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Brain Fingerprinting

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ABSTRACT
Brain Fingerprinting is a new computer-based technology to identify the culprit of a crime accurately and scientifically by measuring brain-wave responses to crime-relevant words or pictures presented on a computer screen. Investigators' need for accurate, scientific means of linking perpetrators with crime scene evidence has inspired some scientists to ask, "What does the criminal always take with him from the crime scene that records his involvement in the crime?" The answer to this question, of course, is the Brain. Brain fingerprinting is based on the finding that the brain generates a unique wave pattern when a person encounters a familiar stimulus. Persons asked to lie show different patterns of brain activity than they do when being truthful. In the field of criminology, a new lie detector has been developed in the United States of America. This is called "brain Fingerprinting". This invention is supposed to be the best lie detector available as on date and is said to detect even smooth criminals who pass the polygraph test (the conventional lie detector test).
This purpose of this document is to discuss the need of brain fingerprinting, its applications, advantages and its limitations.
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Keywords:
Electroencephalography (EEG); MERMER; Testimony; Forensic science; Perpetrator

Abbreviations: EEG: Electroencephalography, DNA: Deoxyribonucleic acid, MERMER: Memory and Encoding Related Multifaceted Electroencephalographic Response

1. INTRODUCTION

1.1 What is Brain Fingerprinting?

Brain Fingerprinting is a controversial forensic science technique that uses electroencephalography (EEG) to determine whether specific information is stored in a subject's brain. It does this by measuring electrical brainwave responses to words, phrases, or pictures that are presented on a computer screen. The theory is that the suspect's reaction to the details of an event or activity will reflect if the suspect had prior knowledge of the event or activity. This test uses what Farwell calls the MERMER ("Memory and Encoding Related Multifaceted Electroencephalographic Response") response to detect familiarity reaction.

1.2 Why Brain Fingerprinting?

Brain Fingerprinting is based on the principle that the brain is central to all human acts. In a criminal act, there may or may not be many kinds of peripheral evidence, but the brain is always there, planning, executing, and recording the crime. The fundamental difference between a perpetrator and a falsely accused, innocent person is that the perpetrator, having committed the crime, has the details of the crime stored in his brain, and the innocent suspect does not. This is what Brain Fingerprinting detects scientifically, the presence or absence of specific information.

Conventional fingerprinting and DNA match physical evidence from a crime scene with evidence on the person of the perpetrator. Similarly, Brain Fingerprinting matches

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informational evidence from the crime scene with evidence stored in the brain. Fingerprints and DNA are available in only 1% of crimes. The brain is always there, planning, executing, and recording the suspect's actions. Brain Fingerprinting has nothing to do with lie detection. Rather, it is a scientific way to determine if someone has committed a specific crime or other act. No questions are asked and no answers are given during Farwell Brain Fingerprinting. As with DNA and fingerprints, the results are the same whether the person has lied or told the truth at any time.

2. HISTORY

Brain fingerprinting was invented by Lawrence Farwell. The theory is that the brain processes known and relevant information differently from the way it processes unknown or irrelevant information (Farwell & Donchin 1991).

The brain's processing of known information, such as the details of a crime stored in the brain, is revealed by a specific pattern in the EEG (electroencephalograph) (Farwell & Smith 2001, Farwell 1994).

Farwell's brain fingerprinting originally used the well known P300 brain response to detect the brain's recognition of the known information (Farwell & Donchin 1986, 1991; Farwell 1995a).

Later Farwell discovered the MERMER ("Memory and Encoding Related Multifaceted Electroencephalographic Response"), which includes the P300 and additional features and is reported to provide a higher level of accuracy than the P300 alone (Farwell & Smith 2001, Farwell 1994, Farwell 1995b).

Brain fingerprinting has been applied in a number of high-profile criminal cases, including helping to catch serial killer JB Grinder (Dalbey 1999) and to exonerate innocent convict Terry Harrington after he had been falsely convicted of murder (Harrington v. State 2001). Brain fingerprinting has been ruled admissible in court (Harrington v. State 2001, Farwell & Makeig 2005).

3. SCIENCE OF BRAIN FINGERPRINTING

3.1Technique

The person to be tested wears a special headband with electronic sensors that measure the EEG from several locations on the scalp. The subject views stimuli consisting of words, phrases, or pictures presented on a computer screen. Before the test, the scientist identifies.

Figure 1: Technique of brain fingerprinting

the targets to the subject, and makes sure that he/she knows these relevant stimuli. The scientist also makes sure that the subject does not know the probes for any reason unrelated

to the crime, and that the subject denies knowing the probes. The subject is told why the probes are significant (e.g., "You will see several items, one of which is the murder weapon"), but is not told which items are the probes and which are irrelevant.

The technique uses the well known fact that an electrical signal known as P300 is emitted from an individual's brain beginning approximately 300 milliseconds after it is confronted with a stimulus of special significance, e.g. a rare vs. a common stimulus or a stimulus the subject is asked to count (see P300, Gaillard and Ritter 1983, and Picton 1988 for a comprehensive discussion of this effect). The application of this in brain fingerprinting is to detect the P300 as a response to stimuli related to the crime or other investigated situation, e.g., a murder weapon, victim's face, or knowledge of the internal workings of a terrorist cell.

3.2 How it works

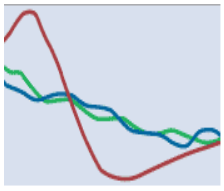
Brain fingerprinting uses brain waves to test memory. A crime suspect is given words or images in a context that would be known only to the police or the person who committed the crime.

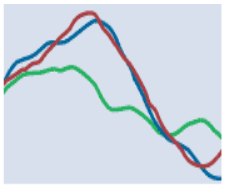
A Suspect is tested by looking at three kinds of information represented by Different colored lines:

-----Red: information the suspect is expected to know

-----Green: information not known to suspect

-----Blue: information of the crime that only perpetrator would know





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

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

Figure 2 Using brain waves to detect guilt

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3.3 Four phases of Farewell Brain Fingerprinting

1. Brain Fingerprinting ***Crime Scene Evidence Collection*:**
   In the Crime Scene Evidence Collection, an expert in Brain Fingerprinting examines the crime scene and other evidence connected with the crime to identify details of the crime that would be known only to the perpetrator
2. Brain Fingerprinting ***Brain Evidence Collection***:
   The expert then conducts the Brain Evidence Collection in order to determine whether or not the evidence from the crime scene matches evidence stored in the brain of the suspect.
3. Brain Fingerprinting ***Computer Evidence Analysis***:
   In the Computer Evidence Analysis, the Brain Fingerprinting system makes a mathematical determination as to whether or not this specific evidence is stored in the brain, and computes a statistical confidence for that determination.
4. Brain Fingerprinting ***Scientific Result:***
   The determination and statistical confidence constitute the Scientific Result of Brain Fingerprinting: either "information present" ("guilty") – the details of the crime are stored in the brain of the suspect – or "information absent" ("innocent") – the details of the crime is not stored in the brain of the suspect.

4.ROLE IN CRIMINAL PROCEEDINGS

The application of Brain Fingerprinting testing in a criminal case involves four phases: investigation, interview, scientific testing, and adjudication.

The first phase is undertaken by a skilled investigator, the second by an interviewer who may be an investigator or a scientist, the third by a scientist, and the fourth by a judge and jury.

This is similar to the forensic application of other sciences. For example, if a person is found dead of unknown causes, first there is an investigation to determine if there may have been foul play. If there is a suspect involved, the suspect is interviewed to determine what role, if any, he says he has had in the situation. If the investigation determines that the victim may have been poisoned, then scientific tests can be conducted to detect these specific substances in the body. Then the evidence accumulated through the test, the investigation, and the interview is presented to a judge and jury, who make the adjudication as to whether a particular suspect is guilty of a particular crime. In such a case, the science of forensic toxicology reveals only whether or not specific toxins are in the body. The science of forensic toxicology also does not tell us whether a particular suspect is innocent or guilty of a crime.

PHASE 1: Investigation

The first phase in applying Brain Fingerprinting testing in a criminal case is an investigation of the crime. Before a Brain Fingerprinting test can be applied, an investigation must be undertaken to discover information that can be used in the test. The science of Brain Fingerprinting accurately determines whether or not specific information is stored in a specific person's brain. It detects the presence or absence of specific information in the brain. The role of investigation is to find specific information that will be useful in a Brain Finger printing test. As with any scientific test, if the outcome of the Brain Fingerprinting test is to be useful evidence for a judge and jury to consider in reaching their verdict.

PHASE 2: Interview of Subject

Once evidence has been accumulated through investigation, and before the Brain Fingerprinting test is conducted to determine if the evidence can be linked to the suspect, it can in some cases be very valuable to obtain the suspect's account of the situation. For example, if an investigation shows that specific fingerprints are found at the scene of a murder, a suspect can be interviewed to determine if there may be some legitimate reason that his prints are there. If the suspect's story is that he was never at the scene of the crime, then a match between his fingerprints and the fingerprints at that scene would be highly incriminating. If, on the other hand, the suspect's story is that he was at the scene for some legitimate reason just before the crime, then fingerprints must be interpreted differently, particularly if there is corroborating evidence of the suspect's presence at the scene before the crime. The interview with the suspect may help to determine which scientific tests to conduct, or how to conduct the tests. Prior to a Brain Fingerprinting test, an interview of the suspect is conducted.

PHASE 3: Scientific Testing with Brain Fingerprinting

It is in the Brain Fingerprinting test where science contributes to the process. Brain Fingerprinting determines scientifically whether or not specific

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information is stored in a specific person's brain. Brain Fingerprinting is a standardized scientific procedure. The input for this scientific procedure is the probe stimuli, which are formulated on the basis of the investigation and the interview. The output of this scientific procedure is a determination of "information present" or "information absent" for those specific probe stimuli, along with a statistical confidence for this determination. On the basis of this and all of the other available evidence, a judge and jury make a determination of guilty or innocent.

PHASE 4: Adjudication of Guilt or Innocence

The final step in the application of Brain Fingerprinting in legal proceedings is the adjudication of guilt or innocence. This is entirely outside the realm of science. The adjudication of guilt or innocence is the exclusive domain of the judge and jury. It is not the domain of the investigator, or the scientist, or the computer. It is fundamental to our legal system that decisions of guilt or innocence are made by human beings, juries of our peers, on the basis of their human judgment and common sense. The question of guilt or innocence is and will always remain a legal one, and not a scientific one. Science provides evidence, but a judge and jury must weigh the evidence and decide the verdict.

Figure 3
Guilty Brain scan

5. APPLICATIONS

5.1) Criminal Justice system

Used with MERMER technology.

FBI and CIA endorsed to convict criminals

1. P300 brainwave is emitted if a memory of presented stimulus exits in the brain.
2. Difference between perpetrator and the innocent is the memory of the crime scene embedded in the brain.

A critical task of this system is to determine who has committed a crime. The key difference between a guilty party and an innocent suspect is that the perpetrator of the crime has a record of the crime stored in their brain, and the innocent suspect does not. Until the invention of Brain Fingerprinting testing, there was no scientifically valid way to detect this fundamental difference.

Brain fingerprinting testing will be able to dramatically reduce the costs associated with investigating and prosecuting innocent people and allow law enforcement professionals to concentrate on suspects who have verifiable, detailed knowledge of the crimes.

5.2) Medical diagnosis

The incidence of Alzheimer's and other forms of dementia is growing rapidly throughout the world. There is a critical need for a technology that enables early diagnosis economically and that can also accurately measure the effectiveness of treatments for those diseases. MERMER technology, developed and patented by Brain Fingerprinting Laboratories, includes the P300 brainwave and extends it, providing a more sensitive measure than the P300 alone.

Using the very precise measurements of cognitive functioning available with this technology, pharmaceutical companies will be able to determine more quickly the effects of their medications and potentially speed FDA approval.

5.3) Security testing

Brain fingerprinting technology can play a significant role in security testing when investigators know specific details of a crime, training or group affiliation. It can also determine if a person has specific "classified" or confidential information stored in their brain. Typical applications include visa applications, second level testing, polygraph "False-Positive", corporate security, insurance fraud, security clearances, computer hacking.

5.4) Counter terrorist applications

Brain Fingerprinting technology can determine the presence or absence of specific information, such as terrorist training and associations. This exciting new technology can help address the following critical elements in the fight against terrorism:

1.Aid in determining who has participated in terrorist acts, directly or indirectly.

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2.Aid in identifying trained terrorists with the potential to commit future terrorist acts, even if they are in a "sleeper" cell and have not been active for years.
3.Help to identify people who have knowledge or training in banking, finance or communications and who are associated with terrorist teams and acts.
4.Help to determine if an individual is in a leadership role within a terrorist organization.

5.5) Advertising

Brain fingerprinting allows advertisers to determine what information from an ad is retained in memory
1.What elements do people pay attention to
2.What type of media is most effective.
3.How to advertise to people all over the world.
Brain Fingerprinting Laboratories will offer significant advances in measuring campaign and media effectiveness. Most advertising programs today are evaluated subjectively using focus groups. This technology will be anle to help determine what information is actually retained in memory by individuals. We will also be able to measure the comparative effectiveness of multiple media types.

5.6) National security

Identify terrorists and accomplices prior to attacks by determining whether specific information is embedded in the memory of the subject.

5.7) Insurance industry

Brain Fingerprinting Laboratories will be able to help reduce the incidence of insurance fraud by determining if an individual has knowledge of fraudulent or criminal acts. The same type of testing can help to determine if an individual has specific knowledge related to computer crimes where there is typically no witness or physical evidence.

6. LIMITATIONS OF BRAIN FINGERPRINTING

1. Brain fingerprinting detects information-processing brain responses that reveal what information is stored in the subject's brain. It does not detect how that information got there. This fact has implications for how and when the technique can be applied. In a case where a suspect claims not to have been at the crime scene and has no legitimate reason for knowing the details of the crime and investigators have information that has not been released to the public, brain fingerprinting can determine objectively whether or not the subject possesses that information.

2. Another situation where brain fingerprinting is not applicable is one where the authorities have no information about what crime may have taken place. For example, an individual may disappear under circumstances where a specific suspect had a strong motive to murder the individual. Without any evidence, authorities do not know whether a murder took place, or the individual decided to take a trip and tell no one, or some other criminal or non-criminal event happened. If there is no known information on which a suspect could be tested, a brain fingerprinting test cannot be structured.

3. Brain fingerprinting is not applicable for general screening, for example, in general pre-employment or employee screening wherein any number of undesirable activities or intentions may be relevant. If the investigators have no idea what crime or undesirable act the individual may have committed, there is no way to structure appropriate stimuli to detect the telltale knowledge that would result from committing the crime. Brain fingerprinting can, however, be used for specific screening or focused screening, when investigators have some idea what they are looking for.

4. 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.

5. Brain fingerprinting does not determine whether a suspect is guilty or innocent of a crime. This is a legal determination to be made by a judge and jury, not a scientific determination to be made by a computer or a scientist. Brain fingerprinting can provide scientific evidence that the judge and jury can weigh along with the other evidence in reaching their decisions regarding the crime. To remain within the realm of scientific testimony, however, a brain fingerprinting expert witness must testify only regarding the scientific test and information stored in the brain revealed by the test. A brain fingerprinting scientist's testimony does not include interpreting the scientific evidence in terms of guilt or innocence.

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6. Just as all witness testimony depends on the memory of the witness, brain fingerprinting depends on the memory of the subject. Like all witness testimony, brain fingerprinting results must be viewed in light of the limitations on human memory and the factors affecting it. Brain fingerprinting can provide scientific evidence regarding what information is stored in a subject's brain. It does not determine what information should be, could be, or would be stored in the subject's brain if the subject were innocent or guilty. It only measures what actually *is* stored in the brain. How this evidence is interpreted, and what conclusions are drawn based on it, is outside the realm of the science and the scientist. This is up to the judge and jury. It is up to the prosecutor and the defense attorney to argue, and the judge and jury to decide, the significance and weight of the brain fingerprinting evidence in making a determination of whether or not the subject committed the crime.

7. Like all forensic science techniques, brain fingerprinting depends on the evidence-gathering process which lies outside the realm of science to provide the evidence to be scientifically tested. Before a brain fingerprinting test can be conducted, an investigator must discover relevant information about the crime or investigated situation. Brain fingerprinting science only determines whether the information tested is stored in the brain of the subject or not. It does not provide scientific data on the effectiveness of the investigation that produced the information about the crime that was tested.

7. CONCLUSION

Today's sophisticated crime scene analysis techniques can sometimes place the perpetrator at the scene of the crime. However, physical evidences are not always present. Knowledge of numerous details of the crime such as the murder weapon, the specific position of the body, the amount of money stolen - any information nat available to the public may reveal that a particular individual is associated with the crime.

Brain Fingerprinting is a revolutionary new scientific technology for solving crimes, identifying perpetrators and exonerating innocent suspects, with a record of 100% accuracy(in proving the presence or absence of a wide variety of evidence stored in the brains of individuals involved in many cases) in research with US government agencies, actual criminal cases, and other applications. Also, the high confidence level of the results provides further support for results from previous research using brain MERMER testing.

The technology fulfills an urgent need for governments, law enforcement agencies, corporations, investigators, crime victims and falsely accused innocent suspects in a trillion-dollar worldwide market. The technology is fully developed and available for application in the field. The technology is proprietary and patented.

Additionally, if research determines that brain MERMER testing is reliable enough that it could be introduced as evidence in court. It may be the criminal investigative tool of the future.

In addition to the physical and circumstantial evidence that can be obtained from the crime scene and elsewhere, there is one place where an extensive record of the crime is stored: in the brain of the perpetrator. Now that this record can be tapped, criminal investigation, corporate security, and counterintelligence will be revolutionized.

It would be inappropriate to generalize the results of the present research because of the small sample of subjects.

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