetts, for instance, suggests that even with an incentive to improve, the ability of the polygraph to progress remains weak. Having recognized the negativeincentives of a blanket prohibition, Massachusetts made polygraph evidence admissible by discretion, with the explicit hope that this would cause advocates and researchers to improve their techniques now that there would be some kind of marginal benefit in the form of increased admissibility for increased

[††] Insofar as an instrument gives results that even slightly above chance – something that even strenuous critics of polygraphy, among whom I must count myself – do not deny, it will alter the probability of reaching the "correct" result in a case whose probable outcome absent polygraphic evidence is 50/50. Such circumstances blunt one of the major objections to polygraph evidence, because even if a fact-finder mistakenly believes the device to be more accurate than it actually is, they will arrive (on average) at the correct legal outcome, their only error of "prejudice" being that they are more confident of the decision than they ought to be.

[‡‡] *Sanchez*, 118 F.3d at 197 (holding that the traditional rule that polygraph evidence is never admissible to impeach the credibility of a witness "*is binding* upon us in this case" (emphasis added)). In so doing, we effectively reaffirmed our per se ban on polygraph evidence. *Cf. United States v. Scheffer*, 523 U.S. 303, 311, (1998) *United States v. Prince-Oyibo* 320 F.3d 494, 501 (4th Cir. 2003)

[§§] *United States v. Scheffer*, 523 U.S. 303, 313 (1998) (emphasis in original). Although this might be so at the present time – it is not "fundamental" in the way that term is usually employed, as a historically invariant or logically necessary feature. *See* George Fisher, *The Jury's Rise as a Lie Detector*, 107 YALE L.J. 575, 579 (1997). "When and why did the system declare that jurors had the wisdom to arbitrate unvarnished credibility conflicts at criminal trials? To the question 'when,' the surprising answer is very recently."

[***] Ken Alder, *A Social History of Untruth: Lie Detection and Trust in Twentieth-Century America,* REPRESENTATIONS 80: 1(2002).

[†††] For an updated version of this debate, *see* DAVID L. FAIGMAN ET AL., MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY, 2nd ed., Ch. 10 (2002). Notably, this is the only part of the treatise sufficiently controversial that it requires the adversarial process rather than the learned voice of scholarly consensus normally characteristic of the genre.

accuracy.[‡‡‡] After waiting more than a decade, however, Massachusetts reverted to its older rule – noting the conspicuous failure of the polygraph to respond to the opportunity they had presented.[§§§]

Given the stagnation in polygraph technology and technique, the more interesting question might be why its admissibility remains such a live and recurrent issue. One explanation might be that some litigants, when the facts and the law seem to be going against them, may resort to a polygraph, thinking that a favorable result might occur and they have in effect nothing to lose (since they would, in the absence of stipulation, be left free to introduce the test or not). *Ceteris paribus*, this would attract those with the weakest cases, who are disproportionately deceptive in their litigation position. Consequently they would be attracted by the very *unreliability* of the polygraph test (and the more unreliably administered the better for them), since a favorable result would perforce be an inaccurate one. Fifty-fifty odds or worse of such a result (technically, a false negative showing no deception)[****] might worth the gamble to such a desperate party, for instance if it might generate reasonable doubt for a criminal defendant – a common context for an attempt at polygraph admissibility.[††††]

[‡‡‡] *Comm. v. Vitello*, 381 N.E. 2d 582 (Mass. 1978).

[§§§] *Comm. v. Mendes*, 547 N.E.2d 35 (Mass. 1989)

[****]For purposes of clarity, what I mean by accuracy is a low rate of both Type I error, detecting "something" when there is actually nothing, as well as Type II error, detecting "nothing" when what is being sought for is actually present; a Type I error is sometimes called a "false positive," and a Type II error a "false negative." Since in this paper, the "something" is deception – truth or falsity itself – I generally avoid these labels which would lead to difficult locutions such as an unwarranted positive being a "false falsity." Rather I will speak of the rates of undetected deceit or "evasions" (the Type II problem) and truth mischaracterized or "artifacts" (the Type I problem).

[††††]An uncontrolled "market" for self-administered detection of deception devices has many of the classic hallmarks of a "market for lemons." George Akerlof, *The Market for Lemons* (1973). The polygraph is known to produce errors, at rate *E*, and different methods and testers have different rates of error, which are not visible to the consumer. The consumer comes in two types, either honest or deceptive, and therefore favors a low *E* or high *E*, respectively. Quite apart from any estimate of the relative frequency of these types who become criminal defendants, the chances are that any other evidence in the case will tend to corroborate honesty and contradict deceit. Therefore the honest person will find the evidence largely redundant (at rate 1-E) and damaging at rate E – a risk rarely worth taking. The deceitful will more often find themselves in circumstances where their expected rates of loss exceed 1-E, meaning they attempt a polygraph, because it gives them E chance of an inaccurate result, reasonable doubt, and acquittal. The rate at which the evidence is admitted is irrelevant to this calculation since it merely reduces the potential benefit of an erroneous test, without its ceasing to be of marginal benefit. To the extent the foregoing is true, the less accurate methods of the polygraph will be chosen by the dominant type of consumer, and the average level of E will increase (or at the very least not fall), meaning the discipline would become less accurate over time, or least no more accurate. I discuss some ways to get around this problem of adverse selection. Part III, *infra*. In this case, one might say that the polygraphy industry has taken lemons and learned to make lemonade.

Assuming this is *part* of the answer that explains when admissibility is actually sought, the more fundamental reason why polygraph evidence will not “go away” is that it remains relevant to recurrent issues in adjudication, those of credibility, and the substitute methods of adjudicating these issues – usually through the naked eye assessment of witness demeanor – are not superior to the polygraph. This demeanor evidence as going to the credibility of the accompanying statements is assessed in an artificial context (the courtroom) under questioning by an “expert” (the lawyer). So it is hardly distinguishable in form from polygraph evidence.[‡‡‡‡] The fact is that the court uses the human mind as a DDD, providing it with visual and paraverbal data, but when this built-in “device” is tested for accuracy, it fails miserably.[§§§§] Even individuals in law enforcement generally perform at levels barely above chance,[*****] and they presumably have more experience and incentive than juries or even judges in assessing statement credibility. Consequently, the whole process of making witnesses sweat on the stand, however integral it might be to the self-image of the bar, is highly dubious as an aid to the truth.[†††††] Supposing the polygraph to have improved, but not much, the best that could be said of live examination over the last century is the same, meaning its relative value for adjudication has not really changed, and there is still plenty of demand for greater accuracy in this area. At some level, most courts surely realize this, or so one would hope, and this continued and unfilled

[‡‡‡‡] James P. Timony, *Demeanor Credibility*, 49 CATH. U. L. REV. 903, 937 (2000) (citing the “disquieting empirical evidence” regarding demeanor credibility)

[§§§§] *See* Holly Orcutt, et al., *Detecting Deception in Children’s Testimony: Factfinders’ Abilities to Reach the Truth in Open Court and Closed Circuit Trials,* LAW AND HUM. BEH. 22: 339, 365 (2001) (finding jurors incapable of telling when witnesses are dissembling). “I am led by my investigations to serious doubt concerning the ability of a trial jury to perform the central task assigned to them: to assess credibility. And, I must add, insofar as I can determine, the laws of evidence and the contribution of the trial courts in interpreting and applying the laws do little to enhance confidence.” H. Richard Uvilller, *Credence, Character, and the Rules of Evidence: Seeing Through the Liar’s Tale*, 42 DUKE L.J. 776, 778 (1993)

[*****] *See* Christian A. Meissner, Saul M. Kassin, *“He’s guilty!”: Investigator Bias in Judgments of Truth and Deception*, LAW AND HUM. BEH. 26: 469, 472 (2002), (showing in a review of studies no effect of training, except increased likelihood of labeling all individuals as deceitful, yielding more Type II errors, along with increased false confidence in one’s abilities

[†††††] It is important to distinguish this from the questioning process used to identify inconsistencies or evasions; this is clearly valuable for credibility purposes, since by fleshing out the witness’s account, its actual level of relative plausibility is more easily assessed. What I question is the marginal value of conducting this questioning *live*, in order to achieve parallel transmission of non-verbal demeanor evidence that will inevitably affect credibility where that is at issue, despite the proven unreliability of such evidence.

demand explains their willingness to reconsider any apparent system whose improved ability might fill this need.

Moreover, and more importantly, from a biological standpoint, nonverbal demeanor evidence and polygraph measure are essentially metrics of the same phenomenon, a general level of sympathetic nervous system arousal loosely associated with an anticipated risk of detection or the transgression of norms (fear or embarrassment). The likelihood is that changes in blood pressure, sweating, and so forth have been used to assess credibility of accompanying verbal statements since the beginning of spoken language; likewise these markers have always been unreliable.[‡‡‡‡‡] What current research offers is what the polygraph fundamentally did not, a way to go beyond the external correlates of deception and into the specific neural processes that underlie the different types of deceptive behavior.

II. The Science and Technology of Detecting Deception

A. *The method of cognitive neuroscience*

The cognitive neuroscience way of looking at the mind is driven fundamentally by a desire to know how the brain produces behavior. Most cognitive neuroscientists would agree that their particular approach, as it has emerged over the last quarter-century, has been inspired by computer science to ask "how a machine with the physical properties of the brain can produce specific behaviors when given specific inputs."[§§§§§] What cognitive scientists mean by "specific" in this regard is usually defined in terms of an information-processing goal – or for inputs, a type of information – that can be *specified* computationally as a series of steps. For deception, no one

[‡‡‡‡‡] A larger anthropological question is implicated by this point, regarding why our system of verbal communication has apparently stabilized around imperfect deception, given that there are countervailing selective pressures for a signaler to deceive and for a receiver to detect deception. Recent research suggests that in systems with repeated interactions, "bad liars" may be favored. *See* Paul W. Andrews, *The influence of postreliance detection on the deceptive efficacy of dishonest signals of intent- understanding facial clues to deceit as the outcome of signaling tradeoffs*. EVOLUTION & HUM. BEH. 23 103, 115 (2002). This result, which could maintain a mix of types genetically, is in line with a theoretical model that would assume "tells" (indicators of deception) are not selected against because it will be easier to forgive and trust someone after a revealed deception if their deceptions are accompanied by "tells"; hence such signals are a form of costly insurance advantageous to certain types. By contrast, if a lie is sent without such insurance, the "once-bitten, twice-shy" deceived receiver will not be able to categorize future transmissions and may simply mistrust the sender.

[§§§§§] FRONTIERS IN COGNITIVE NEUROSCIENCE, xxiv, Stephen M. Kosslyn, and Richard M. Anderson, eds., MIT 1992.

has yet specified precisely what one must do to deceive, and this is almost certainly because there are many different kinds of deception, with different demands. What can be noted is what is *not* needed as an informational matter. Specifically, that it is *not necessary* that a person "feel bad" or signal fear or otherwise engage the body in somatic arousal. Indeed this behavior is probably counter-productive for what might be taken as working definition of the cognitive goal: to induce in the receiver of a signal a belief the sender thinks plausible but false, a process that entails the receiver mistaking the signal as one emitted in order to convey information the sender believes to be true.[******] Consequently, a cognitive neuroscientist would begin the study of deception not by looking at bodily arousal as is the case with polygraphy or the visual observations of stress reactions, but by examining "directly the organ that produces lies, the brain … identifying specific patterns of neural activation that underlie deception."[††††††]

Ideally, problem specification in cognitive neuroscience is to be done quite apart from, and prior to, actually looking at the physical properties and relationships of groups of neurons, which founding cognitive neuroscientists such as Marr referred to as the "level of implementation."[‡‡‡‡‡‡] The implementation level corresponds conceptually to building a working piece of computing technology, and was contrasted by Marr with the computational level of "abstract problem analysis," which consisted of decomposing the problem into its primary parts (for example, the need to combine visual data from two eyes into a single image, and then to store this image). The intermediate level for Marr was that of the algorithm, giving a formal "programming" procedure that would in principle yield the right output for the inputs.[§§§§§§] Once these levels had been penetrated the researcher would see how one would

[******] There are to be sure inadequacies with this definition – for instance whether merely concealing an expected signal counts, but these are beside the point for the moment. Note, however, that this definition does not imply that the receiver is denied "the truth." The deceitful sender may also be mistaken about what is actually true, and yet may still act to mislead, under this definition, as what he (the deceiver) *thinks* is true. *Accord*, Augustine, *De Mendacio*, ¶ 3 (lying is the intentional negation of the subjective truth).

[††††††] G. Ganis, S. M. Kosslyn, S. Stose, W. L. Thompson, & D.A. Yurglun-Todd, *Neural Correlates of Different Types of Deception: An fMRI Investigation*, CEREBRAL CORTEX 13: 830, 830 (2003)

[‡‡‡‡‡‡] *See supra* note ___, xxiii.

[§§§§§§] *See* FOUNDATIONS OF COGNITIVE SCIENCE, Michael A. Posner ed., 1989 MIT, pp. 302-303, Ch. 8, "Brain and Cognition, Terrence J. Sejnowski and Patricia Smith Churchland (discussing Marr's theories, especially as articulated in David Marr, VISION, MIT (1982).

actually build this machine out of neurons within the brain (or rather, how evolution *had* potentially done so). In practice, however, these levels are not pursued independently, because the structure and organization of the brain acts not only to constrain theorizing, but to suggest more basically "what problems need to be solved," as well as giving hints about how the brain actually does solve them by processing information.

Therefore, an inquiry into detection of fabricated responses would begin quite differently from, for instance, the pioneers who developed the polygraph, if this inquiry were informed by cognitive neuroscience. The first theoretical goal would be to define how to build a machine for *lying*,[*******] not one for *lie detection* – because the structure of the latter must be wholly dependent on the structure of the former. Only by understanding the nature of the device we possess for lying to other human beings could we hope to build another external machine that detects when this internal machine is operating. For precision greater than the detector we already possess, it is necessary to identify those distinct processes involved in implementing "the lying function" an identification that is greatly facilitated by knowing (1) what additional information or operations are needed to create a lie as opposed to uttering the truth, and (2) where in the brain information and operations of this type are performed.

Hence, a function-driven perspective is melded with traditional approach in neuropsychology, which, starting from a "natural history" of the brain, sought to identify what various anatomical structures did and how they did it. One way to characterize the distinction is that cognitive neuroscience starts with the question of what tasks the brain must accomplish in order to carry out its functions, and then goes looking in the neuroanatomy for the mechanisms that actually accomplish these tasks. By contrast, the more traditional approach, which was often tied to the clinical examination of patients with particular injuries, would begin with the anatomical structure and go on to infer its function from its observed effect on behavior.[†††††††]

[*******] I will allow the reader to insert his own witticisms regarding lawyers, politicians, or expert witnesses.
[†††††††] In this context, clinical neuropsychology would attempt to find what one might term a "clinical George Washington" someone "who could not tell a lie," literally, because they lacked the equipment to do so. (This is unlike the punctilious truth-teller, of whom it is more accurate to say that they *would* not tell a lie.)

Put more simply, the ultimate goal of cognitive neuroscience was to identify the neurological origin for every behavior that the brain performs, and the ultimate goal of neuropsychology was to find the associated behavioral function for every piece of the brain, and these questions ultimately converge.

One of the most important techniques carried over from the naturalistic study of neuroanatomy is the identification of the dissociation and double dissociation of different cognitive capacities, which show the independence of different types of information processing.[‡‡‡‡‡‡‡] A dissociation between cognitive functions is demonstrated when the first function (for example, short term memory) disappears although a similar function (for example, long-term memory) remains. A double dissociation is more informative, because it more conclusively shows independence of the capacities; this would occur if there were cases where long term memory disappeared but the individual could recall material in the short term. For many years, such dissociations –describing the way "cognition is carved at the joints" were painstakingly identified through the study and comparison of brain-damaged patients with peculiar deficits. To the extent function could be tied to structure, the nature of the patient's injury would provide the basis for any inference, even when it was difficult to tell exactly the role the damaged part played in the lost behavior (that is, the most that one could infer was that the anatomical structure was somehow necessary).

Neuroimaging allows one to pose a particular task and observe the parts of the brain that respond to it, and consequently has obvious advantages over the adventitious method formerly used to identify anatomical correlates, making it the most important methodological advance for cognitive neuroscience.[§§§§§§§] Nevertheless, the logic of inquiry as sketched above, although greatly accelerated, remains the same: if a structure (usually a group of interlinked structures) is

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[‡‡‡‡‡‡‡] Rosaleen A. McCarthy, Elizabeth K. Warrington, COGNITIVE NEUROPSYCHOLOGY: A CLINICAL INTRODUCTION Academic Press: 1990, 17

[§§§§§§§] COGNITIVE NEUROSCIENCE, 2[ND] ED., Michael S. Gazzaniga, Richard B. Ivry, George R. Mangun , eds., W.W.Norton (2002) 136 ("The most exciting methodological advances for cognitive neuroscience have been provided by new imaging techniques [that] … enable researches to identify brain regions that are activated during these tasks, and to test hypotheses about functional anatomy.")

activated by one task, but not by other similar tasks, the tasks can be considered dissociated, and if the second task activates a distinct pattern or "signature," there is double dissociation and "independence" – although the more complex picture of the brain revealed by neuroimaging usually shows overlaps for those processing steps common to both tasks. As one skeptical commentator acknowledges:

> With the development of functional imaging techniques capable of monitoring the brain's physiological response to cognitive tasks, researchers are rapidly gaining insight into the neural mechanisms that underlie vision, sensation, hearing, movement, language, learning, memory, and certain sex differences in language processing. Functional neuroimaging allows researchers to confirm long-standing hypotheses--first formulated from neuropsychological testing of brain-damaged patients--about structure-function relationships in the normal brain.[********]

The result of this type of empirical work, togeher with the task-based orientation of cognitive neuroscience led it to view the mind as essentially "modular." Without delving too deeply into the various debates over *how* modular,[††††††††] it is enough to simply note that there are "[f]unctional and/or anatomical components that are relatively specialized to process only certain kinds of information."[‡‡‡‡‡‡‡‡] The modular view has been particular conducive to evolutionary theorizing, because the "cognitive task" can be recharacterized as a relatively discrete adaptive problem to be solved by natural selection, the ultimate result of this being a specialized mental organ adapted to fulfill the information processing need of the organism.[§§§§§§§§] As applied to the study of deception, this does not necessarily indicate there exists a "module" for deception,[*********] since deceit is an ancient biological feature that is part of

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[********] Jennifer Kulynych , *Psychiatric Neuroimaging Evidence: A High –Tech Crystal Ball?,* 49 STAN. L. REV. 1249, 1258 (1997) (this student note is, thus far the only previous considerations of the legal ramifications of this technology and considers critically its potential role in diminished capacity or insanity defenses).

[††††††††] See STEPHEN PINKER, THE BLANK SLATE. Viking (2002) 39-41 and passim. (discussing different views on this point, as well as the broader implications of the modular view for the psychological and social sciences)

[‡‡‡‡‡‡‡‡] Ralph Adolphs, *Cognitive Neuroscience of Human Social Behavior*, NATURE NEUROSCIENCE REV., 4: 165, 166 (2003) (noting "evidence of domain-specific processing that is specialized for specific ecological categories (such as faces and social contract violations)")

[§§§§§§§§]For a recent articulation of the cognitive neuroscience framework, with several suggested applications to legal theory concerned with decision-making processes, see Terence Chorvat and Kevin McCabe, *The Brain and the Law*, 359 PHIL. TRANS R. SOC. LOND. B, 1727-1736, 2004. See also the other articles in this special issue devoted to legal neurobiology, especially, Owen D. Jones, *Law, Evolution and the Brain: Applications and Open Questions*, id., 1697-1707.

[*********] The state of the scientific research is reviewed, although not legally analyzed, by Sean A. Spence, et. al, *A Cognitive Neurobiological Account of Deception: Evidence from Functional Neuroimaging*, 359 PHIL. TRANS R.

many different social behaviors and predates the evolution of language,[†††††††††]although some would argue language led it to a new efflorescence of complexity.[‡‡‡‡‡‡‡‡‡] On the other hand, an ambitious detection of deception project would rely on the possibility that there may be features that are *distinctive to and common among the class of tasks we can identify as deceptive*, even if those tasks show significant variation between each other.

B. *Electroencephalograms and the "brain fingerprinting" method*

Before examining the application of neuroimaging to deception in more detail, it may be useful to distinguish this technique from an alternative method of monitoring mental activity, already being applied to some extent as a way of measuring deception. An "event-related potential" (ERP)[§§§§§§§§§] is recorded by an electrode on the skull of a subject performing some task, and usually presented as a set of waveforms on an electroencephalogram (EEG). Because actual brain activity is electrical, this is a direct measure of the presence of information-processing; the primary drawback, however, that the electrical activity impinging on the skull electrode is very difficult to localize to a particular piece of neuroanatomy within the "black box" of the brain. (The use of several different electrodes is common, providing some capacity to "triangulate" through differential levels of activity what broad region of the brain is being used).

As in neuroimaging, or polygraphy for that matter, the goal of the EEG deception researcher is to find a distinctive "signature" associated with a deceptive response. An EEG will not reveal precisely why and how the signature is created, so in this sense is much like a polygraph.

SOC. LOND. B, 1727-1736, 2004 (briefly discussing forensic potential for investigations and determinations of responsibility and mitigation)

[†††††††††]Robin Dunbar,, *On the origin of the human mind* In CARRUTHERS P, AND CHAMBERLAIN A. EDS. EVOLUTION AND THE HUMAN MIND: MODULARITY LANGUAGE, AND META-COGNITION. 238-253 Cambridge (2000) (showing that the frequency of tactical deception increases with the size of the neocortex in primate species)

[‡‡‡‡‡‡‡‡‡] ROBERT TRIVERS, SOCIAL EVOLUTION, 416 Benjamin Cummings (1985) ("In human evolution, processes of deception and self-deception were greatly heightened by the advent of language. Language permits individuals to make statements about events distant in time and space and these are least amenable to contradiction. Thus, language permits verbal deception of many different kinds.")

[§§§§§§§§§]Technically, what one does is to extract from the background EEG, which records all the ongoing electrical activity of the brain, the particular waveform that was triggered by the stimulus. *See* Adophs, *supra* n. ___. "Electrical potentials … are generated in the brain as a consequence of the synchronized activation of neuronal networks by external stimuli. These evoked potentials are recorded at the scalp and consist of precisely timed sequences of waves or 'components.'"

However, consistent with cognitive neuroscience and unlike polygraphy, the brain-based measure used is more closely tied to the cognitive activity required for the deception to occur, as opposed to more contingent physiological correlates such as sweating or blood pressure. The type of deception that has attracted the most attention in this area is guilty knowledge, as general research into ERP and memory has demonstrated consistently different reactions of the brain in response to "significant" (i.e. remembered) as opposed to non-significant information. Consequently, if a person was genuinely unfamiliar with a piece of evidence X (say a damning memo or a murder weapon), they should treat them as no more "significant" than similar memos or weapons with which they are presented. This marker for the reaction is a particular waveform commonly known as the P300 wave (indicating its position next to the parietal lobe, which is involved in memory and recall).

One clinical application of this technique is the detection of "malingerers," people who pretend for a variety of reasons, including for fraudulent insurance or legal claims, to possess an illness they do not have.[**********] Psychologists attempt to spot those pretending to brain damage by giving such patients memory tests. Genuinely disabled people will of course not recognize a stimulus they have forgotten, while fakers will feign ignorance although the P300 wave of their brains will be consistent with the item being significant.[††††††††††] Current approaches allow the classification of approximately 87% of the deceptive subjects, with no misclassification of truthful subjects.[‡‡‡‡‡‡‡‡‡‡] A series of laboratory studies in which subjects were given incentives to lie about "guilty knowledge" of a simulated crime produced showed an ability to correctly classify 96% of the subjects as honest or deceptive.[§§§§§§§§§§]

[**********] *See* Douglas Mossman, Daubert, *Cognitive Malingering, and Test Accuracy*, L. & HUM. BEHAV. , 27: 229, 231 (discussing case law involving possible feigning of cognitive deficits to avoid standing trial and for other reasons).

[††††††††††] *See* J. Peter Rosenfeld, Joel W. Ellwanger, Katie Nolan, Susan Wu, Romina G. Bermann, and Jerry Sweet, *P300 Scalp Amplitude distribution as an index of deception in a simulated cognitive deficit model*, INT'L J. OF PSYCHOPHYSIOLOGY 33: 3, 17 (1999).

[‡‡‡‡‡‡‡‡‡‡] *See id* .at 16.

[§§§§§§§§§§] See John J. B. Allen & William G. Iacono, *A Comparison of Methods for the Analysis of Event-Related Potentials in Deception Detection*, 34 PSYCHOPHYSIOLOGY 234, 234-240 (1997).

The forensic use of this technique has acquired the soubriquet of "brain fingerprinting,"[***********] although its primary promoter, one Dr. Lawrence Farwell, refers to it as the Farwell MERMER technique.[†††††††††††] In any event, Farwell has attempted to promote this as a replacement for the polygraph, with limited success, although with a fair amount of media interest, particularly after the technique was admitted as competent evidence by an Iowa court in 2001.[‡‡‡‡‡‡‡‡‡‡‡] More recently, Farwell has been less successful in introducing this material in Oklahoma, after his examination of a capital defendant there.[§§§§§§§§§§§]

Despite the hype, the amount of peer-reviewed material available to study the efficacy of this method is almost nonexistent; it turns out that much of the basic research was funded and or conducted by the CIA in the late 1980's and early 1990's and therefore is publicly unavailable.[************] The CIA terminated its research after Farwell refused to reveal the algorithm used to analyze the EEG readings, on the basis that he considered it proprietary. He subsequently appears to have received two patents and to have gone into the private business of detecting deception,[††††††††††††] a process that it seems has hampered the ability of the scientific community to either validate or build upon his research.[‡‡‡‡‡‡‡‡‡‡‡‡]

[***********] See SCIENCE IN THE LAW, supra n___, v. 3, § 10.3.3.13[2]; Andre A. Moenssens, *Brain Fingerprinting – Can It Be Used to Detect the Innocence of Persons Charged With a Crime*?, 70 U.M.K.C. L. REV., 891, 895 (2002)

[†††††††††††]Lawrence A. Farwell and Sharon S. Smith, *Using Brain MERMER Testing to Detect Knowledge Despite efforts to Conceal*, J. FORENSIC SCI., 46: 135, (2001) (MERMER is Farwell's acronym for the particular waveforms he uses, one of which is derived from P300).

[‡‡‡‡‡‡‡‡‡‡‡]*Harrington v. State of Iowa*, PCCV073247, 5 March 2001 (evidence deemed insufficiently persuasive to overturn sentence of convicted murderer); Moensssens, supra n. ___, at 905-907 (discussing expert testimony in this case).

[§§§§§§§§§§§]"Dr. Farwell allegedly asked numerous details concerning 'salient details of the crime scene that, according to [Petitioner's] attorneys and the records in the case, ... the perpetrator experienced in the course of committing the crime for which Mr. Slaughter was convicted.' According to Dr. Farwell, Petitioner's brain response to that information indicated 'information absent.' *Slaughter v. State*, 105 P.3d 832, 834 (Okla.Crim.App. 2005). In part because Farwell failed to provide the Oklahoma court with a promised report on his work, including the salient details tested or peer validation of the technique, the court rejected this material as "new evidence" and concluded that "Brain Fingerprinting, based solely on the MERMER effect, would [not] survive a *Daubert* analysis"

[************] Report of the General Accounting Office, GAO-02-22, Investigative Techniques: Federal Agency Views on the Potential Application of "Brain Fingerprinting," pp. 9 & 14 n.1. Apparently Farwell conducted a 40 subject study in which half (20) of the subjects had participated in a simulation, and half had not. All subjects were then presented with pictorial stimuli – presumably of the simulation – and their EEG's compared. Farwell claimed 100% classification had occurred in that study, which used only the P300 measure. See supra n. ___ at 137.

[††††††††††††] See supra n.___ nn.19-20 (indicating his acquisition of two patents in 1995).

[‡‡‡‡‡‡‡‡‡‡‡‡]If the history of the polygraph is a guide, commercialization and proprietary control of scientific technique is unlikely to improve the technique, at least if this occurs before the background science is well understood and accepted (and researchers compete on *relative* accuracy or other grounds). In an atmosphere of bitter conflict among the early developers of the polygraph, one of them, Leonarde Keeler, patented his own version, and when the

Nevertheless, other researchers into the use of ERPs are able to replicate what Farwell is able to do (or claims to be able to do) in terms of detecting significant material whose significance is denied. Moreover, there is some theoretical basis for explaining the electrical activity of the P300 wave as what is termed "orienting response" toward surprising or important information, a response that can be detected by either EEG or by polygraph, or a combination of the two. As argued recently by proponents of using this method forensically, responses to "guilty knowledge" mediated by an orienting response are *not* in fact premised on the type of fear arousal usually associated with measurement of the polygraph, but are wholly cognitive, based on the fact that the organism will focus attention on any item of importance, independent of how they might emotionally react to this item.[§§§§§§§§§§§§§] The main problem with the use of the physiological correlates of this response are that these track the stimulus by periods of up to 25 seconds, making them vulnerable to countermeasures.[*************] (Any somatic polygraph measures would also remain susceptible to the criticism that stray thoughts or otherstimuli could induce arousal that would be very difficult to distinguish from that correlated with cognitive activity, whether or not this arousal was intentional.). Therefore, the authors fall back ultimately on the contention that the P300 response would be a suitable measure, as it appear and disappears within about 2 seconds after the stimulus.[†††††††††††††]

Recent reports ofexperiments conducted in Beijing at the National Laboratory on Machine Perception support the promise of this technique in using event-related potentials ERP measurements, and is of particular relevance for forensic work.[‡‡‡‡‡‡‡‡‡‡‡‡‡] The experimental

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patent expired, began a commercial training service for examiners. Although this produced a standardized, mass-produced machine, Keeler's training methods were not oriented to scientific validation but rather to the desires of his customers (employers and police departments) to maximize the chance of subject confession. Ken Alder, *A Social History of Untruth: Lie Detection and Trust in Twentieth-Century America*, REPRESENTATIONS 80: 1, 22 (2002). Moreover, it is probable that the limited paraprofessional training of polygraphers on Keeler's machine (or its descendants) would have the potential to create a network effect that would make them resistant to hardware changes away from the design on which they were trained.

[§§§§§§§§§§§§§] Gershon Ben-Shakhar, Maya Bar-Hillel, and Mordechai Kremnitzer, *Trial by Polygraph: Reconsidering the Use of the Guilty Knowledge Technique in Court*, LAW AND HUM. BEH., 26: 527, 530 (2002).

[*************] *Id*. at 532.

[†††††††††††††] *Ibid*.

[‡‡‡‡‡‡‡‡‡‡‡‡‡] Fang Fang, Yitao Liu, Zheng Shen, *Lie Detection with Contingent Negative Variation*, Int'l J. of Psychophysiology (2003).

subjects (hooked to thirty different electrodes) were presented with nine faces, three of whom were strange, and six of whom were familiar, and were told to deny familiarity with three of the known faces (the "targets"). The subjects were told they would be penalized if the "computer" caught them lying, and the regardless of the subjects actual ERP, the computer pretended to "catch them" five times out of the thirty times they responded.[§§§§§§§§§§§§§] (A feature apparently used to maintain the subject's fear).

This particular protocol reveals a serious problem with the use of P300 measure of "significance" in deception research. As Dr. Fang astutely discusses, with regard to a stimulus like faces, an orienting response might occur to a *familiar* face because that would be something of interest. However, it might be equally expected to occur to an *unfamiliar* face of a stranger, thus making the equation of "significance" with "knowledge" extremely problematic; indeed the Chinese researchers found that familiar and strange faces were not distinguishable based only on the "orienting response."[**************] Fang and his colleagues, however, by combining the electrical activity at all thirty electrodes, were easily and reliably able to use statistical techniques to distinguish when a "target" face had been presented and the subjects had denied knowing this person. That is, other electrical measures showed a distinguishing pattern, and this complex statistical signature – rather than the "orienting response" – served as the functional and neural basis for the deception marker. Because of the experimental design, fear or indeed anticipation of detection might explain much of the electrical signature, along with a greater amount of cognitive activity devoted to deception related efforts such as self-control.[††††††††††††††] Consequently, although the Chinese method may be relatively useful in detecting deception as to

[§§§§§§§§§§§§§] *Id*. at __.
[**************] *Id*. at __.
[††††††††††††††] The subjects were instructed specifically to "keep their minds calm" in order to avoid detection, and since any cognitive activity directed to this end would increase electrical activity, following this advice would actually contribute to the observed effect. Although this confuses the scientific interpretation of the result, it would be useful in practical terms because it suggests that many polygraph countermeasures that could control items like blood pressure still require cognitive effort and so would be much less effective against ERP detection.

whether one knows another person, any ability to make inferences between brain and behavior have been sacrificed in order to achieve the clearest marker of deceit. [‡‡‡‡‡‡‡‡‡‡‡‡‡‡]

It is unlikely that such an atheoretical approach to understanding deception will be satisfying scientifically or legally. Despite the claims of those using ERP's to detect "information" stored in the brains of the subjects, in fact only a responsive orientation reaction is usually detected, and this correlated only in a rather loose way with whether the information has already been encoded. Without observing the actual processes of memory encoding and memory retrieval, as they pertain to a stimulus (i.e., whether the former or the latter occurs), it remains speculative whether or not the stimulus was present in the brain prior to its presentation. More fundamentally, even if in a particular context, a global EEG signature can tell true from false responses, without understanding the basis of this difference, it becomes difficult to know to what extent the result can be generalized, or to what extent other behaviors (outside the limited range available in a laboratory experiment) could produce the same result. Logically, the only way to doubly dissociate deception is to observe and understand the anatomical correlates that are required to implement the deceptive act – the extra processing steps necessary to deceive as opposed to performing a similar but honest behavioral response. Then, *a priori*, we could ask if in the particular context in which credibility is assessed, those functions would be called upon by a deceptive response, and if so, we could, in effect, watch the lie as it was being constructed.

[‡‡‡‡‡‡‡‡‡‡‡‡‡‡] The feigned ignorance paradigm is difficult to apply in most criminal investigations or civil trials, particularly given the discovery and disclosure rules governing these proceedings, but has perhaps wider applicability than is realized. In the United States there is a relatively small amount of what one might call "forbidden knowledge." For a distillation of commonly-held norms, *see* NICHOLAS RESCHER, FORBIDDEN KNOWLEDGE AND OTHER ESSAYS ON THE PHILOSOPHY OF COGNITION, 9, Dordrect: Reidel (1987) ("There seems to be no knowledge whose possession is inappropriate per se. Here inappropriateness lies only in the mode of acquisition or the prospect of misuse. With information, possession in and of itself – independent of the matter of its acquisition and utilization – cannot evoke moral inappropriateness.") In other words, it would incriminate a subject if he were shown as familiar with bomb-making equipment and procedures, *given* that he was under suspicion of misusing this knowledge, and familiarity with classified or proprietary information is punishable as probative of complicity in its unlawful *transfer*. This criminalization of knowledge can be much more expansive in an authoritarian political system, making the use of knowledge detection technology potentially pervasive. Especially when combined with a lack of concern about false positives, it would be relatively straightforward to obtain results indicating a subject's mere recognition of forbidden writers and passages of their works, banned religious rituals or symbols, outlawed works of art or media broadcasts, or even suppressed or "enemy" languages. Clearly such interrogation about the contents of one's mind would (among other things) violate the freedom of thought protection at the core of the First Amendment. *See Vaughn v. Lawrenceburg Power System*, 269 F.3d 703, 717-18 (6th Cir. 2001).

C. *Functional neuroimaging, especially using magnetic resonance*

Having now argued that for purposes of assuring scientific validity, detection of deception will require functional neuroimaging, at least in the medium term,[§§§§§§§§§§§§§§] it then remains to describe more fully the limits and capacities of these techniques as they are currently practiced. The main methods are positron-emission tomography (PET) and magnetic resonance imaging (MRI), but I will concentrate on the latter for several reasons: (1) although the use of PET predates the use of MRI, the hardware involved in the latter is far less expensive and now much more common, (2) the temporal and spatial resolution of MRI is superior, allowing easier correlation of short-duration events with specific regions in the brain, and most determinative for legal use, (3) PET involves, among other things, the injection of radioactive tracers into the blood stream, which for clinical use strictly limits the amount of PET scanning one can do on an individual, and probably bars it entirely from use as a quasi-deposition technique that any (United States)court would countenance.[***************]

MRI scanning, as done in most major hospitals, is non-invasive, and uses a very strong magnet and directs radio waves at the subject's body. For neural imaging by MRI the subject lies on a table, with his head surrounded by a large magnet. The magnet causes some of the protons within the atoms inside the subject's brain to align with the magnetic field. A pulse of radio waves is then directed at the patient's head and some of it is absorbed by the protons, knocking them out of alignment. The protons, however, gradually realign themselves, emitting radio waves as they do. These radio waves are captured by a radio receiver and are sent to a computer, which constructs the brain image. The patient cannot sense either the magnet or the

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[§§§§§§§§§§§§§§] One efficient way to solve the specificity problems associated with ERPs would be simultaneously record an EEG trace while the subject is undergoing a neural imaging scan. If in fact the neuroimaging is able to specify a distinctive activation pattern for deceit, it would then be possible to use it as a standard against which one could measure patterns of electrical activity on the skull. Then if one or more of these patterns possesses a precise correlation with actual brain states during deceptive activity, it would be possible to dispense with the MRI equipment in later studies that were essentially replicating the circumstances where the EEG-MRI relationship had been established. Since none of the preconditions for this shortcut have yet been fulfilled, I consider it useful to concentrate on identifying the brain-behavior relationship using MRI.

[***************] *See* COGNITIVE NEUROSCIENCE, supra n. ___, at 138-39.

radio waves; in fact, the patient only knows the machine is working because of the noise it makes during scanning. Different parts of the brain respond to the radio waves differently, and emit slightly different radio signals depending, among other things, on the local water and fat content. This provides a picture of brain structure.

In order to use an MRI scanner to view the functioning brain as it responds to a task, the following important but not heroic assumptions need to be noted. First, there is the general cognitive neuroscience premise that particular types of cognitive activity can be reliably associated with specific areas of the brain, and that some of those areas in fact provide the neurological machinery for carrying out the cognitive task. As indicated by the caveat, it is sometimes difficult to distinguish between parts of the brain whose stimulation is *correlated* with a cognitive event and those that actually process it. For instance, speaking involves, among other things, hearing one's own words, so the auditory portions of the brain are normally active during speech production. These areas are not, however, necessary for speech production, since the hearing impaired (either clinically or experimentally induced) can in fact accomplish this task, albeit with less fluency. Second, it assumes that active portions of the brain during the task can be identified by an increased amount of blood flow to those areas during the task. In order to operate, brain tissue requires oxygen carried by blood hemoglobin. If an area has increased demands for oxygen, the circulatory system responds by increasing blood flow (and thus hemoglobin, and thus oxygen) to the area. What fMRI actually measures is the ratio of oxygenated hemoglobin to deoxygenated hemoglobin, O+/O-, which it can do because the deoxygenated kind responds more readily to the magnetic field emitted by the machine.

Obviously, there is a small time delay between any event calling upon greater cognitive resources, the response of neurons in some region with increased electrical activity, and then what is actually measured, a circulatory adjustment coupled to the increased cellular demands in that area of the brain. An event can be identified as having occurred within about a two second window.[†††††††††††††††] What studies have shown about the circulatory, or hemodynamic, response to neural activity is the following: in the first couple of seconds of processing, the activated brain region uses the oxygen at hand, and the O+/O- ratio falls from the baseline state; after that, blood flow increases and in fact "overcompensates" by providing more fresh oxygenated blood than the tissue can absorb, and hence the O+/O- ratio increases and stays above baseline while the region is actively working.[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] In actual physical terms, the hemoglobin in the area under observation becomes less sensitive to the magnetic field of the fMRI. (This can be confusing because most pictures of an active area represent it as glowing colorfully – while the machine actually is measuring activity by the *lowered* emission of energy in an active area now flooded with less sensitive molecules). The key measure is usually reported as the BOLD (blood oxygenation level dependent) effect, measured by subtracting the difference between the background activation shown in the area prior to the task from the level of activation during the task. That is, where the researcher has shown a BOLD effect in an area, that area is implicated by the stimulus or task.

D. *Current neuroimaging research on deception*

Because much of the previous discussion has focused on the attempt to discover whether a subject is familiar with a particular piece of information it is worth noting at those preliminary studies directly investigating whether a subject can falsely deny such familiarity. However, these direct investigations, which I will refer to for convenience as the Pennsylvania study[§§§§§§§§§§§§§§§] and the Hong Kong study,[***************] do not exhaust the relevant neuropsychological research

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[†††††††††††††††] Luis Hernandez, David Badre, Douglas Noll, and John Jonides, *Temporal Sensitivity of Event-Related fMRI*, NEUROIMAGE 17:1018, 1025 (2002). The brain should return to a baseline statement within about 20 seconds, which is therefore the spacing required between stimuli whose effect is to be separately assessed (as for instance in a series of deposition questions whose answers are to be monitored).

[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡]COGNITIVE NEUROSCIENCE, *supra* n. ___, at .94. This is almost certainly because the key demand during brain activity is for the blood to remove the by-products of metabolic activity rather than to supply energy and oxygen.

[§§§§§§§§§§§§§§§] D.D. Langleben, et al., *Brain Activity during Simulated Deception: An Event-Related Functional Magnetic Resonance Study*, NEUROIMAGE 15: 727,727 (2002).

[***************] Tatia M.C. Lee et al., *Lie Detection by Functional Magnetic Resonance Imaging*, HUMAN BRAIN MAPPING 15, 157, 159 (2002).

in this area. The encoding of memory, one part of which seeks to distinguish processing of novel and familiar stimuli, has been a central focus of cognitive neuroscience from its start, and has continued during the current era of functional neuroimaging studies. These studies involve comparisons of stimuli seen for the first time and stimuli that have become familiar through previous presentation.[††††††††††††††††] Novelty-driven activation in various parts of the brain has been repeatedly demonstrated for scenes, words, object-noun pairs, word pairs, and line drawings.[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] Similar results have been obtained for faces: when a novel face is encountered, the left prefrontal cortex is activated along with the hippocampus (which is involved in many memory storage operations), while when the face is recognized later completely distinct regions of the prefrontal cortex and no hippocampal activation are seen.[§§§§§§§§§§§§§§§§] In fact, recent fMRI studies have been able to distinguish between new items, actually familiar items from a memorized list, and words the subject falsely believes to have been on the list.[*****************]

Consequently, it seems highly likely that any form of malingering with regard to specific information should be detectable by observation of brain responses, since even good faith mistaken responses in this area are detectable. While memory impairment is perhaps too simple to debunk, malingering more generally is an active and increasingly successful area of research, particularly with regard to testing claims of pain or paralysis.[†††††††††††††††††] In subjects actually incapable of motion, areas of the brain responsible for initiation of motor activity are silent, while fakers show activation in the prefrontal cortex, apparently where they issue commands to

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[††††††††††††††††]Craig E. Stark and Larry R. Squire, *Functional Magnetic Resonance Imaging (fMRI) Activity in the Hippocampal Region During Recognition Memory*, J. NEUROSCIENCe 7776-7781 (2000); John D.E. Gabrieli, *Functional Neuroimaging of Episodic Memory*, 262, *In* HANDBOOK OF FUNCTIONAL NEUROIMAGING OF COGNITION, Roberto Cabeza & Alan Kingston MIT (2001).

[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡]Gabrieli, *id*. at 268, 273; *see also* Endel Tulving, *et. al*, *Novelty Encoding Networks in the Human Brain: Positon Emission Tomography Data*, NEUROREPORT 2525-2528 (1994).

[§§§§§§§§§§§§§§§§] COGNITIVE NEUROSCIENCE, supra n. ___ at 338.

[*****************]*See id*. at 340-341 (the false items are “implanted” by having the subject memorize a series of words such as “thread, pin, eye, sewing, sharp, point, haystack, pain, injection.” Most subjects will later be convinced that they saw “needle” on this list, but an fMRI can show a different pattern despite this subjective belief.

[†††††††††††††††††] David Oakley et. al, *Differential brain activations for malingered and subjectively 'real' paralysis*, 280, *in* MALINGERING AND ILLNESS DECEPTION, PETER HALLIGAN, CHRISTOPHER BASS, AND DAVID OAKELY, eds. Oxford (2003) inhibit the motion by conscious effort. Quite apart from any use this application might ultimately have in assessing credibility by measurement of familiarity with relevant details, neurological examination by fMRI is of obvious forensic use, most clearly in cases such as insurance fraud.

1. The Pennsylvania Study

Participants were given an envelope containing twenty dollars and the five of clubs, and were told they would be allowed to keep the money if they could keep the identity of the card a secret from "the computer."[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] The computer displayed pictures of different playing cards on a screen inside the MRI machine, and asked if the subjects had the card, to which the subjects responded by pressing a "yes" or "no" button in their hand. (In fact, they always responded "no"). Significant differences were identified in a variety of areas between the pattern of brain activity when they truthfully denied having other cards and when they falsely denied having the five of clubs.[§§§§§§§§§§§§§§§§§] However, no attempt was made to examine the subjects on an individual basis to classify them as truthful or deceptive. It was suggested that areas showing greater activation indicate that lying required greater activity in areas responsible for "executive" functions or decision-making, as well as in premotor areas required to suppress or inhibit forelimb movement (presumably to press "yes").

2. The Hong Kong Study

This was a feigned memory impairment test, in which subjects were told to intentionally do poorly on a test of recall. They responded with a yes/no button. Subjects demonstrated

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[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡]As the study notes, one difference between this experiment and actual deception circumstances is the lie is some sense "permitted" – *see supra* n. ____ at 728 – although this could also be true in certain conditions where the individual believed he was acting morally for ideological reasons, was self-deceived about the truth status of the statement, or was essentially amoral. In an individual who believed he was violating a social norm, however, any activated regions for deception would be accompanied by those cognitive areas responsible for what is behaviorally termed a "conscience" or "morals." Although it would be beyond the scope of this paper, the identification of this neural area is of legal interest, since under certain theories of responsibility, the activation of this region is considered to enhance "responsibility" and increase punishment. Somewhat paradoxically, the failure to activate the region during proscribed conduct is often considered, with justification, to bespeak caution regarding the future propensity of the subject to commit the conduct. Rather than extend this into the suggestion of how a full neurological specification of conduct may clarify philosophical concepts, and thereby affect concepts of criminal and civil liability, I note only that it is likely to do so, but that the influence on the brain as information-processing organ will proceed regardless of whether the law allows itself to be so affected.

[§§§§§§§§§§§§§§§§§] *See supra* n. ___ , at 730 (the areas showing greater activation were "Brodmann" areas 1-4, 6, 8, 24, 32, 40) activation of areas responsible for memory recall, as well as for planning and calculation (since there were only two responses, in order to be plausible “malingerers” the test paradigm forced the subject to keep track of how many wrong answers they gave in order to approximate chance). They also showed an apparent inhibition of the relevant motor area associated with responding through use of their forelimb.[*****************] (That is, as in the Pennsylvania study, it appeared there was an instinctive movement or “pre-movement” toward the true answer, which was suppressed). No individual variation or classification was done.

As with earlier technology exploring “guilty” knowledge, there is the inherent problem of a subject either possessing familiarity in an “innocent” fashion. For instance, in the paradigmatic case with a presentation of several firearms, one of which is a murder weapon, the subject may turn out to show greater recognition of the weapon of interest, simply because it is the most common of the set presented, or because the subject himself possesses a weapon of that generic type.[††††††††††††††††††] This complicates the interpretation of such evidence, and weakens the strength of the conclusion that can be drawn from a “test-positive” result, but any error would be an inferential one, or arise through lack of proper rebuttal, rather than intrinsic to the method. Moreover, as fMRI memory research may be able to partially vitiate this problem to the extent it can detect the *context* in which a subject became familiar with an item, in addition to its mere familiarity. Thus, it is theoretically possible to distinguish between someone who has become familiar with a person or item by being shown it or told about it, and one who saw the person or item at a particular place and time.[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] Were DDD evidence to begin to be employed to validate memory claims, and counter-strategies of “inoculation” by familiarization are

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[*****************] *See supra* n. ___, at 162 (the areas showing greater activation were “Brodmann” areas 6. 9-10, 21, 23, 40, 46).

[††††††††††††††††††] *See* Ben-Shakar et. al., *Trial By Polygraph*, *supra* n. ___.

[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] *See* Ken Paller, *et al*., *Neural Correlates of Person Recognition,* 10 LEARNING & MEMORY 256 (2003) (showing specific additional networks activated when individuals retrieve “the spatiotemporal context of the initial episode of viewing the face”); Scott M. Hayes, Lee Ryan, David M. Schyner, & Lynn Nadel, *An fMRI Study of Episodic Memory: Retrieval of Object, Spatial, and Temporal Information,* 118 BEHAVIORAL NEUROSCIENCE 885-896 2004 (describing detectable differences when subjects, after viewing videotaped tour of four houses filled with memorized items, were presented with objects in their original setting, versus isolated or alternative settings).

developed, context-retrieval will presumably become of increasing importance, although it does not appear to have yet been adapted for deception research.

The use of fMRI in the area of memory would have relatively little impact on the legal process, at least in comparison with the use of neuroimaging that would genuinely function as a "lie detector." For this to occur, the technology would need to go beyond determining the presence or absence of bits of information and actually distinguish confabulated statements from "true" statements – with truth meaning more specifically a verbal expression of what the speaker actually recalls from their memory when prompted by a stimulus question, and "a lie" meaning an alternative statement that the speaker has creatively generated to take the place of the expression generated spontaneously within the brain by the stimulus. This area, the key one for assuring the veracity of testimony, has now been the subject of four studies, all of which have become available only within the last few years, and all of which purport to lay the groundwork for the use of neuroimaging as a lie detector. I will refer to these for convenience as the South Carolina study,[§§§§§§§§§§§§§§§§§§] the Harvard study,[******************] the Sheffield Study,[††††††††††††††††††] and most recently, the New York Study.[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡]

3. The South Carolina Study

This research program has so far been the one most closely tied to a simulated possible crime. In the primary study, the subjects were taken to two rooms, Room 1 and Room 2; in each of the rooms were five objects; beneath one of these five objects was a fifty dollar bill. The subjects "discovered" the bills, but did not disturb them. In the MRI, they were then shown pictures of the objects and asked if the bill was hidden under them. This differs from the

[§§§§§§§§§§§§§§§§§§] F. Andrew Kozel, et. al, *A Pilot Study of Functional Magnetic Resonance Imaging Brain Correlates of Deception in Healthy Young Men,* 16 J. OF NEUROPSYCHIATRY AND CLINICAL NEUROSCIENCES 295-305 (2004).

[******************] G. Ganis, S. M. Kosslyn, S. Stose, W. L. Thompson, & D.A. Yurglun-Todd, *Neural Correlates of Different Types of Deception: An fMRI Investigation*, CEREBRAL CORTEX 13: 830, 830 (2003).

[††††††††††††††††††] Sean A. Spence, et. al , *Behavioural and functional anatomical correlates of deception in humans,* NEUROREPORT 12 2849, 2850 (2001).

[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] Jennifer Marie Nunez, B. J. Case, Tobias Egner, Todd Hare, and Joy Hirsch, *Intentional False Responding Shares Neural Substrates with Response Conflict and Cognitive Control*, ___ NEUROIMAGE, in press (2005) familiarity-based studies reported supra, because the subjects were "familiar" with all the objects displayed. They responded "yes" by holding up one finger, "no" by holding up two. As a control, they were told to respond truthfully as to the objects in Room 1 and they would get the fifty dollars there. As to Room 2, however, they were instructed to lie twice, denying the correct hiding place, and then picking one of the four objects and affirmatively claim that was the hiding place. If they successfully deceived, they were told they would get the other fifty dollars.

As a group, the subjects showed greater activation in the "executive" function area of the anterior cingulate cortex, as well as other areas, when they were responding with a lie as opposed to when they were giving truthful responses.[§§§§§§§§§§§§§§§§§§§§] Interestingly, however, in this study, each of the eight subjects was individually assessed. One subject showed no greater activation with regard to lying and truth-telling, and although the other seven did, their activations were in quite heterogeneous parts of the brain. Moreover, there was no area of the brain that was differentially activated in all seven subjects so as to provide a "marker" for deception.

In a subsequent replication of this research, using ten subjects, aggregating the subjects once again allowed a statistical discrimination of the lying brain, and showed – as a group phenomenon – similar activation in areas such as the anterior cingulate cortex and prefrontal areas.[*********************] In this replication, the researchers also managed to get somewhat more consistent *individual* results, in that seven of the ten subjects showed greater activation when lying in the same general area of the brain. What remains to be shown is that each of these individuals, if retested, would show the same pattern, thereby allowing their responses to be matched against a standard calibrated to that particular individual. As the researchers acknowledge, but have not yet addressed, interscan variability even with the same subjects can be high,[†††††††††††††††††††††] and this would be extremely problematic if there is already sufficient

[§§§§§§§§§§§§§§§§§§§§] *See supra* n.____, at ___.
[*********************] Frank Andrew Kozel, Tamara M. Padgett, and Mark S. George, A *Replication Study of the Neural Correlates of Deception*, 118 BEHAVIORAL NEUROSCIENCE 852-856 (2004).
[†††††††††††††††††††††] *See id.* at 855.

inter-individual variability that reliable research requires an individual profile of deceptive and truth brain states.

One of the ten subjects, for example, showed clear differences but seemed to activate a different area of the brain, and as in the earlier study, some subjects (here two out of ten) failed to show greater activation when lying than when responding truthfully. Although this suggests that some individuals could be assessed for deceptive responses, it also carries the corollary that the process of deception could be sufficiently variable between persons that a certain percentage of the population could essentially be immune from this type of examination. From the legal perspective, this would not pose a significant problem so long as this group could be identified and if it were difficult or impossible for a person to make themselves immune through countermeasures.

4. The Harvard Study

The subjects were interviewed about their work and vacation experiences. They were then asked to respond with short verbal answers about where these took place. Sometimes the subjects were asked to respond truthfully, sometimes they were asked to respond with a pre-pared falsehood, and for some questions they were asked to make up a spontaneous lie (although the lie was supposed to be a plausible one – i.e. they were not to say they had spent their last vacation "on Mars" or with a nonsense response like "purple bookmark"). The spontaneous lies showed the greatest number of other activated areas, and the prepared fabrication showed greater activation in areas associated with the retrieval of episodic memory.[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] No individual investigation or classification of subjects was done, but the researchers were well aware of this issue, stating that "whether fMRI can become a useful tool for the detection of deception … depends on whether reliable neural signatures of deception can be identified in single participants and in single trials."[§§§§§§§§§§§§§§§§§§§§]

5. The Sheffield Study

[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] *See supra* n.____, at 833 (Areas showing greater activated in both deceit paradigms: 7, 10, 36, and 37).

[§§§§§§§§§§§§§§§§§§§§] *Id*. at 835.

Subjects completed a questionnaire before entering the MRI as to whether or not they had done certain common activities that day. They then essentially "retook" the questionnaire twice inside the MRI, one being asked by using of an auditory cue and once by visual query. At random, they were cued to lie on some of these responses. The subjects responded by pressing yes or no on a keypad. These results were broadly consistent across the two types of questioning, showing activation in areas responsible for the inhibition of motor and other responses.[********************] Individual subjects and possible heterogeneity were not examined.

6. The New York Study

Broadly speaking, this was similar in format to the Sheffield study, in having the subjects initially fill out a "yes/no" questionnaire, and then redoing the questionnaire within the MRI.[††††††††††††††††††††] In this research, however the subjects actually did the questionnaire twice within the scanner, answering truthfully to all questions during the first scan, and falsely to all questions during the second scan. The results were generally consistent with the research considered above by finding "there is increased neural activity within the anterior cingulate, [and] dorsolateral prefrontal cortex … when individuals answer falsely as compared to truthfully."[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] Again, this was a generalization, and although individual results were not reported except to note that reaction times were longer for all subjects when answering falsely, it is apparent there was considerable variability in the nature of individual brain activation. Interestingly, some of this variability was found to be correlated with the results of a personality profile the subjects took. This suggests that much of the variability between people is part of the emotional "noise" that is associated with lying, and which is reflected in activation of different areas of the brain. The well-known fact that people vary in their emotionality about falsehood – the very reason that measures of emotionality such as the polygraph are so limiting –

[********************] *See supra* n.____, at 2851 (Areas showing greater activated in both deceit paradigms: 6, 8, 32, 40, and 47)

[††††††††††††††††††††] See supra n. ____, at ___ (Areas showing greater activation 6-10, 32, 44-47)

[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] Id. at ____.

is therefore implicated in interpreting the fMRI in order to isolate those cognitively necessary components of falsification that are invariant (or at least less variant).

Summary

Although the specific areas of the brain noted as indicative of a lie differed substantially, there was some agreement among the six studies that: (1) some form of "executive" function that deals with conflicting pressures, generally the anterior cingulate gyrus, was used to handle the "choice" of whether and when to lie, and (2) this often acted with some form of inhibitory mechanism to suppress the truthful response, whether that response was verbal or motor.[§§§§§§§§§§§§§§§§§§§§§] These results are in accord with the theoretical prediction that witnesses will have a relatively greater amount of difficulty fabricating testimony than telling the truth. This comparative difficulty in increased "cognitive load" is directly and quantitatively measured in an MRI context. However, as Sanchirico has recently discussed, it also provides the basis for the successful use of cross-examination against an untruthful witness, who will generally lack the cognitive capacity to generate false memories quickly and with the same detail and consistency as true memories, a limitation the skillful cross-examiner exposes.[**********************]

Despite the theoretical soundness of MRI deception research generally, the current divergence between the tasks posed, and the results obtained, suggests that no single overarching marker of deception is likely to be soon identified. Even with regard to simply lying, there has so far been no unique marker. Most tellingly, in the only study to break apart individuals, from South Carolina, the individuals all showed distinct patterns. It is therefore probable that the other studies also contained a large amount of individual variation hidden within their group reports. Since all of the above were in effect pilot studies, it will be interesting to see whether replication of the experiment will show – at least on the group level – the same areas of

[§§§§§§§§§§§§§§§§§§§§§] *See* Spence et al., *A Cognitive Neurobiological Account of Deception*, *supra* n. ___ (coming to a similar conclusion regarding the presence of executive differences and inhibition of truthful responses as a common feature of early studies, because truthfulness is the "baseline" and the brain must make extra efforts to respond in some other way, as partially evidenced by the failure of all studies to show areas that are *more* activated by truth-telling than by telling lies).

[**********************] Chris William Sanchirico, *Evidence, Procedure, and the Upside of Cognitive Error*, STANFORD LAW REVIEW 57: 291, 320 (2004).

activation. Similarly, if a particular individual was retested, it would be of interest whether on an individual basis the differential levels of activation could be replicated, or if, in effect, people lie in different ways on different days. The pilot studies demonstrate that lies are distinguishable – in gross – from honest responses using neuroimaging. However, if, holding the subject and the experimental paradigm constant, results are not reproducible, there is serious doubt that the technique will soon be ready to operate as a lie detector. On the other hand, if consistent results can be achieved under those controls, a challenge to the credibility of a crucial witness using fMRI should be scientifically feasible and legally cognizable.

III. *A Model For Admitting Detection of Deception Evidence*

What fMRI does, at least with regard to issues of memory, is simply strip off further the layers of assumption and non-specificity that attach to the "guilty-knowledge" or feigned ignorance testing paradigm. Rather relying on merely an empirically-derived construct such as the "orienting response," it is now possible to see the brain react to new information in a way distinctive from material that is familiar.[††††††††††††††††††††††] As with the polygraph and the EEG used to detect concealed knowledge, there will be an argument that the cases are rare where this type of information will be useful,[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] or where the examined party will not already have been given access to the material details and become familiar with them through means of discovery. However, the duty to disclose adverse information can be regulated by the court in the following way: if a party discovers material evidence, familiarity with which by an opposing party witness would be probative of an issue in the case, then under certain circumstances, the witness could be examined for this familiarity before the truth about these facts is revealed. Criminal defendants, of course, would be protected against such examination

[††††††††††††††††††††††] There is considerable evidence that the brain will react differentially to familiar information even if it has been consciously "forgotten" and it is not retrievable. This relates to the challenges of having neuroimaging overcome deception that is bolstered by self-deception, which for cognitive science purposes, means simply that little or no cognitive effort is required to suppress the "true" answer to the question.

[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] *But see* SCIENCE IN THE LAW, supra n.___ § 10-3.4.2 (arguing that once a guilty-knowledge test "breaks through" as courtroom evidence, that law enforcement and others will begin to gather material at the outset of the case that can be used to implement it).

by their right against self-incrimination, but in circumstances where they might be innocent, they should share an incentive to take the test with the prosecution (which clearly has a greater belief in their guilt).

Once a particular neural pattern is validated as indicative of memory or deception, then the recognition of this pattern on a series of neuroimages can occur by computer, or by someone independent and unfamiliar with the purpose of the test. The time stamp of the image is then synchronized with the time sequence of the examination and correlated question and response. Expert testimony would be used to explain the nature of the technique, the criteria used for scoring, and the background assumptions. Cross-examination or rival expert testimony would then be introduced focusing on issues such as the error rate, possible contamination, invalid assumptions and so forth. All of these types of challenges occurred (and continue to occur, although usually with more precision) on the uses of DNA technology. Nor is it difficult to believe that this process, as absurd as certain of the challenges to DNA now seem in retrospect,[§§§§§§§§§§§§§§§§§§§§§§] served to refine the process and presentation of DNA evidence in court. Whether evidentiary challenges impeded or improved forensic use of DNA, they certainly did not halt it. Over the last decade, this process along with technical advances in DNA sequencing have converted this to technology to the “gold standard” for identification,[***********************] even displacing the traditional bias toward eyewitnesses, which the courts clearly consider to be less reliable.

In a certain manner, the neuroimaging of a subject’s information state is merely the converse of the collection of DNA traces left behind. Just as it is difficult for an individual to interact with the external world without affecting it, and leaving behind his distinctive genetic pattern in the form of spent surface cells, each distinctive part of the external world leaves its mark on the

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§§§§§§§§§§§§§§§§§§§§§§ *See, e.g., United States v. Chischilly,* 30 F.3d 1144, 1154 (9th Cir. 1994) (rejecting claims made by academic commentators such as Jennifer Hoeffel, *The Dark Side of DNA Profiling: Unreliable Scientific Evidence Meets the Criminal Defendant,* 42 STAN.L.REV. 465, 509 (1990), that DNA matching failed tests of general acceptance, relevancy and unknown rates of error).

*********************** *Id*. at §11-1.2.1 (recounting the furious evidentiary debates that surrounded DNA through the early 1990’s and concluding that “in little more than a decade, DNA typing made the transition from a novel set of methods for identification to a relatively mature and well studied forensic technology”).

human body, acting on the cellular level to imprint a trace of itself. Formerly, only those comparatively rare parts of the external world possessing the capacity to adhere to the surface of the subject (fibers, mud, semen, etc.) were able to imprint themselves as evidence of the subject-environment interaction. The distinct auditory, visual, olfactory or tactile properties of an environment, although sensed and recorded by the subject, could not be accessed without accessibility to those cells (brain cells) acted on by these features.

As to deception or misleading *per se*, it is far less clear as yet how or when neuroimaging will prove its worth. A thoroughgoing evolutionary approach, which sees deception as basic to the adaptations underlying language and thought, would be expected to predict a "module" for deceit recognizable when activated. The difficulty in finding this module is that we do not turn deceit off and on the way we might the reflex to sneeze. Rather, the potential for multifarious deception may be so deeply embedded in our social decision-making that it is simply not possible to distinguish it from the ordinary way in which we communicate where we "modulate" what we say, how we say it, and what we don't say, in order to convey the desired impression. A recent meta-analysis of 1,338 cues of deception appears to indicate this is indeed the case, and there is a significant psychological gray area between truth and deceit.[†††††††††††††††††††††††] Therefore, any global measure of deceit detectable in the brain would be like the behavioral indicators of deceit and be better assessed as a continuous rather than discrete variable. As a practical matter for neuroimaging, therefore, it is quite unlikely on the current facts that we could reliably detect when someone is "shading the truth" or "being misleading" because those states could not be objectively specified as processing or transmitting information in a way distinct from ordinary social communication.[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡]

[†††††††††††††††††††††††] Bella M. DePaolo, et al., *Cues to Deception*, PSYCH BULL. 129: 74, 105 (2003).

[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] No one familiar with developments in the area of cognitive technology can be unaware that it is likely to pose significant privacy issues in the future. When neuroimaging becomes more accurate in detecting deception than the polygraph one non-libertarian justification restraining the use of the deception detection will be abrogated, requiring a more direct confrontation between individual rights and institutional desire to know. The theme of this article, is, of course, that testing be initially developed in the limited and more controlled circumstances of *court* cases where the technology is critical to accurate adjudication. For reasons of cost and the substantial burden, quite apart from the novelty of the technology, it is unlikely that most employers would resort to functional neuroimaging in order to investigate or screen their employees. In particular, there would be no reason to

Somewhere in the middle of plausibility is lie detection, and this is where the focus of current research is likely to be. Since it is clear that we have as yet only exploratory studies, none of them replicated, and all of them with significant limitations, nobody is likely to be able to walk into a courtroom tomorrow and challenge an opposing witness to spend an afternoon in a magnetic resonance chamber. On the other hand, at the basic level of distinguishing a group of lies from a group of honest answers, these tests do “work.” Moreover, there is a scientific rationale in the form of an argument for *why* they should so. Lies as informational products require more processing steps or inputs, in most instances, than does truth.[§§§§§§§§§§§§§§§§§§§§§§§§] If a lie is called for, it appears that some executive or “conflict-resolving” portions of the brain must hold in working memory both the honest answer and the proposed lie (whether retrieved or made up on the spot) and compare the two. In addition, the true answer and the associated motor activity that would commnicate it must be inhibited. Based on the limited results of the recent studies, it appears these tasks are accomplished differently depending on precisely how they are framed, and it may well be that different individuals accomplish them using different neuroanatomical structures.

Nevertheless, there is some hope that, for instance, an individual subject’s pattern of honesty or deception could be reliably identified. As in the “control-question” method in polygraphy, the subject would be asked to generate a certain number of known lies. The neuroanatomical correlates to these events would then be compared (in a blind test) with those corresponding to his known truthful answers. The statements on which his credibility is in doubt would then be classified to see into which category they would fall. This avoids many of the pitfalls inherent to the “control question” technique as now practiced by polygraphers, since it (1) does not depend

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alter the Employee Polygraph Protection Act. 29 U.S.C. § § 2001-2009 (1988). If courts deem it unreliable, the rationale of the Act (that employers not be allowed to use a bogus lie-detector as an intimidation tactic) remains valid. However, if courts rule – as I believe inevitable – that some types of this evidence are sufficiently reliable, the need for independent employer use remains dubious, since many deterrent ends would be achieved simply by the credible threat of a potential legal action (for conversion where embezzlement is suspected) and a court-supervised form of evidence would be available. Hence, it is unclear to me that a slippery slope argument directed against my proposal has great force. On the other hand, I reiterate that potential uses of neuroimaging for investigatory purposes by state authority might well be more prone to abuse. *See supra* n. ___.

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on arousal but on the similarity of cognitive demands, therefore making it less susceptible to confounding influences, and (2) because the outcome is a complex pattern of activation, if there is some irrelevant psychological influence such as stress that causes the target questions to be different than the known truths, this influence would be far more likely to generate a third distinctive pattern than it would the pattern corresponding to known lie, meaning a minimum of false positives. I will speculate regarding the "near-future" admissibility of this type of evidence, assuming a modest development of the technology along the lines I have just outlined.

A. *The* Frye *Standard and the Contrast with Polygraphy*

Many states continue to adjudicate the admissibility of scientific evidence under the principle of "general acceptance" in the relevant field. In this respect, at least as to methodology, functional neuroimaging has significant advantages over the polygraph. Although what constituted the appropriate reference group for polygraphers was always a matter of acrimonious debate, the fact that the majority of psychologists never accepted it as a valid instrument was one of the primary bases for its exclusion under the *Frye* standard.

By contrast, fMRI research not only is common throughout what is undoubtedly the relevant group, cognitive neuroscience, it is closely related to the general use of MRI in many different disciplines. Thus the fact that an fMRI measures how a brain reacts to an event would be "generally accepted."[*************************] In addition, the ability to infer the differing effects on a brain between a novel and a familiar stimulus would likewise be generally accepted, as issues of learning and memory are central foci of cognitive neuroscience, and the match between behavior and structure activation is relatively well developed in this area.

What would be far more questionable would be any general acceptance of whether a particular neural pattern corresponds to a lie. It would have been theoretically possible for any of the studies thus far on this question to have shown so distinct a pattern that, based on validity

[*************************] *See* Kulynych, *supra* n. ___ at 1265 (" For neuroimaging, the general scientific consensus is that most methods of PET and MRI scanning consistently produce useful information about brain status, within the known limits of temporal and spatial resolution for a given technique").

of the technology and the statistics used, there would be general acceptance. However, this did not occur, and the initial researchers do not yet claim this. In my speculative example where a single individual is tested and retested, yielding consistent differences between lies and truthful answers, the question would be a close one, but assuming that a distinctive pattern was shown for statements known to be untrue, this research – considered apart from its conclusions – does not deviate from the normal practice in clinical cognitive neuroscience that measures the responsiveness of single subjects to stimuli such as pharmaceuticals. It would therefore also be likely to find "general acceptance," in part because a cognitive neuroscientist would *a priori expect* that the cognitive operation of lying would produce *some* distinctiveness on a neuroimage, even if it might be too subtle or variable to be of use (this latter problem being overcome by the rigor of the research).

B. *Scientific Status of fMRI Under Rule 702 and the* Daubert *Standard*

Under the federal rules, a cognitive neuroscientist could testify as to either memory or deception, "provided that (1) the testimony is sufficiently based upon reliable facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case."[††††††††††††††††††††††††] Again, with regard to memory the result of this step of the inquiry would clearly pass the test of admissibility, at least so long as the test was conducted with due regard to the individual variation in brain structure activation. This would require matching neuroimages with stimuli known to be familiar and unfamiliar *to that person*, before assessing the level of familiarity the subject has with the item whose familiarity level is unknown and relevant.

With regard to lie detection, although the principles and methods would be deemed reliable, and presumably they would be applied reliably, the evidence would fail on the first criteria, because there are not currently any reliable "deception signatures" against which the individual's neuroimaging result could be matched to say whether it was or was not deceptive. Moreover, the

[††††††††††††††††††††††††] Fed. R. Evid. 702.

particular brain structures implementing deception (or alternative sets of structures varying between persons) have not yet been identified in more than the most tentative fashion, undermining any inference that activation of such structures in a particular subject is indeed "deception." As under *Frye*, at least once the foregoing scientific groundwork has been established, if for purposes of the case a researcher could develop reliable data (for instance, a set of data on known lies showing a distinct pattern with little variation) on what counted as deception, this application of generally accepted procedures would be admissible insofar as Rule 702 is concerned.

Under *Daubert* itself, a court would inquire into testability, error rate, peer review and publication, and general acceptance.[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] Clearly any general hypothesis about how a particular part of the brain generates behavior, or the consistency of the neuroimaged response to a particular task, is testable, and if posed as a general rule, falsifiable. Because the particular technique has not yet been applied for purposes of classification, it would not yet have an error rate, although to the extent there is inter-individual or intra-individual variation of the type reflected in the South Carolina study, an error rate could be based on that in conjunction with how general are the claims being made. At the current time, the estimated error rate for any particular pattern activation as indicative of lying, without calibration on the individual, would be unacceptably high for admissibility. Since there are literally thousands of event-related fMRI studies in the peer-reviewed literature (although very few on deception), this would be a relatively easy test, since this factor is generally seen as referring largely to the methodology rather than the particular application.[§§§§§§§§§§§§§§§§§§§§§§§§]

The particular application to the assessment of deception, and more precisely, to the case at hand, would instead be governed under the rules laid out in *Joiner*, which requires that the expert testimony be able to close "the analytical gap between the data and the opinion

[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] *Daubert v. Merrel Dow Pharm*, 509 U.S. 579, 593 (1993). Compare for the polygraph, D. Gallai, Polygraph evidence in federal courts: Should it be admissible? AM. CRIM. L. REV. 36: 87-116 (answering this question in the negative) (1999).

[§§§§§§§§§§§§§§§§§§§§§§§§] *See* SCIENCE IN THE LAW, VOL.1, supra n. ___, §1-3.4.

proffered."************************* Applying *Joiner*, the proponent would face several challenges. First, for the admissibility of an opinion regarding the credibility of a specific subject, the court should be shown that neuroimaging can in principle identify lies, and second, this would be greatly aided by a causal theory of why the particular structures implicated as involving lies are in fact involved. As mentioned, any such causal theory remains only in development, awaiting identification of those areas that are consistently shown to activate during lying. However, there is at least the potential of making such a connection between the data (an fMRI) and the process of forming a lie.

By contrast, it is generally considered unlikely that the polygraph, at least outside the guilty-knowledge test, will *ever* be able to bridge this gap. The most common technique of the polygraph, put simply, attempts to detect deception by noting the difference in physiological response between "control questions" and the "test questions" designed to elicit legally relevant information. At the most fundamental level, the difficulty is one of validity – that in *Joiner* terms, there is too great a gap between the method chosen and the inferences it attempts to make. Its invalidity stems from a variety of sources, including what is often termed "construct" validity – that there is no necessary connection between differential response under the CQ technique and deception – the response may stem from stress, fear, surprise or other sources activating the sympathetic nervous system, such activation being the only thing the polygraph measures.†††††††††††††††††††††††††

C. Limited Admissibility May Be Proper For Purposes of Rules 402 and 403

Scientific validity under Rule 702 and *Daubert/Joine*r is only the threshold measure of judicially-determined reliability that might permit such evidence to be lawfully used. It still remains to be considered whether neuroimaging evidence can be projected to satisfy the

************************* *General Elec. v. Joiner*, 522 U.S. at 519 (1997).
††††††††††††††††††††††††† L. Saxe & G. Ben-Shakhar, *Admissibility of polygraph tests: the application of scientific standards post-Daubert*. PSYCHOLOGY, PUBLIC POLICY AND LAW 5 203-223 (1999)

remaining strictures on presentation of material at trial.[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] Because of the expense involved, the amount of time required from the court, and the potential confusion to the jury, Rule 403 would limit admissibility to only those circumstances where the evidence of credibility was particularly relevant (under rule 402) and probative of key issues under Rule 403. Three particular circumstances come to mind. Because functional neuroimaging has achieved a greater level of validation with regard to malingering, it may be called for in civil cases where insurance fraud is suspected, for instance if the plaintiff is suing on a claim whose proof is founded on essentially his own testimony regarding pain or impairment. Another class of cases that turns on credibility is where evidence of the criminal defendant's guilt derives primarily from an alleged accomplice or other potentially untrustworthy source. In the latter circumstances, the impeachable witness could be subject to a potential DK test as to the details of the crime scene he claims to have viewed. A third type of case where current technology might be obviously relevant would be in patent or trade secret actions, in which the defendant may have to disclaim familiarity with the work he is alleged to have misappropriated. Particularly when such actions verge on industrial espionage in which blueprints, designs, or prototypes are taken and misused, a party's credibility about unfamiliarity is both material and potentially testable.

Moreover, in order to avoid neurological evidence overwhelming the case, it could be limited in two other ways that some courts already employ for polygraph testimony and therefore, *a fortiori*, would be appropriate for a developed neuroimaging test of deception. First, the testimony should be limited to impeachment only, rather than for its substantive truth.[§§§§§§§§§§§§§§§§§§§§§§§§§] In other words, neuroimaging during statements of a witness would call such statements into question, but they would not establish the converse (that the witness did in fact know something of which he claims to be ignorant, or was ignorant of that which he

[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] This is true whether or not the action actually proceeds to trial or is disposed of by pre-trial summary judgment. *See* FED. R. CIV. PROC. 56(e) (requiring facts presented for adjudication by motion to be "as would be admissible in evidence")

[§§§§§§§§§§§§§§§§§§§§§§§§§] *See United States v. Piccinonna*, 885 F.2d 1529, 1535-37 (11th Cir. 1989) (allowing polygraph evidence only for impeachment or corroboration).

claims to know); his statements would simply be nullified. Second, in order to admit this form of evidence to impeach, the proponent of the evidence would have to show not only that credibility generally was of key importance to the case, but also that the credibility of the particular witness who he proposes to examine has been put in question by at least some other form of evidence such as contradiction by others or a reputation for untruthfulness. Given the foregoing constraints, the evidence should be admissible under the basic hurdles of Rules 402 and 403 or their state equivalents.

D. *Admissibility of Neuroimpeachment Should Proceed Under Rule 607*

Assuming neuroimaging evidence is introduced for purposes of impeachment, one might legitimately ask how to further classify it in conventional terms, since the Federal Rules limit the type of material acceptable for these purposes. If, as I propose, the proponent of the evidence is seeking to use brain imaging to impeach, this is clearly challenging the direct testimony of an opposing party with extrinsic evidence going to the credibility of this testimony. In particular, it is introducing an event, recorded by fMRI in which the witness made a statement consistent with his direct testimony, but simultaneously to making this statement, his brain state recorded that this statement was not true (i.e. it showed novelty or familiarity where this was denied, or alternatively, indicated the individual was lying).

Obviously, the rule on prior *inconsistent* statements does not apply here, unless one stretches this term to mean that while the witness was saying one thing, his brain was "saying" another.[**************************] Nor can one easily argue for the use of Fed. R. Evid. 608, as the test does not bear on a witness's *character* for untruthfulness. No one is able to offer a competent opinion on the individual's character based on the previous examination alone. Under 608(b) it might be possible to inquire into the fMRI on cross-examination of the witness himself,

[**************************] Fed. R. Evid. 613(b).

as a "specific instance" where the witness was untruthful, this rules bars extrinsic evidence, which in this case would include the fMRI itself.

The way out of this legal puzzle for fMRI evidence is admit the evidence on the general ground of Fed. R. Evid. 607, because whatever else it might be, *it is evidence tending to contradict a statement of a witness.*[††††††††††††††††††††††††††] The evidentiary bar of "Rule 608(b) does not apply … when extrinsic evidence is used to show that a statement made by a witness on direct examination is false, even if the statement is about a collateral issue."[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] Under this view, admissibility is present *because* the verbal statement at trial is consistent or identical with that given during pretrial examination. The extrinsic evidence of the fMRI is admissible, as this contradicts the truth of the equivalent assertion repeated by the witness at trial. At the time of the prior statement, the contemporaneous fMRI had a tendency to show that the statement was false when uttered. If the same statement is made, its veracity is put in doubt by its relationship to the questionable prior statement. Since the witness knows of this threat, he would presumably refrain repeating the deceptive testimony, but this (quite properly) places him in another bind, because he can then be impeached with what he actually said under the prior inconsistent statement rule for hearsay, even if he tries to remain silent on the matter.[§§§§§§§§§§§§§§§§§§§§§§§§§§]

E. *Incentives for Truthfulness and Progress by Structuring Admissibility*

Assuming that the very early stages of research reported here eventually produce a more reliable method of assessing witness credibility, its gradual introduction will have take account of the incentives of the litigants, and ideally, encourage them to choose tests that will be more rather than less accurate. According to the assumptions of the model, the adjudicator will prefer truth to falsehood, as will at least one party in the dispute. The other party will usually prefer

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[††††††††††††††††††††††††††] Impeachment by contradiction is properly considered under Rule 607, not Rule 608(b). 4 JOSEPH M. MCLAUGHLIN, WEINSTEIN'S FEDERAL EVIDENCE, (2nd Ed., 1999) § 607.06, at 607-72-607-84.

[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] *Cadena v. Pacesetter Corp.*, 30 F.Supp.2d 1333 (D. Kan. 1998). *See also Velasquez v. Leonardo*, 898 F.2d 7, 8 (2d Cir.1990) (impeachment with extrinsic evidence proper to contradict testimony on fact material to case).

[§§§§§§§§§§§§§§§§§§§§§§§§§§] *See United States v. Gajo*, 290 F.3d 922 (7th Cir. 2002) (holding that inconsistency under Fed. R. Evid. 801(d)(1)(A) "may be found in evasive answers, ... silence, or changes in positions").

falsehood,[***************************] whenever his expected chance of winning is < .5. If there is a certain amount of uncertainty about the test, then the parties' willingness to have it performed will depend on their individual assessments of the test outcome. If those assessments are equally optimistic or are risk-prone, then there will be a possibility of a joint stipulation regarding the results. If the parties are risk-neutral however, one of them will have no interest in pursuing the DDD option without further legal adjustments. Because of the nature of the equipment such as fMRI, particularly in a DK paradigm, the test could in fact be ordered – and should be ordered in order to prepare the expert evidence prior to the trial. The initial showing described above should be made in pre-trial motions, specifically arguing that the proposed method of testing credibility satisfies the rules for the introduction of scientific evidence, that the credibility of a witness to be so tested has already been put at issue, and that this witness's credibility is sufficiently material to the outcome of the case as to warrant the use examination by MRI.

For convenience, I will call the source of the substantive evidence W, who offers up statement S; when S is uttered by W, it can be denominated S_w. The opposing party – and potential proponent of impeaching fMRI evidence – will be X, the cross-examiner, whose goal in the evidentiary context is to rebut or minimize anything offered by W. In part this occurs by attacking the general credibility of W, his character, background and reputation. In part this also occurs by focusing on the inherent likelihood of S, apart from the fact that it is coming from the mouth of W. Finally, and this is where DDD can be employed, X will attack the specific credibility of S_w, attempting to show thata particular statement coming from that particular speaker should be suspect. Under the polygraph paradigm, the proponent of DDD evidence would usually have been W, testing himself, and it would be a *test-negative* result that would be offered as either substantive or corroborative evidence of the *truth* of S_w. Hence this system favors any test that is highly insensitive to deception, to the untruth of S_w: one that produces a large number of Type II errors.

[***************************] Governmental representatives, of course, have been given incentives to favor truthful outcomes, and other legal and social norms regulate the extent to which even lawyers in civil matters can encourage false beliefs.

In general, the impeachment value of a *test-positive* result on a DDD in some particular instance, D^+, is determined by both the rate of Type I and Type II error, such that the probability of the S_w's truth, T, given the result of the test is defined by the following Bayesian updating:

$$\text{Prob}(T|\ D^+) = \frac{(D^+|T)}{(\{D^+|T\} + \{\ D^+|\text{not } T\})}$$

This probability of the numerator that a result indicating deception occurs during truth telling is just the false positive rate, and the probability that it occurs with falsehood is 1 – the rate of false negatives. This converts the above equation to more easily understandable form as: [†††††††††††††††††††††††††††]

$$\text{Prob}(T|\ D^+) = \frac{\text{false positives}}{\text{false positives} + (1 - \text{false negatives})\ (1-T)}$$

Introducing one more piece of algebra, I designate the false positive rate as E_1 and the false negative rate as E_2. Ultimately it is the sum of these errors, $E_1 + E_2$, that a rational legal system should seek to minimize over both the individual case, and over the progressive development of more accurate techniques of adjudication and fact investigation. The equation in that form becomes:[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡]

$$\text{Prob}(T)|D+) = \frac{E_1 T}{E_1 T \quad + \ (1-T) \quad - \ E_2(1-T)}$$

The goal of rules of procedure and evidence would therefore be to encourage each party, but in particular the party with most control over the testing procedure, to have an incentive in

[†††††††††††††††††††††††††††] These equations would also play into the initial evaluation of admissibility, as it would be the burden of the testing proponent to shown that there was (1) sufficient doubt about T ($0<T<1$), (2) a likelihood that the marginal effect of a test-positive result would change T, and (3) that the rate of false positives and negatives was sufficiently low that they would not overwhelm any inferences that could be drawn from the test results.

[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] A numerical example may be clarifying. Suppose the pre-test likelihood of a statement, after an initial showing of credibility problems, is 80%. The rate of errors, both false positives and false negatives, E_1 and E_2, is 10%. Then if there is deception detected, the new likelihood is .08/{(.08) + (.2) - (.02)}, or .08/.26; in other words, there is now only approximately a 30% chance of the statement being truthful. Thus, if this is the key issue in the case, the preponderance of evidence W would have otherwise provided disappears. Readers can easily derive for themselves that if T=1 or if T=0, there is simply no point in conducting the test. Likewise, if the error rates become high, the probative value quickly vanishes. However, even a test with a 20% misclassification rate would be useful here, producing a conditional probability of the initially plausible statement of .16/(.16 + .2 - .04) = a 50/50 proposition.

the form of greater expected utility for the reduction of E_1 and E_2. If the utility of the parties can be reasonably approximated by the changing likelihoods of a favorable litigation outcome, I propose that the choice of test be given to X, who has an incentive to minimize at least Type II error ($\Delta U(X)/\Delta E_2 < 0$). Under Rule 403, the court is required to prevent "prejudicial" outcomes, which here would be characterized as dependent on the possibility of "false positives," this will fall in relation to both T and E_1. Consequently, in order to avoid exclusion on this ground, X will also have an incentive to choose tests with a lower rate of E_1 and minimize Type I error ($\Delta U(X)/\Delta E_1 < 0$), as well as to preferentially apply tests only when T is already well below 1. By contrast, the current method of evaluating the admissibility of DDD evidence has the witness W as the proponent of polygraph evidence and although W has the right incentives about Type I error ($\Delta U(W)/\Delta E_1 < 0$), it is difficult to get them aligned so as to minimize Type II error.

Fundamentally, any test must be able to pick up the phenomena of interest, and this is an issue of sensitivity. The probability of a false positive is further reduced in the impeachment context if X is required to bring in evidence of credibility problems of W *before* the test is permitted. This could be a credibility attack of any the kinds suggested before: on the witness W, on the statement S, or on S_w, since the impeachment relevance ultimately of attacks on the witness or on the statement *simpliciter* exists only because of the probable connection they have to the statement whose truth value is actually at issue. All else equal, it is reasonable to assume that an individual with independent evidence against their credibility will be more likely to utter an untrue statement. This directly affects the overall rate of false positives (the numerator above), which is determined by the background likelihood of true statements. Call this foundational impeachment M.

Moreover, the threshold requirement M of attacking W's credibility by conventional means such as past convictions, prior bad acts, character, or reputation will have the effect of – in those cases where the statement tested is in fact true – of encouraging W's cooperation with the detection of deception test. As the rules of procedure and evidence are currently structured, this cooperation made by stipulation as to discovery by neuroimaging, would seem to be necessary in most cases, as an MRI would undoubtedly qualify as a “mental and physical examination” under the Federal Rules, which limits such examinations to parties or those, such as children, under the control of parties.[§§§§§§§§§§§§§§§§§§§§§§§§§§§]

Because impeachment information M is as a practical matter very damaging to W’s credibility despite its dubious relevance to the truth or falsity of his statement, he might be eager to bring evidence on the statement, particularly if by rule or as a practical effect a *test-negative* result on a test chosen byhis adversary X disallows X from introducing M (or some elements of it) at trial. Thus X has to put a certain amount of credibility-attacking material at risk in order to get the benefit of neuroimpeachment. If W refuses to take the test, the proponent of W’s evidence[****************************] might well consider withdrawing W (as they would do, presumably if a deception positive result was obtained), particularly if the court was able to issue an instruction regarding the refusal to take the test which allowed a negative inference to be drawn from this refusal.

The end result would be that in many circumstances, there will in fact be no “battle of the experts” or “trial how to conduct trials.” There will be less evidence actually introduced – less bad evidence. The credibility-challenged W may not be presented, and consequently neither the foundational impeachment M, nor the neuroimaging, will ever be seen. Alternatively, if W “passes the test,” the foundational impeachment will not be presented, and neither will the test-negative result that nullified it, because the test-negative result “bolstering” W’s statement would not be admissible without a prior attempt at impeachment to which it

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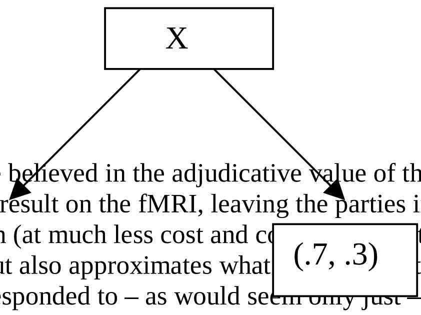
[§§§§§§§§§§§§§§§§§§§§§§§§§§§] Fed. R. Civ. Proc. 35(a). This rule also allows such court orders only when “good cause” has been shown and the examined party’s “condition” is in question. Arguably, this language could be stretched to incorporate the individual’s veracity on a particular declaration since the physical basis for such statements in terms of recall – or the lack of such a physical basis, indicating confabulation – can now be potentially examined. The foundational impeachment would then be formalized as constituting the necessary good cause. However, because of the ambiguities involved in this interpretation, and the limited reach of this rule, it seems more practical to focus on the development of incentive structures that encourage stipulation.

[****************************] Unless W is a party, the actual person with an interest in the case is often in the same informational position as X – they do not really know whether the crucial statement of W is true or not, and their opponent’s attack on W’s credibility will normally update the beliefs of everyone involved about this fact.

responds.[††††††††††††††††††††††††††††] Since the sort of material used for foundational impeachment is not particularly accurate in any event, its occasional loss should not be mourned – the best use of character and reputation evidence may be in form of leverage, rather than as presented as genuinely probative of truth.[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] In neither circumstance will the jury ever hear the term “fMRI.” Magnetic-resonance evidence would only be discussed if the proponent of W, despite his failure on the DDD (or an instruction regarding his refusal to cooperate) decides to “fight the test” (or justify his refusal) using expert testimony,[§§§§§§§§§§§§§§§§§§§§§§§§§§§§] and as the tests improve, this will become less likely.

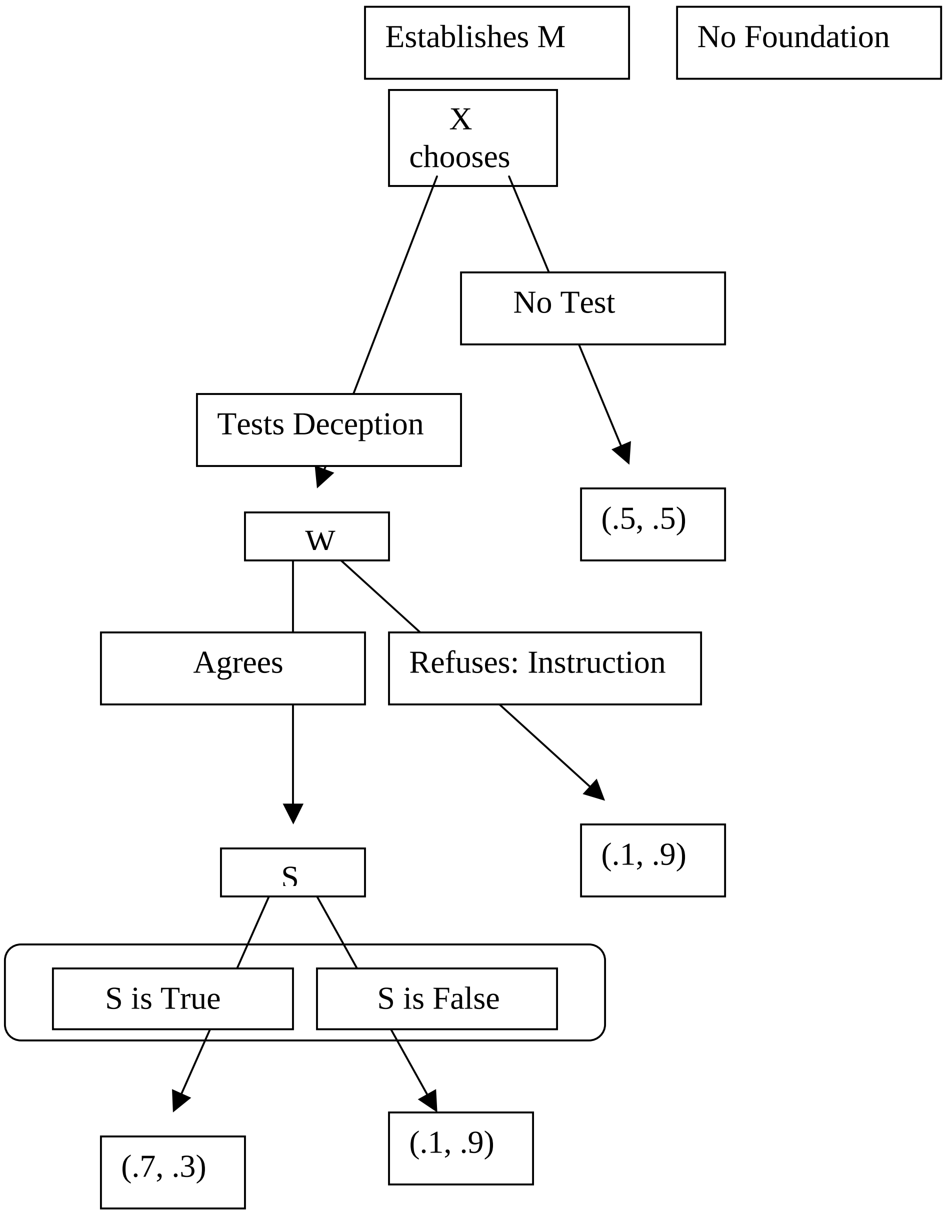
Put in an illustrative game-theoretical (extensive) form, with payoffs (W, X) equal to the probability of favorable verdict, the game between the parties might look like the accompanying figure. In the particular example, even if W knows that S_w is false, he will still marginally favor taking his chances with the test, so long as there is even a minimal error rate, because this cannot be worse than the instruction. Of course, if he knows S_w to be true, he will certainly agree. As for X, he does not know whether S_w is true or not, but his decision is governed by .3T + .9(1-T) > .5, so long as he thinks (in this particular example) that there is at least a 1 in 6 chance that the statement is false, he will go ahead with the test, despite the risk of the loss of his foundational impeachment:



[††††††††††††††††††††††††††††] Hence, even if one believed in the adjudicative value of the foundational impeachment, its exclusion also excludes the rehabilitating result on the fMRI, leaving the parties in much the same evidentiary state as they would be if there was no exclusion (at much less cost and c[illegible]tting M at risk is thus not only a way to create incentives for the parties, but also approximates what [illegible] would be if the material M, used to open the door to neuroimaging, were responded to – as would seem only just – by the countervailing evidence it had engendered.

[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] *See* Richard D. Friedman, *Character Impeachment Evidence: Psycho-Bayesian Analysis and a Proposed Overhaul*, 38 U.C.L.A. L. REV., 637, 658 (1991).

[§§§§§§§§§§§§§§§§§§§§§§§§§§§§] Recalling also that W will already have two strikes against his credibility in the form of foundational impeachment, so that only when the credibility of W’s testimony is absolutely crucial, when indeed the entire dispute hinges on this point, would it be worthwhile to make this fight.



More generally, X will propose impeachment by detection of deception where:

$[TE_1 + (1- E_2)(1\text{-}T)] * [(\text{ prob (winning)} \mid D^+)\text{-}(\text{prob(winning)}|M)],$

which equals the marginal gain in victory probability if the test "works out" for X,

$[T + E_2\ (1\text{-}T) - TE_1] * [\ (\text{prob(winning)}|M) – (\text{prob(winning)})]$,

which is equivalent to the marginal loss if the results of the test favor W. Taking prob(X's winning) and calling it P, and multiplying through, we are left with:

$(TE_1 + TE_2 + 1 – E_2)((P|D))\text{-}\ (P|M)) > (T + E_2 – TE_1 - TE_2)\ ((P|M) – P)$,

which further reduces to the following decision equation:

X uses a DDD | **$\{(2E_1T – (2E_2\ (1– T)) + 1)\ (\Delta P|D) > T\ (\Delta P|M)\}$**

This measures the comparative marginal improvements in success made by the foundational material and the test-positive result, and assesses the potential gains in a test positive result with the losses (reversion to a baseline chance of winning) if a test-negative result occurs. Because E_2, $E_1 << 1$ in any cases where the test would pass *Daubert* standards, and T is always less than 1, X would seem according to this last equation to behave approximately as we would want him to. Taking the right-hand of the equation first, we see that as the likelihood of veracity increases, the motive for examination falls, and as the power of traditional impeachment increases, it becomes increasingly less likely that there will be resort to neuroimpeachment. Now taking the left-hand of the equation, we can see that the potential marginal improvement by DDD will obviously create an incentive, but this is itself negatively dependent on both veracity and on the rate of E_1. In addition, in this form, the more common-sense disincentive for X in error rates showing no deception (E_2 or test-negative results) becomes clear, since the net marginal effect of an increase in E_2 will make it less likely that the equation will be satisfied, and that neuroimpeachment will proceed. Since cross-examiners as the proponents of this type of evidence has been provided with incentives against error, there at least some hope that the examinations they propose will also satisfy or come to satisfy the court; even in the absence of compulsory process requiring their adversaries to undergo such examinations, there will be at least some circumstances where they may voluntarily agree to such investigations, either because they have almost nothing to lose, or because their estimate or knowledge of their own veracity exceeds that of their skeptical opponent.

IV. Conclusion and Prospective

… Jove, with Indignation moved,
At last in Anger swore, he'd rid / The bawling Hive of Fraud, and did.
The very Moment it departs,/And Honsty fills all their Hearts;

There shews 'em, like the Instructive Tree,/Those Crimes, which they're ashamed to see/
Which now in Silence they confess, / By Blushing at their Uglyness;
Like Children, that would hide their Faults, And by their Colour own their Thoughts;
Imag'ning, when they're look'd upon, /That others see, what they have done.

. . .

The Bar was silent from that Day; /For now the willing Debtors pay,
Even what's by Creditors forgot; /Who quitted them, who had it not.
Those, that were in the Wrong, stood mute,/And dropt the patch'd vexatious Suit.
On which, since nothing less can thrive, /Than Lawyers in an honest Hive,
All, except those, that got enough,/With Ink-horns by their Sides trooped off.

Bernard de Mandeville, *The Fable of the Bees* (1705)

The commitment of the legal profession to truth, although often expressed, is surely somewhat deceptive – in all honesty.[*****************************] Above, I have assumed that *society* possesses an interest in truth,[†††††††††††††††††††††††††††††] and that the Anglo-American adversary system purports to serve this interest, but common wisdom accords with economic insight in identifying the practicing lawyer's adverse interest to a reality transparent to all. The general economic approach to litigation holds it is preferred to settlement only so long as the parties have different expectations of trial outcome;[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] a corollary is that a lawyer benefits in added fees by any decrease in the rate at which likelihood of success is revealed. All members of the legal profession extract rents so long as mutual confusion is maintained, while the skill of the litigator is revealed by his capacity to "shift the odds" – that is, to distort the genuine probability of success the law *a priori* would assign to his client in a particular set of circumstances. The high-quality advocate could not then gain a premium level of compensation, which he fully maximizes by unleashing the acme of his skill only late and by

[*****************************] John O. McGinnis, *Lawyers as Enemies of Truth,* 26 HARV. J. L & PUBLIC POLICY, 231 (2003)

[†††††††††††††††††††††††††††††] This is by no means an uncontroversial assumption, given the strong philosophical and political tradition supposing an excess of truth to be harmful or fatal to social order, as Mandeville exemplifies. So, in fairness, a note of caution regarding the introduction of innovation designed to increase honesty, although any harm done might be limited if honesty is confined to the courtroom, even if this casts its "shadow" over ordinary discourse by creating disincentives for deceit. Apart from concepts such as Plato's noble lie, there is, for instance, Pascal, writing: "Man is, then, only disguise, falsehood, and hypocrisy, both in himself and in regard to others… I set it down as a fact that if all men knew what each said of the other, there would be four friends in the world." **Pensees** [1670] (1995). Nevertheless, I am taking this point as a given, by presuming that honesty has not yet reached superabundant levels in American society, and that if the technology discussed here (or more likely, its distant progeny) actually threatened to create such an oversupply, I have the perhaps naïve faith that government and business would adapt to remedy this problem of excess candor.

[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] *See* STEVEN SHAVELL, FOUNDATIONS OF ECONOMIC ANALYSIS OF LAW, Harvard: Cambridge (2004) 405 (discussing the divergence of interest between lawyer and client as a barrier to disclosure of truth) surprise (i.e., at trial), since his total compensation depends on the length of the dispute, along with reputation.[§§§§§§§§§§§§§§§§§§§§§§§§§§§§§]

Common prejudice often errs, however, in identifying the lawyer's interest as *lying*, for this is not what analysis suggests; a successful lie would lead to a determination of a state of affairs contrary to fact, but it *would* lead to a determination. A lawyer's actual interest, all else equal, is in the maintenance of indeterminacy of any state of affairs for as long as possible.[*] It is little wonder then – to the cynic – that lawyers have, at best, reacted unenthusiastically to any innovation that threatened their guild control of adjudicative fact. One telling point may be that in the United States, where lawyers represent a more important special interest group, there has been little movement to eliminate the civil jury as has been done in the United Kingdom. Moreover, this system has imposed on the "finder of fact," over the course of time, a requirement of initial ignorance, which does serve to lengthen proceedings and maintain a legal monopoly on the transmission of relevant information into the decision making process,[†] whatever laudable goals it might have. The legal profession has been similarly lukewarm toward any mechanical method of detecting witness deception that might compete with the advocate's use of verbal cross-examination, which has the capacity to upset the witness's self-presentation so as to induce a belief of untrustworthiness[‡] in the minds of the jury.

One argument often put forward in defense of the status quo is that our evidentiary system is not solely about maximizing truth (or the rate of truth production). This is most obvious with regard to both the constitutional protection afforded to the criminal defendant,

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[§§§§§§§§§§§§§§§§§§§§§§§§§§§§§]Of course, the lawyer must know the true expected value, in order to abandon the case to pursue other more lucrative opportunities if they present themselves. However, this points out the tactical problem for the lawyer in revealing even information beneficial to his side, except at the end, although a client's fears and possibility of settlement (or professional regulation) might force him to reveal it earlier.

[*] An interesting question is therefore raised as to whether the lawyer in the end favors false or true outcomes. A false outcome may be less stable, thus offering greater potential for further gains. However, there are disincentives attached to adjudicative falsity, since one or more participants may be blamed for the error (by contrast, it would be very rare for someone external to the dispute to take action against a lawyer for mere inefficiency). Therefore I must respectfully disagree with Professor McGinnis's characterization of lawyers as "the enemies of the truth;" there are good reasons for them to prefer truthful outcomes if forced to arrive at something, but they are "handicappers" of the truth, perhaps, taking both meanings of this term.

[†]The most obvious exception to the law's cartelization of information is the criminal defendant's capacity to testify in his own behalf or to represent himself, although this is a relatively uncommon event, and generally ends unfavorably.

[‡] Ideally, this would be as to the witness being examined.

along with the other scattered testimonial privileges, and the related asymmetric risk averseness against Type I errors in adjudicating criminal liability. Perhaps more relevant to the current inquiry, the system affords a certain value to the privacy of information, such that the evidentiary value must be worth the loss of privacy.[§] For instance, the rules restricting the use of character evidence generally, or those more specifically to do with victims of sexual assault, can be seen in this light, as can Fed. R. Civ. Proc. 35, restricting the mental or physical examination of parties, and the use of information so obtained.

These objections carry little weight with regard to the credibility of already proposed witnesses. Such individuals have already either volunteered their testimony or else the court has been sufficiently satisfied with its potential value that they have been subpoenaed into giving evidence. Therefore the initial hurdle of their privacy has been overcome before the question of impeachment, by neuroimaging or otherwise, need even be broached. It is in getting the evidence of witnesses to be admitted for its substance that procedure hems in the truth-finding process. Once this point is reached, however, witnesses – according to their oath, anyhow – possess no rights to conceal or to lie. In this local component of the trial, the system does appear to seek a maximization of truth, even if this is not quite so about the legal or trial process more globally. Consequently, using neuroimaging as part of the assessment of the crucial question of oath adherence has seemed to me to be an appropriate entry point for the technology's use by the legal system.

[§] In addition, the various sets of pretrial investigative restrictions in criminal cases also fall into this category. For this reason, although the focus of polygraphs has been, and continues to be, on the finding of a guilty party in a criminal investigation, I do not address this here. Since the standard of proof is lower for an individual to be indicted than for them to be convicted, it would presumably be appropriate at earlier stage of fMRI accuracy to use the devices for such purposes and make the results of an adversarial test cognizable by a grand jury – all else equal. All else, is, however not equal. The level of suspicion required for involuntary questioning by fMRI would presumably be at minimum that required for any form of custodial interrogation. The procedure involved in integrating the technology into this area therefore requires separate treatment. Tentatively, however, I should note that there may be a possible difference here between imaging of memory activation and imaging of false statement activation. It is only the latter that requires a *statement* and that directly implicates the Fifth Amendment. A defendant may exercise "his right to remain silent" while still being shown items, words or pictures to judge his nonverbal reaction. Could his brain be scanned simultaneously, in the way he is now compelled to surrender a DNA sample? I admit this to be a difficult question, but one I think society will inevitably confront, and one well worth exploring in advance of this confrontation.

The unconvinced might consider the irony of the current primary restriction on cross-examination. Apart from distortion of the evidence being impeached, the cross-examiner is somewhat constrained in the manner of the examination by the desire to "protect witnesses from harassment or undue embarrassment."[**] At the same time, it is perfectly obvious that the premise of the display of the impeached witness to the jury, and the jury's supposed role as lie detector, means that impeachment serves two goals, both to reveal further substantive evidence *and* to embarrass the witness (but not unduly) in order elicit "demeanor" reactions from which the jury can (allegedly) assess credibility. One consequence of the current proposal would be to make less salient this latter aspect of the actual impeachment process at trial. Pre-trial impeachment by neuroimaging, whatever its flaws, would be less intrusive – or at least more private in its intrusion – than current practice.

[**] Fed. R. Evid. 611(a)(3).