The Judges' Book

Volume 5 Article 11

2021

Evidence: Evidence of Memory from Brain Data

Emily Murphy

Evidence

Evidence of Memory from Brain Data

Emily Murphy[1]

Introduction

John Henry Wigmore, writing in the 1930s, was optimistic that the courts would embrace something like a perfect memory-detection device to "detect specifically the memory-failure and the lie on the witness-stand."[2] Nearly 100 years of scientific advancement later, it is worth asking: What would it really mean to be able to detect the contents of a person's memory? If a brain-based approach were scientifically reliable, would it be admitted as courtroom evidence? Recent advances in brain imaging analysis techniques introduce the potential for brain-based memory detection and offer new information about the nature of autobiographical memory.

Admissibility in court and the persuasiveness (or prejudicial effect) of evidence is often the focus of legal analysis of the new neuroscience technology.[3] But the deeper question that this research presents is this: if the science is sophisticated enough to demonstrate that accurate, veridical memory detection is limited by biological, rather than technological, constraints, what should that understanding mean for broader legal conceptions of how memory is traditionally assessed and relied upon in legal proceedings? The use of powerful machine-learning algorithms reveals the limits of technological capacities to detect true memories and affirms existing psychological understanding that all memory is potentially flawed.

---

[1] Excerpted and adapted from Emily R.D. Murphy & Jesse Rissman, *Evidence of Memory from Brain Data*, J.L. & BIOSCI. (2020).

[2] JOHN H. WIGMORE, WIGMORE ON EVIDENCE § 875 (2d ed. 1935).

[3] *See, e.g.*, Teneille Brown & Emily Murphy, *Through a Scanner Darkly: Functional Neuroimaging as Evidence of a Criminal Defendant's Past Mental States*, 62 STAN. L. REV. 1119 (2010); Lyn M. Gaudet & Gary E. Marchant, *Under the Radar: Neuroimaging Evidence in the Criminal Courtroom*, 64 DRAKE L. REV. 577 (2016).

Technological Advancements, Biological Limits

Memory detection is distinct from lie detection, or "truth verification."[4] The existence (or absence) of a memory trace could theoretically be detected regardless of whether the subject is affirmatively misrepresenting or concealing that information.[5] The forensic appeal of memory detection is based on the assumption that certain brain activity is less subject to fabrication, reinterpretation, or concealment than subjective reports or even than physiological measurements of the body such as skin conductance, heart rate, breathing rate, and eye movements. This assumption has been tested by assessing the efficacy of countermeasures—behavioral or cognitive strategies for "beating the test" or manipulating results.

But active countermeasures are not the only form of potential distortion; others come from the innate imperfections of human memory. Normal people experience spontaneous memory errors (such as déjà vu) as well as imagined or suggested memory errors (sometimes called "source confusions").[6] Exactly how, and how well, the brain distinguishes autobiographical memories from other memories is unclear. Recent research suggests that the degree of autobiographical content may make episodic memories neurobiologically distinguishable.[7] Thus, some consider the problem of accurate forensic memory detection to be one of technological limitations. But the limitations on memory detection

---

[4] *See* Henry T. Greely & Judy Illes, *Neuroscience-Based Lie Detection: The Urgent Need for Regulation*, AM. J.L. MED. 377 (2007).

[5] Daniel V. Meegan, *Neuroimaging Techniques for Memory Detection: Scientific, Ethical, and Legal Issues*, 8 AM. J. BIOETHICS 9 (2008).

[6] *See* Ira E. Hyman Jr. & Elizabeth F. Loftus, *Errors in Autobiographical Memory*, 18 CLINICAL PSYCHOL. REV. 933, 933–94 (1998); Elizabeth F. Loftus & Hunter G. Hoffman, *Misinformation and Memory: The Creation of New Memories*, 118 J. EXP. PSYCHOL. 100 (1989).

[7] Hung-Yu Chen, Adrian W. Wilmore, Steven M. Nelson & Kathleen B. McDemott, *Are There Multiple Kinds of Episodic Memory? An fMRI Investigation Comparing Autobiographical and Recognition Memory Tasks*, 37 J. NEUROSCI. 2764 (2017); *see also* Tiffany E. Chow, Andrew J. Westphal & Jesse Rissman, *Multi-voxel Pattern Classification Differentiates Personally Experienced Event Memories from Secondhand Event Knowledge*, 176 NEUROIMAGE 110 (2018).

may be *biological* as well. That is, some limitations on memory detection may come from the nature of memory itself.

Techniques based on electroencephalography (EEG) can detect some memories with accuracy exceeding 90%. These techniques measure brain activity as a subject is presented with a series of stimuli—typically words, pictures, or sounds. The EEG can detect the subject brain's differentiated responses to unrecognized, recognized, or meaningful stimuli.[8] Not all information is equally well-remembered, however. People often remember very little about incidental details of real-world experiences.[9] Is this a problem that can be addressed with technical advances? Or will those advancements simply reveal the outer bounds of what our memory is capable of?

Functional magnetic resonance imaging (fMRI) images brain function. Unlike EEG, fMRI can provide data from the entire brain, which is useful because memories are encoded and stored in networks of brain regions. Advanced fMRI studies of memory detection assess complex network connections and use machine-learning algorithms to recognize subtle patterns in brain networks.[10] One of the algorithms successfully classified the self/other status of a picture from daily life events 91% of the time on average—only by looking at the brain data of a person viewing the picture.[11] But, in a study of memory for previously seen or new faces, while the algorithm proved to be very good at decoding a participant's *subjective* memory state, it was not nearly as good at

---

[8] *See* J. Peter Rosenfeld, *P300 in Detecting Concealed Information*, *in* MEMORY DETECTION: THEORY AND APPLICATION OF THE CONCEALED INFORMATION TEST 63–64 (Bruno Verschuere, Gershon Ben-Shakhar & Ewout Meijer eds. 2011).

[9] Pranav Misra, Alyssa Marconi, Matthew Peterson & Gabriel Kreiman, *Minimal Memory for Details in Real Life Events*, 8 SCI. REP., Article 16,701 (2018).

[10] Jesse Rissman, Tiffany E. Chow, Nicco Reggente & Anthony D. Wagner, *Decoding fMRI Signatures of Real-world Autobiographical Memory Retrieval*, 28 J. COGNITIVE NEUROSCI. 604, 606–07 (2016) [hereinafter "Rissman, *Decoding*"]; Jesse Rissman, Henry T. Greely & Anthony D. Wagner, *Detecting Individual Memories Through the Neural Decoding of Memory States and Past Experience*, 107 PROCEEDINGS NAT'L ACAD. SCI. 9849, 9852 (2010) [hereinafter "Rissman, *Detecting*"].

[11] Rissman et al., *Decoding*, *supra* note 10, at 606–07.

detecting the participant's *objective* experiential history.[12] In another study, the algorithm could not tell whether the presence of crime-related memories had been obtained by way of crime execution, crime planning, or reading about the crime-relevant details.[13]

In short, the biological limitations of memory detection may be unsurmountable. Even with sophisticated technology able to detect different types of autobiographical or episodic memory processes, there may be no way for scanners and algorithms to distinguish between an objectively false but subjectively believed memory, or distinguish between someone who has knowledge of, but did not participate in, a particular event. Those limitations may represent biological truths rather than technological failures.

Courtroom Admissibility

For lawyers and judges, courtroom admissibility is the *sine qua non* for forensic applications of memory-detection technology.[14] Some have argued that brain-based memory-detection technologies are not "lie detection" and should not be painted with the same brush of unreliability and thus inadmissibility.[15] But "admissibility" is not an inherent quality of technology, but rather is a complicated legal, factual, and scientific question in a particular case.

In court, the admissibility of evidence depends upon, among other things, whether it is relevant to the factual issues presented in the case. Brain-based memory detection can potentially determine which memories are autobiographical. It may detect memories that help prove identity. So memory-detection evidence may be relevant to establish what happened or who did what. But

---

[12] Rissman et al., *Detecting*, *supra* note 10, at 9852–53.

[13] Judith Peth, Tobias Sommer, Martin N. Hebart & Gerhard Vossel, *Memory Detection using fMRI—Does the Encoding Context Matter?* 113 NEUROIMAGE 164, 165–66 (2015).

[14] *See, e.g.*, John B. Meixner, Jr., *Admissibility and Constitutional Issues of the Concealed Information Test in American Courts: An Update*, *in* DETECTING CONCEALED INFORMATION AND DECEPTION 405, 406 (J. Peter Rosenfeld ed. 2018).

[15] *See* John Meixner, Jr., *Liar Liar: Jury's the Trier? The Future of Neuroscience-Based Credibility Assessment in the Court*, 106 NW. U. L. REV. 1451, 1474–75 (2012).

brain-based technologies cannot, at present, detect past intent or past mental state.[16] Thus, memory-detection evidence is probably not admissible to prove or disprove mental state and intent, which are frequently disputed in court.

In terms of mechanics, in the federal system and many states, the *Daubert* trilogy of cases and Federal Rule of Evidence 702 (or state analogs) govern the method by which judges must determine the admissibility of an expert's testimony. Presently, courts and commentators agree that brain-based deception-detection techniques fail to meet the *Daubert* standard because of their lack of understood error rates.[17] Some commentators nevertheless argue that tests that detect recognition require a "radically" different analysis under *Daubert*.[18] This is analytically incorrect. Like deception detection, the forensic application of memory-detection methods has unknown error rates and lacks "general acceptance" in the scientific community.[19] Moreover, both deception detection and recognition detection are fundamentally assessments of witness credibility, as discussed below. Accordingly, the evidentiary standards should, at present, continue to exclude expert testimony opining that brain-based memory detection proves the presence or absence of a particular memory.

Even if scientific acceptance grows, reliability still will vary across types of memory being assessed. Memory detection will work best in situations where a subject has a repeated experience resulting in a sturdy, non-fragile memory. Base rates in memory inaccuracies will depend upon the type of memory and the circumstances of its encoding and retrieval. For example, even just "imagining an event that might have occurred in someone's past can increase confidence or believe that the event actually occurred, lead individuals to claim that they performed actions

---

[16] *See* Brown & Murphy, *supra* note 3.

[17] *See, e.g.*, Daniel D. Langleben & Jane Campbell Moriarty, *Using Brain Imaging for Lie Detection: Where Science, Law, and Policy Collide,* 19 PSYCHOL., PUB. POL'Y, L. 222, 231 (2012); United States v. Semrau, 693 F.3d 510 (6th Cir. 2012); Mem. Op. & Order at 5–6, Maryland v. Smith, No. 106589C (Md. Sup. Ct. Oct. 3, 2012); Wilson v. Corestaff Servs., L.P., 900 N.Y.S.2d 639 (N.Y. Sup. Ct. 2010).

[18] Meixner, *supra* note 15.

[19] Chow et al., *supra* note 7, at 122.

that they in fact only imagined or result in the production of specific and detailed false memories of events that never actually happened."[20] Normal people, describing non-traumatic life events over successive interviews, show high degrees of variability in their autobiographical memory.[21] The relevant base rates—i.e., how often false or inaccurate memories happen in day-to-day life—are unknown.

The admissibility of brain-based memory detection may be relaxed if introduced by a criminal defendant. Because criminal defendants have a constitutional right to compulsory process, to which evidentiary rules must sometimes yield,[22] a defendant may be able to admit brain-based memory-detection evidence that is less reliable than what the prosecution would be able to put forward. The Constitution may impose other potential hurdles on the prosecution. Whether the output of a memory-detection device is physical evidence or testimonial evidence for purposes of the Fifth and Sixth Amendments remains unresolved.[23] A defendant could, for example, raise a Confrontation Clause challenge to memory-detection evidence of a state witness unavailable for cross-examination at trial.

Memory Detection as Credibility Assessment

Even were brain-based memory-detection evidence admitted into trial evidence, the jury would have to assign weight to the evidence, which is fundamentally a measure of the witness's

---

[20] Daniel L. Schacter & Elizabeth Loftus, *Memory and Law: What Can Cognitive Neuroscience Contribute?*, 16 NATURE NEUROSCI. 119, 121 (2013); Joyce W. Lacy & Craig E.L. Stark, *The Neuroscience of Memory: Implications for the Courtroom*, 14 NATURE 649 (2013).

[21] Stephen J. Anderson, Gillian Cohen & Stephanie Taylor, *Rewriting the Past: Some Factors Affecting the Variability of Personal Memories*, 14 APPLIED COGNITIVE PSYCHOL. 435 (2000).

[22] Rock v. Arkansas, 483 U.S. 44 (1987); Chambers v. Mississippi, 410 U.S. 284 (1973).

[23] *See* Kiel Brennan-Marquez, *A Modest Defense of Mind Reading*, 15 YALE J. L. & TECH. 214, 218 (2013); Nita A. Farahany, *Incriminating Thoughts*, 64 STAN. L. REV. 351 (2012); Matthew B. Holloway, Note, *One Image, One Thousand Incriminating Words: Images of Brain Activity and the Privilege Against Self-Incrimination*, 27 TEMP. J. SCI. TECH. & ENVL. L. 141, 144 (2008).

credibility. Credibility assessment, in the context of evidence law, means assessing how worthy evidence is of being believed.[24] Lying and insincerity are obvious factors, but witness credibility also includes other testimonial capacities of ambiguity, memory loss, and misperception.[25] Brain-based memory detection admitted in court via an expert witness should be *double-credibility dependent*. That is, the jury must assess the credibility of the memory itself (that is, witness credibility), *and* the credibility of the memory-detection technology (such as imprecise or ambiguous outputs, incorrect inferences, and any biases of the expert testifying). [26] This "double credibility" analysis is not sufficiently scrutinized by existing *Daubert* and *Frye* reliability requirements for expert methods.[27]

The key point is that, depending upon the situation at hand, brain-based memory detection may offer little to no probative value in assessing the *accuracy* of a witness's memory. If memory-detection technology cannot reliably distinguish false from true memories, then its evidentiary value is limited to bolstering or undermining witness *sincerity*—and it is subject to the same objections as lie-detector tests of impermissibly impinging upon the role of the jury.[28] That is, in many applied contexts, memory detection is probably indistinguishable from lie detection—and thus is subject to the same objections regarding the role of the jury as the ultimate assessor of credibility. The most advanced scientific and technological work in memory detection presently suggests that no machine, no matter how sophisticated, could detect a false but subjectively believed memory. But the use of brain-based technology and sophisticated machine-learning algorithms may obscure that fact with the veneer of factual accuracy. The technological and biological complexity of sophisticated brain-based memory detection makes it exceedingly

---

[24] *Credibility*, BLACK'S LAW DICTIONARY (10th ed. 2014) (defined as "worthiness of belief").
[25] *See, e.g.*, Edmund Morgan, *Hearsay Dangers and the Application of the Hearsay Concept*, 62 HARV. L. REV. 177 (1948).
[26] Andrea Roth, *Machine Testimony*, 126 YALE L.J. 1972, 1979 (2017).
[27] *Id.* at 2035.
[28] George Fisher, *The Jury's Rise as Lie Detector*, 107 YALE L.J. 575 (1997).

difficult—perhaps impossible—for mere laypersons to assess whether, and how much, they should ultimately believe it as fact.

If We Could, Should We?

If we had a "perfect" brain-based memory detector, should we use it? Decisional accuracy is undoubtedly a crucial value for the jury system, but "soft" systemic values of "dignity, equity, and mercy" also play a role.[29] As Justice Linde of the Oregon Supreme Court once wrote: "I doubt that the uneasiness about electrical lie detectors would disappear even if they were refined to place their accuracy beyond question. Indeed, I would not be surprised if such a development would only heighten the sense of unease and the search for plausible legal objections."[30] Accurate fact determination may be the dominant value in assessing evidence that can go to the jury,[31] but it is not so dominant to entirely set aside personhood issues, particularly when biological limitations may prevent even perfect technology from revealing the truth.

The fundamental value of personhood—as opposed to the reductionist, objectified readout of one's brain—is a cornerstone of procedural justice.[32] Personhood values apply not only to witnesses, but to jurors, in their ability to appreciate the personhood of a witness whose credibility they must assess.[33] Personhood is central to witness credibility, as evidenced by the history of witness-competency rules and existing doctrine of impeachment.[34] The dark side of the history of credibility assessment is that social and behavioral status has long been, and still is in character-based impeachment doctrine, [35] a proxy for

---

[29] Andrea Roth, *Trial by Machine*, 104 GEO L.J. 1245, 1282–90 (2016).
[30] State v. Lyon, 744 P.2d 231, 238 (Or. 1987) (Linde, J., concurring).
[31] James R. McCall, *The Personhood Argument Against Polygraph Evidence, Or "Even If the Polygraph Really Works, Will Courts Admit the Results?*," 49 HASTINGS L.J. 925, 942 (1998).
[32] TOM R. TYLER, WHY PEOPLE OBEY THE LAW (revised ed. 2006).
[33] *Cf.* McCall, *supra* note 31, at 943.
[34] Julia Simon-Kerr, *Credibility by Proxy*, 85 GEO. WASH. L. REV. 152, 161–66 (2017).
[35] *See id.* at 186 (noting that the "link between credibility, reputation, and criminality drawn in today's impeachment rules thus continues to reflect the notion that the indicia of being a bad person, however defined, is also the indicia of a liar").

who is worthy of belief, with disproportionate effects on persons of color and communities without privilege.[36] The urge to replace these troublesome status-based credibility assessments with reliable and objective lie-detection science is justifiable.[37] But if science-based techniques can only identify *subjective* experience—filtered through the impressions and decisions of whoever is probing the witness's brain—are we really any closer to establishing objective truth? Or are we now assessing witness credibility based on the social status of the expert and her sophisticated machine?

Conclusion

Courtroom admissibility is a misdirected pursuit of memory-detection technology. At present, its admissibility would be precluded under *Daubert*, *Frye*, or state equivalents, primarily for lack of known error rates and lack of general acceptance in the relevant scientific communities. But were it to clear these hurdles, brain-based memory detection may still not be suitable for courtroom use. The most advanced brain-based memory-detection studies suggest that only subjective experiences, rather than objective truths, may be accessible, rendering memory detection generally on the same footing as sincerity detection. Further, the method of acquiring that information requires machine-learning algorithms that may be opaque or even unexplainable to a jury, hindering their ability to assess the machine's (and expert's) credibility and assign appropriate weight. And even if the perfect memory-detection device worked perfectly well, its use as evidence would risk marginalizing the personhood of witnesses and thus undermining procedural justice.

---

[36] *Id*. at 189–91.
[37] *Id.* at 158.

* * *