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Brain Fingerprinting

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Abstract: Throughout the history of the criminal justice system, numerous technological innovations have signaled landmark changes in how authorities conduct investigations. From fingerprinting to DNA testing, these one-time technological marvels turned police investigation staples have shaped the way that justice is conceptualized in America, as well as the way in which society interacts and is influenced by law enforcement. One such new technology carries with it an emerging potential to revolutionize the investigatory landscape Brain Fingerprinting (BF) the law enforcement technology [1].
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INTRODUCTION

Brain Fingerprinting was developed and patented in 1995 by Lawrence A. Farwell, Ph.D., chairman of the Brain Wave Institute in Fairfield, Iowa, and former Harvard University research associate. Brain fingerprinting is based on the theory that throughout any action, the brain plans, records, and executes all of the actions. Such details, all concealed within the brain, can now be revealed through brain fingerprinting. This technique measures how brain waves respond to specific words or pictures flashed across a screen. Pictures, both relevant and irrelevant to the actions, are shown. The relevant images should trigger memories of subject [2].

It is a scientific technique to determine whether specific information is stored in an individual brain or not. In this technique relevant words, pictures, sounds, videos etc are presented to a subject by a computer in a series with stimuli.

Basic fundamental of this technique is whether an individual recognizes specific information related to an event or activity by measuring electrical brain wave responses to words, phrases or pictures presented on computer screen. The technique can be applied only in situations where investigators have a sufficient amount of specific information about an event or activity that would be known only to the perpetrator and Investigator. In this respect, Brain Fingerprinting is considered a type of Guilty Knowledge Test.

Existing (polygraph) procedures for assessing the validity of a suspect's "guilty" knowledge rely on measurement of emotion based physiological signals such as palm sweating, heart rate and blood pressure while Brain Fingerprinting measures electrical brain activity via a fitted headband containing special sensors [3].

Technique: The technique uses an electrical signal known as P300 which is emitted from an individual's brain beginning approximately 300 milliseconds after it is confronted with a stimulus of special significance. 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 Because it is based on EEG signals, the system does not require the subject to issue verbal responses to questions or stimuli.

"The P300 (P3) wave is an event related potential (ERP) which can be recorded via *electroencephalography (EEG)* as a positive deflection in voltage at a latency of roughly 300 ms in the EEG."

"The P300 signal is an aggregate recording from many neurons".

Go for MERMER, Not Just P300: Dr Lawrence Farwell improvised on the P300 test. He recognized that the P300 is only a subcomponent of a more complicated response called a MERMER, which is elicited when a person recognizes and processes a stimulus that is particularly noteworthy to him/her. The MERMER (Memory and Encoding Related Multifaceted Electroencephalographic Response) includes the P300 and another longer latency, electrically negative subcomponent with a latency of up to two seconds post-stimulus. In other words, a positive wave followed by a negative one. Tests using the MERMER produced no false negatives or positives and no indeterminate [5].

Figure 1. The person undergoing Brain Fingerprinting

The person who is going to be tested wears a special headband with electronic sensors that measure the EEG from several locations on the scalp.

Electroencephalography: Electroencephalography (EEG) is the measurement of electrical activity produced by the brain as recorded from electrodes placed on the scalp. EEG is collected from tens to hundreds of electrodes positioned on different locations at the surface of the head. EEG signals (in the range of mili-volts) are amplified and digitalized for later processing.

Different types of stimuli are used in this technique. There are three types of stimuli:
1) Irrelevant: Kind of stimuli those are irrelevant to the investigated situation and to test subject both,
2) Target: Kind of stimuli that are relevant to the investigated situation and are known to the subject.
3) Probe: Kind of stimuli that are relevant to the investigated situation and that the subject denies knowing.
Probes contain information that is known only to the perpetrator and investigators and not to the general public or to an innocent suspect who was not at the scene of the crime. Before the test, the scientist identifies 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 [4].
Since brain fingerprinting uses cognitive brain responses, brain fingerprinting does not depend on the emotions of the subject, nor is it affected by emotional responses. Brain fingerprinting is fundamentally different from the polygraph (lie-detector), which measures emotion-based physiological signals such as heart rate, sweating, and blood pressure. Also, unlike polygraph testing, it does not attempt to determine whether or not the subject is lying or telling the truth. Rather, it measures the subject's brain response to relevant words, phrases, or pictures to detect whether or not the relevant information is stored in the subject's brain [4].
By comparing the responses to the different types of stimuli, the brain fingerprinting system mathematically computes a determination of "information present" (the subject knows the crime-relevant information contained in the probe stimuli) or "information absent" (the subject does not know the information) and a statistical confidence for the determination. This determination is mathematically computed, and does not involve the subjective judgment of the scientist [4].

Instrumental Requirements:

Personal Computer
A data acquisition board
A graphics card for driving two monitors from one PC
A four channel EEG amplifier system
Software developed by the brain fingerprinting

Applications:

1. To detect symptoms of Alzheimer's disease, Mental Depression and other forms of dementia including neurological disorders 'Brain Fingerprinting' is the patented technology that can measure objectively, for the first time, how memory and cognitive functioning of Alzheimer sufferers are affected by medications. First generation tests have proven to be more accurate than other routinely used tests, and could be commercially available in 18-24 months. The 30 minute test involves wearing a headband with built-in electrodes; technicians then present words, phrases and images that are both known and unknown to the patient to determine whether information that should be in the brain is still there. When presented with familiar information, the brain responds by producing MERMERs, specific increases in neuron activity. The technician can use this response to measure how quickly information is disappearing from the brain and whether the drugs they are taking are slowing down the process.

2. Criminal cases.

A critical task of the criminal justice 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 does not prove guilt or innocence. That is the role of a judge and jury. This exciting technology gives the judge and jury new, scientifically valid evidence to help them arrive at their decision. DNA evidence and fingerprints are available in only about 1% of major crimes. It is estimated that Brain Fingerprinting testing will apply in approximately 60 to 70% of these major crimes. The impacts on the criminal justice system will be profound. The potential now exists to significantly improve the speed and accuracy of the entire system, from investigations to parole hearings. 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.

3. Test for several forms of employment, especially in dealing with sensitive military and foreign intelligence screening.

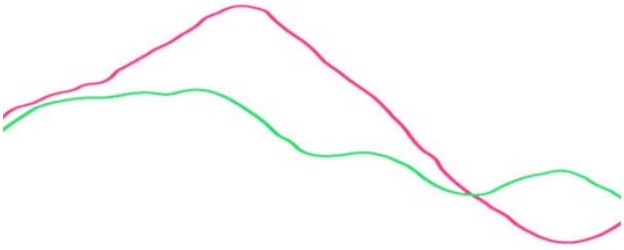
4. Advertisements (researches are being carried on).

In advertising, Brain Fingerprinting Laboratories will offer significant advances in measuring campaign and media effectiveness. Most advertising programs today are evaluated subjectively using focus groups. We will be able to offer significantly more advanced, scientific methods to help determine the effectiveness of campaigns and be very cost competitive with current methodologies. This technology will be able to help determine what information is actually retained in memory by individuals. For example, in a branding campaign do people remember the brand, the product, etc. and how do the results vary with demographics? We will also be able to measure the comparative effectiveness of multiple media types.
In the 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.

5. Counter-Terrorism.
Brain fingerprinting can help address the following critical elements in the fight against terrorism:
I. Aid in determining who has participated in terrorist acts, directly or indirectly.
II. 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.
III. Help to identify people who have knowledge or training in banking, finance or communications and who are associated with terrorist teams and acts.
IV. Help to determine if an individual is in a leadership role within a terrorist organization.
Brain fingerprinting technology is based on the principle that the brain is central to all human acts. In a terrorist act, there may or may not be peripheral evidence such as fingerprints or DNA, but the brain of the perpetrator is always there, planning, executing, and recording the crime. The terrorist has knowledge of organizations, training and plans that an innocent person does not have [6].

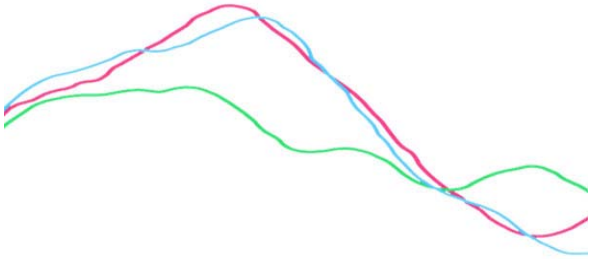
Limitations:
If, however, the suspect knows everything that the investigators know about the crime for some legitimate reason, then the test cannot be applied. There are several circumstances in which this may be the case.
If a suspect acknowledges being at the scene of the crime, but claims to be a witness and not a perpetrator, then the fact that he knows details about the crime would not be incriminating. There would be no reason to conduct a test, because the resulting "information present" response would simply show that the suspect knew the details about the crime – knowledge which he already admits and which he gained at the crime scene whether he was a witness or a perpetrator.
There are one another problem intent of subject cannot be identified properly by brain fingerprinting.
If the suspect knows everything what would be ask by the tester then he/she can control his mind and may give wrong information confidently and could not be caught by the machine.
We human have some limitations about memory and it could affect the procedure because if the incident is forgotten from the memory it could be useless, but this could be lesser because the criminal may not forget this kind of activity.
Even in appropriate cases: "The technique, however, can't be used on the mentally ill, heavy alcoholics and 'might fail on a habitual criminal.'"
Authorities have no information about what crime may have taken place.
Case Studies:
The biggest breakthrough, according to Farwell, was its role in freeing convicted murderer Terry Harrington, who had been serving a life sentence in Iowa State Penitentiary for killing a night watchman in 1977. In 2001, Harrington requested a new trial on several grounds, including conflicting testimony in the original trial.
Farwell was faced with an immediate and obvious problem: 24 years had passed since the trial. Evidence had been presented and transcripts published long ago; the details of the crime had long since come to light. What memories of the crime were left to probe? But Farwell combed the transcripts and came up with obscure details about which to test Harrington. Harrington was granted a new trial when it was discovered that some of the original police reports in the case had been missing at his initial trial. By 2001, however, most of the witnesses against Harrington had either died or had been discredited. Finally, when a key witness heard that Harrington had "passed" his brain fingerprinting test, he recanted his testimony and the prosecution threw up its hands. Harrington was set free [7].
Brain Fingerprinting has been used successfully in solving real-life crimes. J.B. Grinder, the prime suspect in the murder of Julie Helton, eluded justice for more than 15 years. During the 15 years after the murder, Grinder had given several different, contradictory accounts of the crime. Some accounts involved his participation and some did not. Some involved participation by several other individuals. Grinder's accounts contradicted both the physical evidence and the statements of an alleged witness.
After spending over 10,000 man-hours investigating the case, Macon County Sheriff Robert Dawson asked Dr. Lawrence Farwell to use Brain Fingerprinting testing to determine scientifically whether or not Grinder was the perpetrator of the crime. Grinder, already serving time in jail on an unrelated case, agreed to participate in the Brain Fingerprinting test. Sheriff Dawson, Chief Deputy Charles Muldoon, and Randy King of the Missouri Highway Patrol provided Dr. Farwell with the specific background information on the case for use in developing the test.

Grinder was presented with three types of stimuli consisting of words, phrases and images on a computer screen. Some stimuli ("targets) were known by the general public other stimuli were simply irrelevant. The probes – specific information only known to the murderer – were mixed in with these two other types of information.
In this graph above, the groundwork is laid. Grinder's brain reacts normally to well-known information, exhibiting an "aha!" response, called a PSO-300-MERMER. It resembles a peak followed by a valley in the red line.



Grinder's Brainwave Responses to Crime-Scene Information Target Stimuli

Irrelevant stimuli – phrases and images unrelated to the crime – were then presented to J.B. Grinder. The green line measures his reactions, which clearly show that this information was not stored within his brain.



Grinder's Brainwave Responses to Crime-Scene Information Target and Irrelevant Stimuli

Finally, the probes (meaningful information) were introduced. Grinder knew the significance of the probes, but not which were real and which were irrelevant. (Example you will see several items – a knife a pistol, a rifle, and a baseball bat. One of these is the murder weapon. You have told us you do not know which one, right? So you will not recognize the murder weapon when it is presented").

Note J.B. Grinder's reaction. The blue line represents the probes and it follows the same outline as the red line (information that most people would recognize). Grinder's brain automatically betrays him by demonstrating that it contains information known only to him and the investigators [8].

COMPARISON WITH OTHER TECHNOLOGIES:

Conventional fingerprinting and DNA match physical evidence from a crime scene with evidence on the person of the perpetrator. Similarly, Brain Fingerprinting matches 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 [7].

CONCLUSION:

Brain Fingerprinting is a revolutionary new scientific technology for solving crimes, identifying perpetrators, and exonerating innocent suspects, with a record of 100% accuracy in research with US government agencies, actual criminal cases, and other applications. The technology fulfills an urgent need for governments, law enforcement agencies, corporations, investigators, crime victims, and falsely accused innocent suspects.

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