BRAIN FINGERPRINTING

A SEMINAR REPORT

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CERTIFICATE

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ABSTRACT

Brain fingerprinting is based on finding that the brain generates a unique brain wave pattern when a person encounters a familiar stimulus Use of functional magnetic resonance imaging in lie detection derives from studies suggesting that persons asked to lie show different patterns of brain activity than they do when being truthful. Issues related to the use of such evidence in courts are discussed. The author concludes that neither approach is currently supported by enough data regarding its accuracy in detecting deception to warrant use in court.

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) with ease. The new method employs brain waves, which are useful in detecting whether the person subjected to the test, remembers finer details of the crime. Even if the person willingly suppresses the necessary information, the brain wave is sure to trap him, according to the experts, who are very excited about the new kid on the block.

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CHAPTER 1

INTRODUCTION

Brain Fingerprinting is a controversial proposed investigative technique that measures recognition of familiar stimuli by measuring electrical brain wave responses to words, phrases, or pictures that are presented on a computer screen. Brain fingerprinting was invented by Lawrence Farwell. 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. One of the applications is lie detection. Dr. Lawrence A. Farwell has invented, developed, proven, and patented the technique of Farwell Brain Fingerprinting, a new computer-based technology to identify the perpetrator of a crime accurately and scientifically by measuring brain-wave responses to crime-relevant words or pictures presented on a computer screen. Farwell Brain Fingerprinting has proven 100% accurate in over 120 tests, including tests on FBI agents, tests for a US intelligence agency and for the US Navy, and tests on real-life situations including actual crimes.

1.1 DEFINITION:

Brain Fingerprinting is designed to determine 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 a 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, where the "guilty" party is expected to react strongly to the relevant detail of the event of activity.

Existing (polygraph) procedures for assessing the validity of a suspect's "guilty" knowledge rely on measurement of autonomic arousal (e.g., palm sweating and heart rate), while Brain Fingerprinting measures electrical brain activity via a fitted headband containing special sensors.

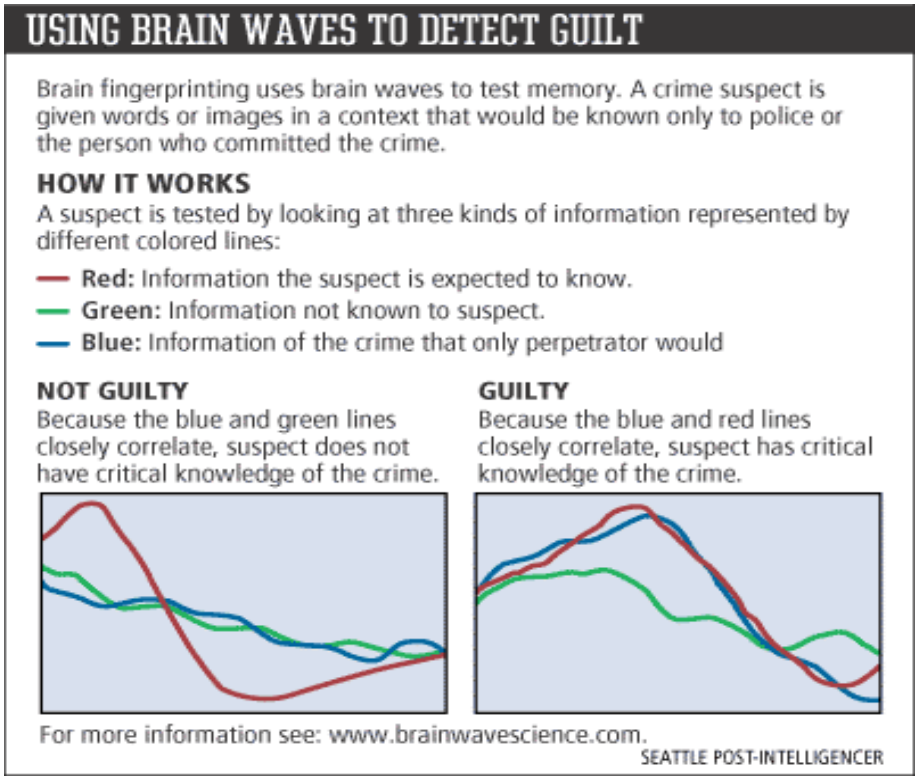

Fig. 1.1 Waves to detect guilt

Brain Fingerprinting is said to be more accurate in detecting "guilty" knowledge distinct from the false positives of traditional polygraph methods, but this is hotly disputed by specialized researchers.

1.2 TECHNIQUE:

The person to be tested wears a special headband with electronic sensors that measure the electroencephalography from several locations on the scalp. In order to calibrate the brain fingerprinting system, the testee is presented with a series of irrelevant stimuli, words, and pictures, and a series of relevant stimuli, words, and pictures. The test subject's brain response to these two different types of stimuli allow the testor to determine if the measured brain responses to test stimuli, called probes, are more similar to the relevant or irrelevant responses.

The technique uses the well known fact that an electrical signal known as P300 is emitted from an individual's brain approximately 300 milliseconds after it is confronted with a stimulus of special significance, e.g. a rare vs. a common stimuls or a stimulus the proband is asked to count. The novel interpretation in brain fingerprinting is to look for P300 as response to stimuli related to the crime in question e.g., a murder weapon or a victim's face. Because it is based on EEG signals, the system does not require the testee to issue verbal responses to questions or stimuli.

Brain fingerprinting uses cognitive brain responses, brain finger printing 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.

CHAPTER 2

ELECTROENCEPHALOGRAPHY

Electroencephalography (EEG) is the measurement of electrical activity produced by the brain as recorded from electrodes placed on the scalp. Just as the activity in a computer can be understood on multiple levels, from the activity of individual transistors to the function of applications, so can the electrical activity of the brain be described on relatively small to relatively large scales. At one end are action potentials in a single axon or currents within a single dendrite of a single neuron, and at the other end is the activity measured by the EEG which aggregates the electric voltage fields from millions of neurons. So-called 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 milli-volts) are amplified and digitalized for later processing. The data measured by the scalp EEG are used for clinical and research purposes.

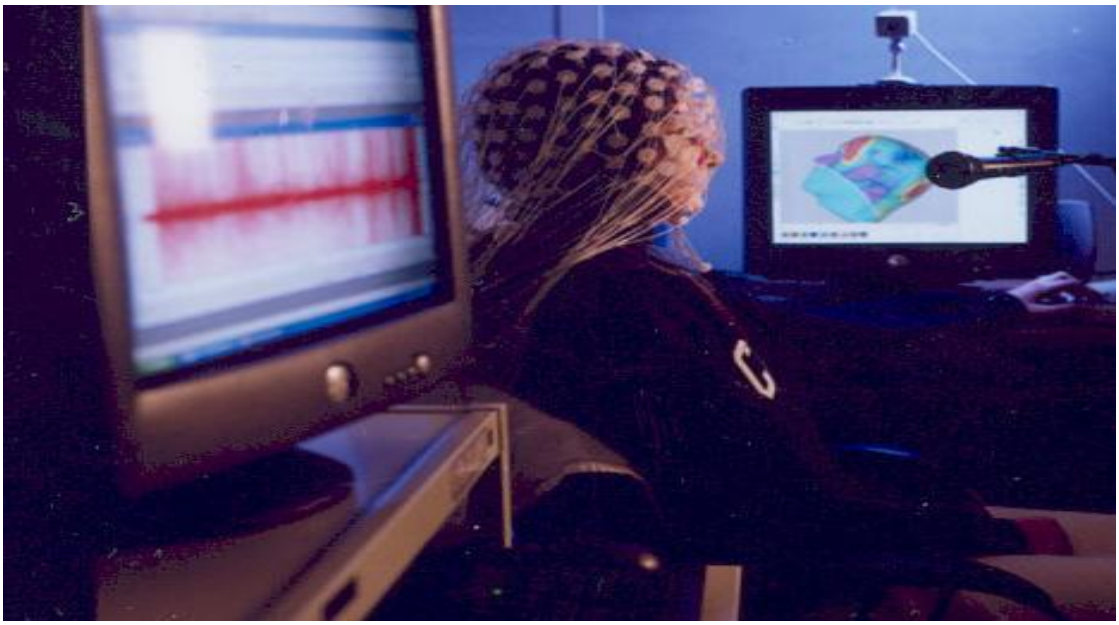

Fig. 2.1 Electrography

2.1 SOURCE OF EEG ACTIVITY:

Scalp EEG activity oscillates at multiple frequencies having different characteristic spatial distributions associated with different states of brain functioning such as waking and sleeping. These oscillations represent synchronized activity over a network of neurons. The neuronal networks underlying some of these oscillations are understood (such as the thalamocortical resonance underlying sleep spindles) while many others are not (e.g. the system that generates the posterior basic rhythm).

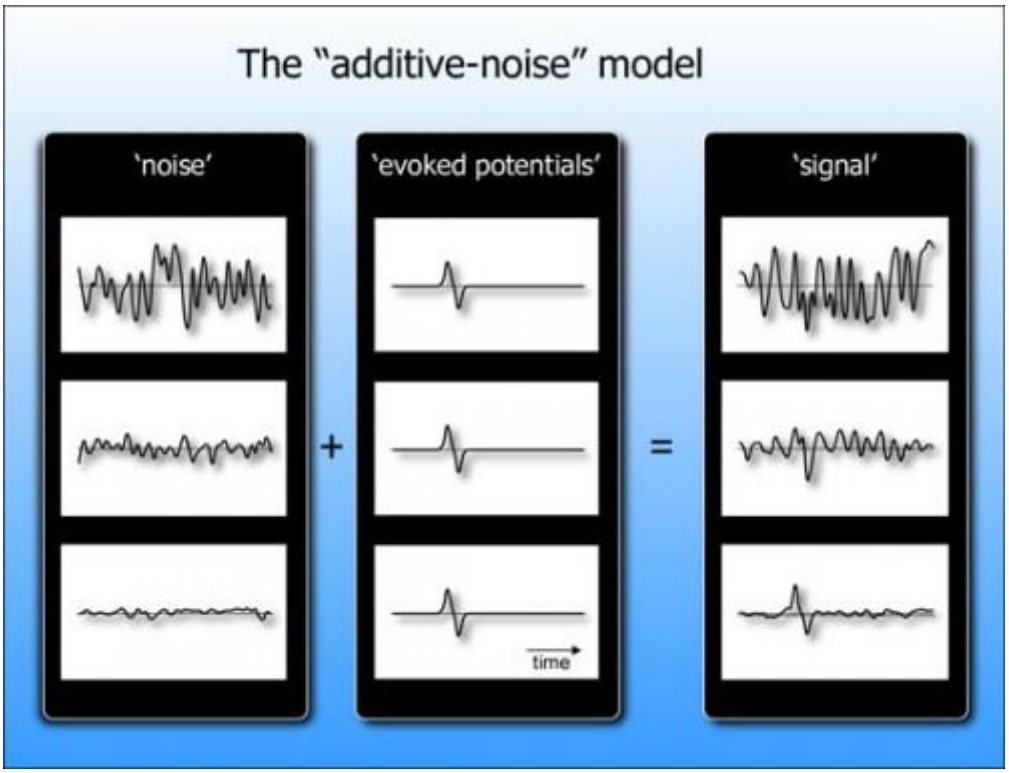

Fig. 2.2 Adaptive noise module

2.2 EEG VS FMRI AND PET

EEG has several strong sides as a tool of exploring brain activity; for example, its time resolution is very high (on the level of a single

millisecond). Other methods of looking at brain activity, such as PET and FMRI have time resolution between seconds and minutes.

EEG measures the brain's electrical activity directly, while other methods record changes in blood flow (e.g., SPECT, FMRI) or metabolic activity (e.g., PET), which are indirect markers of brain electrical activity.

EEG can be used simultaneously with FMRI so that high-temporal-resolution data can be recorded at the same time as high-spatial-resolution data, however, since the data derived from each occurs over a different time course, the data sets do not necessarily represent the exact same brain activity. There are technical difficulties associated with combining these two modalities like currents can be induced in moving EEG electrode wires due to the magnetic field of the MRI.

EEG can be recorded at the same time as MEG so that data from these complimentary high-time-resolution techniques can be combined. Magneto-encephalography (MEG) is an imaging technique used to measure the magnetic fields produced by electrical activity in the brain via extremely sensitive devices such as superconducting quantum interference devices (SQUIDs). These measurements are commonly used in both research and clinical settings. There are many uses for the MEG, including assisting surgeons in localizing pathology, assisting researchers in determining the function of various parts of the brain, neuro-feedback, and others.

2.3 METHOD:

Scalp EEG, the recording is obtained by placing electrodes on the scalp. Each electrode is connected to one input of a differential amplifier and a

common system reference electrode is connected to the other input of each differential amplifier. These amplifiers amplify the voltage between the active electrode and the reference (typically 1,000–100,000 times, or 60–100 dB of voltage gain). A typical adult human EEG signal is about 10µV to 100 µV in amplitude when measured from the scalp [2] and is about 10–20 mV when measured from subdural electrodes. In digital EEG systems, the amplified signal is digitized via an analog-to-digital converter, after being passed through an anti-aliasing filter. Since an EEG voltage signal represents a difference between the voltages at two electrodes, the display of the EEG for the reading encephalographer may be set up in one of several ways.

CHAPTER 3

ROLE IN CRIMINAL PROCEEDINGS

The application of Brain Fingerprinting testing in a criminal case involves four phases: investigation, interview, scientific testing, and adjudication. Of these four phases, only the third one is in the domain of science. 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 using ricin or cadmium, two rare and powerful poisons, 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 are 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. It does not tell us when or where to look for toxins, or which toxins to look for. We must rely on investigation to provide the necessary guidance on these issues. The science of forensic toxicology also does not tell us whether a particular suspect is innocent or guilty of a crime. The question of guilt or innocence is a legal one, not a scientific one, and the adjudication is made by a judge and jury, and not by a scientist or a computer.

3.1 **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. Before we can conduct this scientific test, we need to determine what information to test for. This investigation precedes and informs the scientific phase which constitutes the Brain Fingerprinting test itself. The role of investigation is to find specific information that will be useful in a Brain Finger printing test[t]. 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, then the information tested must have a bearing on the perpetration of the crime.

3.2 **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. For example, a suspect may say that he entered and then left the room where a murder was committed a short time before the murder, and that he never saw or handled the murder weapon. In this context, a finding that the suspect's fingerprints matched the fingerprints on the doorknob would have little value, but a finding that his fingerprints matched those on the murder weapon would provide incriminating evidence.

Prior to a Brain Fingerprinting test, an interview of the suspect is conducted. The suspect is asked if he would have any legitimate reason for knowing any of the information that is contained in the potential probe stimuli. This information is described without revealing which stimuli are probes and which are irrelevant. For example, the suspect may be asked, "The newspaper reports, which you no doubt have read, say that the victim was struck with a blunt object. Do you have any way of knowing whether that murder weapon was a baseball bat, a broom handle, or a blackjack?" If the suspect answers "No," then a test result indicating that his brain does indeed contain a record of which of these is the murder weapon can provide evidence relevant to the case.

3.3 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 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. This determination is made according to a specific, scientific algorithm, and does not depend on the subjective judgment of the scientist.

Brain Fingerprinting tells us the following, no more and no less: "These specific details about this crime are (or are not) stored in this person's brain." On the basis of this and all of the other available evidence, a judge and jury make a determination of guilty or innocent.

3.4 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.

CHAPTER 4

THE ROLE IN LEGAL PROCEEDINGS

In legal proceedings, the scope of the science of Brain Fingerprinting – and all other sciences – is limited. The role of Brain Fingerprinting is to take the output of investigations and interviews regarding what information is relevant, to make a scientific determination regarding the presence or absence of that information in a specific brain, and thus to provide the judge and jury with evidence to aid in their determination of guilt or innocence of a suspect.

As with the other forensic sciences, the science of Brain Fingerprinting does not tell us when to run a test, whom to test, or what to test for. This is determined by the investigator according to his skill and judgment, and evaluated by the judge and jury.

Recall the case of the possible murder by poisoning discussed above. All the science of forensic toxicology tells us is that there is or is not ricin or cadmium in specific cadaver.

Science does not tell us to look for these specific poisons in this specific case. This is determined by the investigator according to his skill and judgment.

Similarly, the science of Brain Fingerprinting does not tell us what information to test for. Again, this information is accumulated by the investigator according to his skill and judgment. Brain Fingerprinting tells us scientifically whether or not this specific information is stored in a specific person's brain.

In the poisoning case mentioned above, science does not tell us whether a particular suspect is guilty. This is determined by the judge and jury according to their human judgment and common sense. The same is true of Brain Fingerprinting, and every other scientific procedure.

Again, the science of Brain Fingerprinting does not tell us if a particular suspect is guilty or not. Only a judge and jury can make a determination of guilt or innocence, and they make this determination according to their human judgment, taking into account all of the scientific and other evidence. It is our view that science, whether it be Brain Fingerprinting or any other science, does not and should not seek to infringe the realm of the judge and jury in making a determination of guilt or innocence.

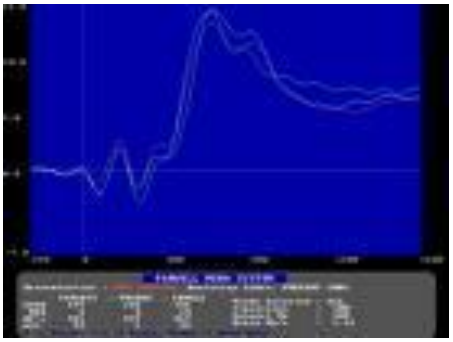

Fig. 4.1 Wave for guilty

Nor is science a substitute for skillful and effective investigation. Science depends on investigation, which is outside the realm of science, to determine when to test, whom to test, and what to test. The evidence provided by science and by investigation ultimately must be weighed and evaluated by the human beings who are the judge and jury, on the basis of their human judgment and common sense, in reaching their verdict regarding the guilt or innocence of the accused.

It is fundamental to our legal system, and essential to the cause of justice, that the judge and jury must be supplied with all of the available evidence to aid them in reaching their verdict. Brain Fingerprinting provides solid scientific evidence that must be weighed along with other available evidence by the judge and jury. In our view, it would be a serious miscarriage of justice to deny a judge and jury the opportunity to hear and evaluate the evidence provided by the science of Brain Fingerprinting, when available, along with all of the other available evidence. In the case of a suspect presenting Brain Fingerprinting evidence supporting a claim of innocence, such a denial would also be unconscionable human rights violation.

Brain Fingerprinting is not a substitute for the careful deliberations of a judge and jury. It can play a vital role in informing these deliberations, however, by providing accurate, scientific evidence relevant to the issues at hand.

CHAPTER 5

USES AND APPLICATIONS

The various applications are as follows:-

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

2. Individuals who were “information present” and “information absent”

3. A group of 17 FBI agents and 4 non-agents were exposed to stimuli.

4. To detect symptoms of Alzheimer's disease, Mental Depression and other forms of dementia including neurological disorders.

5. Criminal cases.

6. Advertisements (researches are being carried on).

7. Counter-Terrorism.

8. Security Testing.

5.1 COUNTER TERRORISM:

Brain fingerprinting 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.

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.

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. Until the invention of Brain Fingerprinting testing, there was no scientific way to detect this fundamental difference.

Brain Fingerprinting testing provides an accurate, economical and timely solution to the central problem in the fight against terrorism. It is now possible to determine scientifically whether or not a person has terrorist training and knowledge of terrorist activities.

With the Brain Fingerprinting system, a significant scientific breakthrough has now become a practical applied technology. A new era in security and intelligence gathering has begun. Now, terrorists and those supporting terrorism can be identified quickly and accurately. No longer should any terrorist be able to evade justice for lack of evidence. And there is no reason why an innocent individual should be falsely imprisoned or convicted of

terrorist activity. A Brain Fingerprinting test can determine with an extremely high degree of accuracy those who are involved with terrorist activity and those who are not.

5.2 CRIMINAL JUSTICE:

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.

5.3 MEDICAL FIELD

'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.

Fig. 5.3.1 Medical treatment

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.

5.4 ADVERTISING APPLICATIONS:

How do we know what information people retain from a media campaign? There is a new technology that allows us to measure scientifically if specific information, like a product brand, is retained in a person's memory. Brain Fingerprinting testing adds a whole new dimension to the methods of

measuring advertising effectiveness, going well beyond subjective surveys and focus groups. The implications for the advertising Industry are very exciting!

5.5 OTHER APPLICATIONS:

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.

CHAPTER 6

LIMITATIONS

The limitations of this technique are discussed with examples (in crime scenarios) as follows:

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. In such a case, brain fingerprinting could provide useful evidence. 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.

2) Another case where brain fingerprinting is not applicable would be one wherein a suspect and an alleged victim – say, of an alleged sexual assault – agree on the details of what was said and done, but disagree on the intent of the

parties. Brain fingerprinting detects only information, and not intent. The fact that the suspect knows the uncontested facts of the circumstance does not tell us which party's version of the intent is correct.

3) In a case where the suspect knows everything that the investigators know because he has been exposed to all available information in a previous trial, there is no available information with which to construct probe stimuli, so a test cannot be conducted. Even in a case where the suspect knows many of the details about the crime, however, it is sometimes possible to discover salient information that the perpetrator must have encountered in the course of committing the crime, but the suspect claims not to know and would not know if he were innocent. This was the case with Terry Harrington. By examining reports, interviewing witnesses, and visiting the crime scene and surrounding areas, Dr. Farwell was able to discover salient features of the crime that Harrington had never been exposed to at his previous trials. The brain fingerprinting test showed that the record in Harrington's brain did not contain these salient features of the crime, but only the details about the crime that he had learned after the fact.

4) Obviously, in structuring a brain fingerprinting test, a scientist must avoid including information that has been made public. Detecting that a suspect knows information he obtained by reading a newspaper would not be of use in a criminal investigation, and standard brain fingerprinting procedures eliminate all such information from the structuring of a test. News accounts containing many of the details of a crime do not interfere with the development of a brain fingerprinting test, however; they simply limit the material that can be tested. Even in highly publicized cases, there are almost always many details that are known to the investigators but not released to the public, and these can be used

as stimuli to test the subject for knowledge that he would have no way to know except by committing the crime.

CHAPTER 7

CONCLUSIONS

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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