

BRAIN FINGERPRINTING AS A LIE DETECTION TECHNIQUE

Árpád Budaházi, PhD¹

Faculty of Law Enforcement, University of Public Service, Budapest, Hungary

Abstract: According to some researchers, the brain fingerprinting technique is suitable for lie detection. Others see concerns about the method, and they doubt the applicability of brain fingerprinting. The technique is based on electroencephalography (EEG). The experts examine the electrical activity of the brain with it. Electrodes are placed on the scalp and connected to an electrically neutral area of the head (e.g., the earlobe). The technique also includes a screen on which the subject sees images. With this method the experts examine how the brain responds to the pictures shown one by one. The paper presents the experiments related to the brain fingerprinting technique. We search how the technique works and analyzes criminal cases in the United States in which brain fingerprinting has been used. We describe the brain fingerprinting examination process and methodology and examine whether the technique is suitable for lie detection. We also answer the question of whether the procedure is ideal for use in criminal cases.

Keywords: lie detection, brain fingerprinting, P300, electroencephalography, testimony.

INTRODUCTION

Larry Farwell has developed a lie-detecting technique that directly examines the brain. The brain fingerprinting detects whether specific information is stored in the human brain or not (Moenssens, 2002). The examinee is shown photographs flashed on a computer screen, amongst which some critical crime-related visual images appear. Should the brain react to the picture or word relevant to a crime, giving a so-called 'ah' signal (Farwell, 2012), the examiners consequently indicate that they are testing the perpetrator. In fact, the 'ah' or 'yeah' signal is 'MERMER' response, namely, Farwell has discovered a 'MERMER' signal in the brain, which is the larger brain frequency component known as P300 (Póczos, 2006). EEG (electroencephalogram) sensors are used in the analysis to detect the

¹ budahazi.arpad@uni-nke.hu



electric brain functions of the subject generated by various external stimuli. In case of a MERMER response the examiner concludes that the information connected to the effect is stored in the subject's memory. On the contrary, the irrelevant stimulus does not result in a MERMER response (Stoller – Wolpe, 2007).

Rosenfeld and colleagues (Rosenfeld et al. 1987; Rosenfeld et al., 2013) concluded that the P300 brain-wave might be suitable for revealing concealed information stored in memory. Even the subject denies that this information (e.g., a particular object, environment, or person) is known. However, the appearance of the P300 potential alone does not indicate a lie but only the recognition of information. Verbal denial of this may mean direct misrepresentation. The technique measurably shows whether the concealed information is present in the subject's consciousness (Littlefield, 2009). The detection of "concealed" memory traces in the brain, the possibility provided by the P300, was recognized by another research group in the United States (Farwell - Donchin, 1986) simultaneously as Rosenfeld and colleagues.

In their study, similar to Rosenfeld and colleagues, the CIT paradigm was applied. Farwell and his team tested the P300 brainwave-based technique both under laboratory conditions and on actual perpetrators. As for the detection of concealed information during the P300-based procedure, Farwell's team reported good results in this early study and subsequent studies. Specificity and sensitivity values generally exceeded 90% (Farwell - Donchin 1991). The name "brain fingerprinting" is also due to this working group. Brain fingerprinting was used in several criminal cases in the United States in the early 2000s. The techniques considered suitable to orient the investigation. According to some researchers, the expert can use the method to answer whether the subject's brain responds to a photo or text related to the crime. If he does not respond, it is presumed that he did not commit the crime. The expert shows pictures such as the gun with which the perpetrator committed the crime. The expert shows the subject several guns and watches which gun triggers the P300 brainwave. Brain fingerprinting is a non-invasive yet safe and painless technique (Fox, 2008). Although it has already been used in three criminal cases in the United States, there are doubts as to its suitability for lie detection. Questions need to be answered as to whether the human brain can recall the details of the crime from a multi-year perspective. Does the passage of years affect the P300 brainwave? Could it be, for example, that a knife seen in a movie triggers a P300 MERMER response and not the crime that happened? Does the brain fingerprinting technique have a place in criminal cases? Is it a limitation if the authority does not have a decent photo in the criminal case?

P300 MERMER RESPONSE

The basis of the operation of the technique is the P300 MERMER response. If the photo is familiar, the brain gives a P300 MERMER response. The P300 brain wave is a group of cerebral bioelectrical signals. It can be examined by electroencephalography (EEG) methods used in medical practice, among others. The EEG signal - i.e., the electroencephalogram - is a continuously changing voltage fluctuation over time, which is the sum of the electrical activities from billions of brain neurons. The EEG signal can be measured by the potential difference between a sensing electrode placed on the scalp ("scalp") and an electrically neutral point on the head (such as the earlobe). EEG is no longer registered from the scalp by scientific research and clinical trials using not one, but usually many, possibly hundreds, sensors so that the activity of each brain area can be monitored with high spatial accuracy. The P300 brain wave, which is important for brain fingerprinting, is an essential class of event-evoked potentials. Sutton and colleagues first described the P300 brainwave in 1965 (Sutton et al., 1965). In



their experiment, subjects were presented with high and low tones in a ratio of 8:2 in random order. Participants had to count the infrequent sounds. As a result of their study, they found that the P300 brain wave was always “triggered” by rare sounds, regardless of whether the high or low sound was the rare stimulus. Depending on which stimuli different in some respects from the series are used, this test situation is called the “oddball” paradigm. The name P300 comes from the fact that after the stimulus is presented, it appears with a delay of about 300 milliseconds (hence 300) (typically lasts for hundreds of milliseconds), and the brainwave has a positive amplitude (therefore P) (Budaházi et al., 2021). As a result of further studies, they described that the amplitude of the P300 wave is most significant in the midline parietal, central, and frontal brain areas. It grows in proportion to the “rarity” of the stimulus and the subjective meaning and the “meaning” of the stimulus. “Meaning in itself” can be certain stimuli, such as information about ourselves, name, birthday, phone number, or information about the crime. In other cases, a particular stimulus can be made “meaningful” to the subject by augmenting it with a task (e.g., in a study to detect concealed information, pressing the appropriate response button after a particular image flashes) (Budaházi et al., 2021).

BRAIN FINGERPRINTING IN CRIMINAL CASES

In 1977, Terry Harrington, who was 17 at the time, was accused of the murder of John Schweer, a retired police captain. The victim worked as a security guard at a car dealership, where the offense took place (Hurd, 2012). In the criminal procedure, Harrington had alleged that he had been at rock concert with friends in another town on the evening of the crime. Several witnesses corroborated the defendant’s alibi. However, Kevin Hughes, a primary prosecution witness who was 16 at the time, testified in contradiction to the defendant’s plea, upon which Harrington was found guilty and sentenced to life without parole. In 1997, Harrington petitioned the Iowa District Court for post-conviction relief for a new trial, and in March 2000, he amended his petition to include the results of Farwell’s brain fingerprinting testing. The applicant alleged that the brain fingerprinting results enhance new evidence unknown to the first decree court and upon which the defendant should have been acquitted. Farwell concluded that Harrington’s brain did not store critical details of the crime subject to his conviction; for example, his brain did not recognize the crime scene.

On the other hand, with regards to critical details on the alibi (he had been at a concert on the evening of the crime), Farwell concluded that Harrington’s brain stored such information. When confronted with the brain fingerprinting test results, Kevin Hughes, the key prosecution witness, recanted his testimony and admitted that he had lied in the original trial, falsely accusing Harrington. Hughes explained that he had lied, fearing that he might have been charged with murder himself if he was telling the truth (Farwell 2021b).

In November 2000, the Iowa District Court held a hearing on the petition for post-conviction relief. Farwell has testified as an expert on the new method. Furthermore, two acknowledged professors, William Iacono of the University of Minnesota and Emanuel Donchin of the University of Illinois, have confirmed the efficiency of the Farwell research and stated that brain fingerprinting – as a scientific method – can recall any information stored in the human brain with a 99.9% accuracy. It enhances the technique to meet the legal standards for admissibility for the authorities proceeding in criminal cases as reliable evidence (Farwell 2021b).

After an eight-hour session, the court ruled that brain fingerprinting testing met the legal standards for admissibility in court as unquestionable scientific evidence. It constituted new evidence in the case



that could be the ground of a new trial opened upon the post-conviction petition. However, the court also ruled that along with other newly discovered evidence in the case it would probably not have resulted in the jury arriving at a different verdict than at the original trial, and therefore it denied the petition for a new trial. In August 2001, Harrington filed an appeal on the Iowa District Court's decision to deny a new trial, resulting in the Iowa Supreme Court ordered a new trial (*Harrington v. State*, 659. N.W.2nd 509 (Iowa 2003, No.96-1232.)). Although the Iowa Supreme Court has undoubtedly acknowledged Farwell's expert opinion on brain fingerprinting testing, the good closure of the case to Harrington was based on the injury of the Brady rule. Thus, the defendant was not confronted with the key prosecution witness since he recanted his testimony when confronted with the brain fingerprinting test results. In the light of the new evidence and the fact that the key prosecution witness of the original case recanted his testimony, the base of the conviction, in 2003 Harrington was released and his conviction was reversed. He has received the compensation of USD 12 million for the years he had spent in jail (Farwell 2021b). In connection with the Harrington case, Rosenfeld criticizes the fact that the concealed information was not found in the convict's mind more than twenty years after the crime was committed, so he believes the naive conclusion that Harrington did not commit the crime was not there (Rosenfeld 2005. p. 29). The suggestion is valid, and it is also questionable when the image of the concert serving as an alibi may have entered his brain. On the day the crime happened or at another time? Also, what photo did Farwell have of the concert? When was it made? Did it trigger a P300 brainwave because Harrington was actually there at the concert seen in the picture on July 22, 1977, or was it just his brain that responded to a photo taken of a concert?

THE JAMES B. GRINDER CASE

James B. Grinder has been the prime suspect of the murder of 25-year-old Julie Helton, despite the defence's conviction that the evidence was insufficient to indict him and convict him in first-degree murder. In January 1984, the abduction of Julie Helton was reported in Macon, Missouri. The victim's body was found three days after near a railroad track outside Macon. The coroner discovered signs of rape and physical abuse on the body and also found a stab wound on the neck. During the 15-year long criminal procedure, Grinder gave several different testimonies. He soon recanted his first testimony confessing his involvement and denied the offense. Some of his testimonies referred to other perpetrators of the crime. However, the testimonies were invariably contradictory to the available material evidence and to the testimony of an alleged witness of the defence. Even DNA tests did not bring favourable results since the blood samples taken at the crime scene were rather old. In 1999, Macon County Sheriff Robert Dawson – after approximately 10.000 man-hours of unsuccessful investigation – turned to brain fingerprinting testing to decide whether Grinder had committed the crime or not. Grinder, who had spent several years in prison before, agreed to the test. The Sheriff gave all significant information gathered during the investigation to Farwell, and Farwell completed the test with the cooperation of an FBI agent. He completed the examination at the correction institute where Grinder was held. During the analysis, he showed Grinder the murder weapon, specific methods of killing the victim, the object the perpetrator used to bind the victim's hands, the crime scene, and the victim's belongings found not far from the location of the offense after discovering the criminal act. Farwell concluded that all the critical information was stored and present in Grinder's brain. Following the principles of the method, the conclusion was that Grinder did commit the offense. Otherwise, his brain would not have enhanced MERMER responses to relevant information.

However, Grinder concluded a plea deal, pled guilty to rape and murder of the victim and in exchange - instead of the death penalty - he agreed to a life sentence without parole. Uniquely, in this



case, Grinder did not only confess to murdering victim Julie Helton, but after the brain fingerprinting examination, he gave a detailed confession to the murder of three more young girls. He first raped and then stabbed or beat his victims to death (Farwell 2021b). As for now, there are two final and binding orders in a conviction of Grinder. Another procedure is still pending. Brain fingerprinting was essential both for confession and for the fact that Grinder committed a crime 15 years before. The method could be used to detect that critical information was in Grinder's brain. The Grinder case dampens Rosenfeld's criticism of the Harrington case that years passed could remove concealed information from the brain.

THE JIMMY RAY SLAUGHTER CASE

In 2004, Jimmy Ray Slaughter, a death row inmate, had pleaded for a new trial referring to negative test results of brain fingerprinting (information not stored in the brain) and other evidence at the Court (of Criminal Appeals) of Oklahoma. The appellant referred to the favourable results of brain fingerprinting and referred to the exempting results of DNA analysis and further evidence proving his innocence (Farwell, 2012).

Slaughter was condemned to death for the July 2, 1991 murder of his former girlfriend, the 29-year-old Melody Wuertz, and their child, the 11-month-old Jessica Rae Wuertz (Lumpkin, 2021). He committed the killing actions in the victims' Edmond home. According to the ruling, Slaughter has shot both his victims in the head. In addition, he has hit his ex-girlfriend in the neck.

Moreover, he had stabbed the victim several times and then mutilated her body (Clark, 2021) Slaughter claimed innocent of the crime all along, although investigation proved that he had a somewhat stormy relationship with his ex-girlfriend, and they had numerous fights and furious quarrels over unpaid child support. In the end, Slaughter was executed. Denying the petition for a new trial, the court has also referred to brain fingerprinting. He stated the court did not recognize the results because the court did not receive a comprehensive and detailed method — neither on nature nor the application or the results of the technique. The brain fingerprinting 'evidence' would not have changed the balance of the scales before the jury – ruled the court (Slaughter v. State, Oklahoma 2005, No. PCD-2005-77.). The Slaughter case also exemplifies that the result of brain fingerprinting alone is not sufficient to order a retrial, because it is not the weight of evidence that would affect the judgment of the retrial court. Although the court justified disregarding the result of brain fingerprinting by not receiving information about the method, in our view, if Farwell had provided sufficient information about brain fingerprinting, the court would probably not have made any decision other than to dismiss the renewal request.

CONCERNS AND LIMITATIONS

The main problem with brain fingerprinting is the lack of proper validation of the method. Although experimental results are available, further validation experiments are needed to verify the reliability of the technique. Simplifying the method can also help to make brain fingerprinting testing more widespread.

Limitations of brain fingerprinting include the need for a photograph to be available about the case; no more than words can be projected onto the subject if there is no photograph. The availability of pic-



tures presupposes that the authority is beyond a practical inspection or research where, for example, a knife, or a corpse, etc., used to commit a crime has been found. Photos can already be taken, but the possibility of applying the method is reduced if neither a picture of the victim, nor a knife is available, nor it is not possible to know exactly where the crime was committed. For example, the polygraph may yield results, but the use of brain fingerprinting seems to be ruled out. Proper timing also plays an important role in the use of the method. On the one hand, this can be done when suitable photos are already available, and on the other hand, the photos should be taken as soon as possible to avoid, for example, a change in the crime scene (not the same picture in winter or summer, etc.).

It is essential whether the brain responds to the image seen on the monitor with the P300 because the person committed the crime or only saw the pistol in the photo on TV. Recent EEG research to eliminate the contrast used in the concealed information test promises a significant turnaround. In one study, Japanese researchers convincingly demonstrated that not only the display of information intended to be concealed could be linked to a specific brain response (the P300 brainwave), but also the process of concealment itself. They concluded that the relevant stimuli elicited a higher amplitude P300 potential than the irrelevant stimuli. They analyzed how the amplitude of the slow frontal wave varies depending on whether the memory content sought is “absent” or “present” in the subject’s brain; and, if present, if the subject intends to conceal or reveal it. The results showed that selective correct hemisphere activation during the slow frontal wave was specifically observed when subjects tried to hide the recognition of the critical relevant stimulus (Matsuda - Nittono 2018). These experimental results suggest that it is possible to determine from the activity of the hemispheres whether P300 can be detected because the subject committed the crime. However, this was only one experiment, and more experiments are needed.

A major, often unacknowledged, problem with brain fingerprinting is the suspect’s possible lack of memory for details due to the passage of time since the crime and/or drug and alcohol use. Additionally, an investigator needs to determine what the suspect will remember (Wilcoxson et al., 2020).

Brain fingerprinting detects information-processing brain responses that reveal what information is stored in the subject’s brain. It does not notice how that information got there, be it a witness or a perpetrator. Brain fingerprinting does not detect lies. It simply detects information. No questions are asked or answered during a brain fingerprinting test. The subject neither lies nor tells the truth during a brain fingerprinting test, and the outcome of the test is unaffected by whether he has lied or told the truth at any other time. The outcome of “information present” or “information absent” depends on whether the relevant information is stored in the brain, and not on what the subject says about it (Dhiraj Ahuja & Bharat Singh, 2012).

CONCLUSIONS

The brain fingerprinting technique, which is also considered suitable for lying, is characterized by the fact that its operation and validity are uncertain, although it has been used in criminal cases. In our view, the method should not have been used before proper validation. They have a high stake in criminal cases, and human destinies may depend on the endless, invalidated technique that should not be used, even if it “only” served the orientation of the investigation and was not taken into account by the court as evidence. Even the misorientation of the investigation no longer led a criminal case astray, which could even result in a “*justizmord*” (judicial murder). Brain fingerprinting needs further



testing, experimentation, and development. It is primarily due to the lack of validation and scientific validation related to the operation of the method that it is rarely used.

REFERENCES

1. Ahuja, D. & Singh B. (2012): Brain fingerprinting. *Journal of Engineering and Technology Research*, 4(6), 98-103.
2. Budaházi, Á., Fantoly, Zs., Kakuszi, B., Bitter I. & Czobor P. (2021). *A műszeres vallomásellenőrzés fejlődési irányai*. Budapest: Ludovika Egyetemi Kiadó
3. Clark County Prosecuting Attorney (2021): *Jimmie Ray Slaughter*. Downloaded July 20, 2021 www.clarkprosecutor.org/html/death/US/slaughter955.htm
4. Farwell Brain Fingerprinting (2021a): *Helps to Free an Innocent Man*, Downloaded July 20, 2021 www.larryfarwell.com/Harrington-Summary-dr-larry-farwell-brain-fingerprinting-dr-lawrence-farwell.html
5. Farwell Brain Fingerprinting (2021b): *Catches a Serial Killer*, Downloaded July 20, 2021 www.larryfarwell.com/Grinder-Summary-dr-larry-farwell-brain-fingerprinting-dr-lawrence-farwell.html
6. Farwell, L. A. – Richardson, D. C. – Richardson, G. M. (2014): Brain fingerprinting field studies comparing P300-MERMER and P300 brainwave responses in the detection of concealed information. *Cognitive Neurodynamics*, 7(4), 263–299. <https://doi.org/10.1007/s11571-012-9230-0>
7. Farwell, L. A. & Donchin, E. (1991): The Truth Will Out: Interrogative Polygraphy (“Lie Detection”) with event-related brain potentials, *Psychophysiology*, 28(5), 531–547. DOI: <https://doi.org/10.1111/j.1469-8986.1991.tb01990.x>
8. Farwell, L. A. & Donchin, Emanuel (1986): The „brain detector”: P300 in the detection of deception, *Psychophysiology*, 23(4). 434–450.
9. Farwell, L. A. (2012): Brain fingerprinting: a comprehensive tutorial review of detection of concealed information with event-related brain potentials, *Cognitive Neurodynamics*, Vol. 6, No. 2. 115–154.
10. Fox, Dov (2008): Brain Imaging and the Bill of Rights: Memory Detection Technologies and American Criminal Justice, *The American Journal of Bioethics*, 8(1), 34–36. DOI: <https://doi.org/10.1080/15265160701828451>
11. Hurd, A. J. (2012): Reaching Past Fingertips with Forensic Neuroimaging – Non-Testimonial Evidence Exceeding the Fifth Amendment’s Grasp, *Loyola Law Review*, Vol. 58, No. 1. 213.
12. Littlefield, M. (2009): Constructing the Organ of Deceit: The Rhetoric of fMRI and Brain Fingerprinting in Post-9/11 America, *Science Technology, & Human Values*, 34(3), 365-392.
13. Lumpkin, J. (2021): *Slaughter v. State – Opinion*, Downloaded July 20, 2021 <https://law.justia.com/cases/oklahoma/court-of-appeals-criminal/1997/60429.html>
14. Matsuda, I. – Nittono, H. (2018): A concealment-specific frontal negative slow wave is generated from the right prefrontal cortex in the Concealed Information Test, *Biological Psychology*, 135 (May), 194–203. DOI: <https://doi.org/10.1016/j.biopsycho.2018.04.002>
15. Moenssens, A. A. (2002): Brain Fingerprinting – Can It Be Used to Detect the Innocence of Persons Charged with a Crime? *UMKC Law Review*, 70, 891–920.



16. Póczos, E. (2006): A hazugságvizsgálat jövőképe, *Belügyi Szemle*, 54(5), 100–109.
17. Rosenfeld, J. P. – Hu, X. – Labkovsky, E. – Meixner, J. & Winograd, M. R. (2013): Review of recent studies and issues regarding the P300-based complex trial protocol for detection of concealed information. *International Journal of Psychophysiology*, 90(2) 118–134. DOI: <https://doi.org/10.1016/j.ijpsycho.2013.08.012>
18. Rosenfeld, J. P. – Nasman, V. T. – Whalen, R. – Cantwell, B. & Mazzeri, L. (1987): Late Vertex Positivity in Event-Related Potentials as a Guilty Knowledge Indicator: A New Method of Lie Detection, *International Journal of Neuroscience*, 34(1–2), 125–129. DOI: <https://doi.org/10.3109/00207458708985947>
19. Rosenfeld, J. Peter (2005): ‘Brain Fingerprinting’: A Critical Analysis. *The Scientific Review of Mental Health Practice*, 4(1), 20–37.
20. Stoller, S. E. & Wolpe, P. R. (2007): Emerging Neurotechnologies for Lie Detection and the Fifth Amendment, *American Journal of Law & Medicine*, 33(2–3), 359–375. DOI: <https://doi.org/10.1177/009885880703300210>
21. Sutton, S. – Braren, M. – Zubin, J. & John, E. R. (1965): Evoked potential correlates of stimulus uncertainty. *Science*, 150(3700), 1187–1188.
22. Wilcoxson, R., Brooks, N., Duckett, P. & Browne M. (2020): Brain Fingerprinting: A Warning Against Early Implementation, Downloaded July 20, 2021 https://www.researchgate.net/publication/344526903_Brain_Fingerprinting_A_Warning_Against_Early_Implementation