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Brain Finger Printing

[I]Dr.Lakshmi. R, [II]Dr. K. K. Jayavardhanan
[I]PhD Scholar, Dept. of Veterinary Biochemistry, CVAS, Mannuthy, Kerala
[II]Professor & Head, Dept. of Veterinary Biochemistry, CVAS, Mannuthy, Kerala

Abstract
Brain finger printing is a new computer based technology used to identify the perpetration of crime accurately and scientifically by measuring the brainwave responses to crime relevant words, pictures presented over a computer screen. Brain finger printing had proven 100% accurate in over 120 tests including the test on FBI agents, US Intelligence agency and US navy also on real life situations including Felony crime. 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

I. Introduction
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 (Farwell & Smith 2001, Farwell*et al*., 2012).

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 todetect the brain's recognition of the known information (Farwell &Donchin 1986, 1991; Farwell 1995a; Farwell1995b). Later Farwell discovered the P300-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 and statistical confidence than the P300 alone (Farwell & Smith 2001, Farwell 1994, Farwell 1995b, Farwell *et a*l., 2012). Farwell and colleagues report less than 1% error rate in laboratory research (Farwell &Donchin 1991) and real-life field applications (Farwell & Smith 2001**,** Farwell *et al*. 2012). In independent research William Iacono and others who followed identical or similar scientific protocols to Farwell's have reported a similar low level of error rate and high statistical confidence (e.g., Allen &Iacono 1997).

Brain fingerprinting has been ruled admissible in court (Harrington v. State 2001**,** Farwell &Makeig 2005, Farwell 2012), and applied in a number of high-profile criminal cases, including the exoneration of Terry Harrington after he had been convicted of murder (Harrington v. State 2001).

II. Techniques
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. 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 (Farwell 2012, Farwell *et al.* 2012). Because it is based on EEG signals, the system does not require the subject to issue verbal responses to questions or stimuli.

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. Stimuli are of three types:

1. "irrelevant" stimuli that are irrelevant to the investigated situation and to the test subject,
2. "target" stimuli that are relevant to the investigated situation and are known to the subject, and
3. "probe" 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 (Farwell 1994, Farwell 2012, Farwell *et al*., 2012).

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 (Farwell & Smith 2001, Farwell 1992a, Farwell 1992b,Farwell 2012). Brain fingerprinting is fundamentally different from the polygraph (lie-detector), which measures emotion-based physiological signals such as heart rate, sweating, and blood pressure (Farwell 1994). 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 (Farwell & Smith 2001, Harrington v. State 2001, Farwell 2012).

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. Thisdetermination is mathematically computed, and does not involve the subjective judgment of the scientist (Farwell *et al*., 2012).

III. EEG (ELECTROENCEPHALOGRAPHY)

EEG (electroencephalography) is the oldest of the neuroimaging techniques, dating back into the 1940s. EEG technology is based on the fact that neurons conduct electricity. This electrical conduction can be measured by sensitive electrodes, which are placed on the skull of a person. As electrical activity moves from one area of the brain to another, it can be measured as distinct "waves" of electrical activity. In particular tasks, some areas of the brain will be more active. This activity will produce a larger wave of electricity, which EEG can detect. More important today is that the electrical activity of the brain can be measured every millisecond (1/1,000th of a second). Therefore, EEG is very sensitive to changes in time in the brain. However, even when 64 electrodes are placed on the skull, EEG is not as good as the other techniques at developing maps as to where processes occur in the brain.

During sleep, our brains produce characteristic electric waves, whose form can be captured by the EEG. These waves are associated with the various stages of sleep. EEG is also important in the diagnosis of epilepsy. To study memory, researchers use a particular method called the event-related potential (ERP). In the ERP technique, EEGs are measured in response to particular stimuli (or events). The EEG starts recording when the stimulus is presented to a participant. It continues for the duration of the trial. The stimulus is then presented in many trials, and the EEGs are then averaged across the trials to eliminate the random activity that may be present during any given trial. What remains is a very clear wave. Once the trials have been averaged together, the resulting data can present a picture as to how electrical activity changes over time in response to the stimulus. Event-related potential can be used to probe the time course of cognitive processes in the brain. One such example involves a brainwave known as the p300. We discuss this here as an example of the usefulness of the technique. For example, when presenting words during a memory experiment, a particular wave occurs about 300 milliseconds after the stimulus is presented. It is called the p300 because it is a positive change in voltage. In a famous paradigm (known as the von Restorff effect), a list of words is presented to a participant. All but one of the words are from the same category. The out-of-category word is called the von Restorff item or the oddball. For example, the oddball item might be the name of a city in California among a list of names of kinds of fish. The p300 part of the event related potential is distinctly higher for the oddball item than it is for in-category items. Being able to see in the ERP exactly where the p300 is and how it correlates to the person's memory allows researchers to make a hypothesis about how memory is processed in the brain.

IV. Positron Emission Tomography (PET)

Positron emission tomography (PET) technology allows scientists to get a detailed image of a living human brain without having to damage any living tissue. It does involve, however, injecting a small amount of a radioactive substance into a person's blood, which does have potentially negative effects. Therefore, it is not a procedure that should be done repeatedly. PET is useful for both medical purposes (it can pinpoint a tumor) and research because it can isolate functional areas of the brain. PET offers, relative to earlier techniques, a superior ability to determine where in the brain a particular function is occurring. However, it does not allow for the detailed description of how in time information is changing in the brain. This is because it requires about 30 seconds of exposure to get a good image of the brain. Thus, activity in the brain is blurred over a 30-second window.

PET is based on a simple assumption: that areas of the brain that are being used will require more blood. Your brain is a biological organ, which is powered by the oxygen and sugars supplied by the blood. Because neurons that are active will require more oxygen, the body should send more blood to those neurons that are engaged in any particular cognitive, emotional, or behavioral task. Therefore, if you can trace where the blood is going to during a particular memory or cognitive task, then you can correlate that area of the brainwith that particular cognitive function. Thus, if you can measure to what parts of the brain the blood is flowing during a particular memory process, you know that the area of the brain is critical for that process.

In PET, a small amount of radioactive tracer is injected into the blood of a willing volunteer. The tracer travels through the bloodstream to all parts of the body and brain. However, the areas of the brain that are active will draw more blood from the circulatory system. Thus, greater amounts of the radioactive tracer will go to areas of the brain that are more active than to those that are less active. PET scans use complex measurements to determine which areas of the brain are emitting more radioactivity. Those areas that are more "radioactive" are associated with whatever cognitive task the volunteer is engaging in. PET allows for very precise maps of the brain to be drawn. Increased activity is often restricted to very small regions of the brain, which can be determined via the PET. PET technology used to isolate hemispheric differences in memory processing. They showed that when people were actively trying to learn new information— as opposed to passively registering information—there was increased activity in both the hippocampus and areas of the left frontal lobe. During retrieval, however, right frontal regions were more active. Other studies show that the right prefrontal lobe is more involved in retrieving events from your personal past, whereas the left prefrontal lobe is more involved in encoding new verbal information

V. Functional Magnetic Resonance Imaging (FMRI)

MRIs are now the medical and research standard. Functional magnetic resonance imaging (fMRI) is the state of the art for cognitive neuroscience research. MRIs, like PET, allow for complex imaging of the brain without any invasive procedures. And today, MRIs are both safer and better at imaging than PET, as they involve no radiation. Magnetic resonance imaging is a common medical tool to examine structural damage in internal organs. It is routinely used to detect tumors, growths, and other damage in the brain. The term MRI means a structural MRI—these images are used to produce a detailed picture of the intact human brain. MRIs are of use medically, if you want to known where tumors or brain damage occur in the brain. They can also specify individual differences in the brain. As such, structural MRIs are useful for medical diagnosis and procedure. fMRI refers to a variant that tracks where in the brain particular functional components occur. That is, fMRIs track blood flow and thus can determine where in the brain certain processes are. The blood flow scan can be superimposed on MRI to reveal the structure responsible. Thus, in addition to acquiring a structural map, the fMRI can show dynamic changes in the brain. MRI works because different molecules in the brain react differently when placed in an extremely strong magnetic field. For structural images of the brain, typical of an MRI, the detector looks for changes in structures in water molecules in the brain. For fMRI, which has been developed to specify cognition-brain region correlations, the detector looks for changes in blood flow, much as PET does. Neither MRI nor fMRI require the introduction of harmful radioactive chemicals, and at present, there are no known adverse effects of the magnet itself. MRIs and fMRIs offer also much greater spatial resolution of where events take place in the brain than any other neuroimaging technique. fMRI can rescan the brain every 5 seconds, thus offering a much better time window than does PET, although still not as good as the EEG technology.

VI. 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. Other methods of looking at brain activity, such as PET and FMRIhave 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-temporalresolution 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 fromthese 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.

VII. 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 acommon system reference electrode is connected to the other input of eachdifferential 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 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.

VIII. Background and Terminology

"Brain fingerprinting" is a computer-based test that is designed to discover, document, and provide evidence of guilty knowledge regarding crimes, and to identify individuals with a specific training or expertise such as members of dormant terrorist cells or bomb makers. It has also been used to evaluate brain functioning as a means of early detection of Alzheimer's and other cognitively degenerative diseases, and to evaluate the effectiveness of advertising by measuring brain responses.

The technique is described in Dr. Farwell's paper "Using Brain MERMER Testing to Detect Concealed Knowledge Despite Efforts to Conceal", published in the Journal of Forensic Sciences in 2001 by Dr. Farwell and FBI Supervisory Special Agent Sharon Smith of the FBI (Farwell & Smith 2001), and in other peer-reviewed publications. For a review, see Farwell 2012; see also Farwell et al. 2012.

These papers describe tests of brain fingerprinting, a technology based on EEG that is purported to be able to detect the existence of prior knowledge or memory in the brain. The P300 occurs when the tested subject is presented with a rarely occurring stimulus that is significant in context (for example, in the context of a crime) (Gaillard & Ritter 1983, Farwell &Donchin 1991). When an irrelevant stimulus is presented, a P300 is not expected to occur (Picton 1988, Farwell &Donchin 1991, Farwell & Smith 2001). The P300 is widely known in the scientific community, and is also known as an oddball-evoked P300 ((Harrington v. State 2001 and P300).

While researching the P300, Dr. Farwell created a more detailed test that not only includes the P300, but also observes the stimulus response up to 1400 milliseconds after the stimulus. He calls this brain response a P300-MERMER, memory and encoding related multifaceted electroencephalographic response. The P300, an electrically positive component, is maximal at the midline parietal area of the head and has a peak latency of approximately 300 to 800 milliseconds. The P300-MERMER includes the P300 and also includes an electrically negative component, with an onset latency of approximately 800-1200ms (Farwell 1994, Farwell & Smith 2001, Farwell 2012, Farwell *et al*., 2012). According to Dr. Farwell, the P300-MERMER includes additional features involving changes in the frequency of the EEG signal, but for the purposes of signal detection and practical application the P300-MERMER is sufficiently characterized by the P300 and the following negative component in the brain response (Farwell 1994, Farwell 2012, Farwell *et al*., 2012).

IX. 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.

A. 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 Fingerprinting testt. As with any scientific test, if the outcome of the BrainFingerprinting 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.

B. PHASE 2: Interview of Subject

Once evidence has been accumulated through investigation, andbefore 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 suspects 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 suspects 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, thesuspects 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 suspects 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 suspects 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 isconducted. 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.

C. 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 persons 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 scientificprocedure 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 personsbrain." On the basis of this and all of the other available evidence, a judge and jury make a determination of guilty or innocent.

D. 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.

X. Uses and Applications

The various applications are as follows:-

1. Test for several forms of employment, especially in dealing with sensitivemilitary 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 otherforms of dementia including neurological disorders.
5. Criminal cases.
6. Advertisements (researches are being carried on).
7. Counter-Terrorism.
8. Security Test

XI. Medical Field

The incidence of Alzhemer's and other forms of dementia is growing rapidly throught the world. There is critical need for a technology that enables early diagnosis economically and that can also accurately meaurse the effectiveness of treatments for there disease. Research has now demonstrated that analysis of the P300 brain wave can show dementia onset and progression. MERMER technology, developed and patened by brain finger printing laboratories include the P300 brain wave and extend it.

Providing a more sentive measure than the P300 alone. Brain finger printing laboratories is now developing dianostic and monitoring system of Alzhemer's using this exciting new technology.

With early diagnosis the progression of Alzhemer's symptom can often be delayed through medications and dietary and lifestyle change. Using the very precise measurements of congenitive functions available with this technology.
Pharmaceutical companies will be able to determine more quickly the effect of this new medication and potentially speed FDA approval. The non invasive nature of P300/MERMER testing technology and simplicity of its administration will allow primary care physicans to monitor the progress of their patients in their own offices and adjust treatment accordingly.
An accurate inexpensive and easy to administer test for Alzhemer's and dementia will improve the healthcare process dramatically and will also help to improve the quality of life for millions of people.

XII. 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 persons 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!

XIII. 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 tocomputer crimes where there is typically no witness or physical evidence.

XIV. Limitations

The limitations of this technique are discussed with examples (in crime scenarios) as follows:
1) Brain fingerprinting detects information-processing brain responses thatreveal what information is stored in the subjects brain. It does not detect howthat information got there. This fact has implications for how and when thetechnique can be applied. In a case where a suspect claims not to have been atthe crime scene and has no legitimate reason for knowing the details of thecrime and investigators have information that has not been released to thepublic, brain fingerprinting can determine objectively whether or not the subjectpossesses that information. In such a case, brain fingerprinting could provideuseful evidence. If, however, the suspect knows everything that theinvestigators know about the crime for some legitimate reason, then the testcannot be applied. There are several circumstances in which this may be thecase. If a suspect acknowledges being at the scene of the crime, but claims to bea witness and not a perpetrator, then the fact that he knows details about thecrime would not be incriminating. There would be no reason to conduct a test,because the resulting "information present" response would simply show thatthe suspect knew the details about the crime – knowledge which he alreadyadmits and which he gained at the crime scene whether he was a witness or aperpetrator.
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 partys 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 testcannot be conducted. Even in a case where the suspect knows many of thedetails 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 examiningreports, 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 brainfingerprinting 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 avoidincluding 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 knowexcept by committing the crime.

XV. Comparision with Other Technologies

Conventional finger printing and DNA match physical evidence from a crime scene with evidence on the person of the perpetrator. Similarly, Brain finger printing matches informational evidence from the crime scene with evidence stored in the brain. Finger prints and DNA are available in only 1% of crime. The brain is always there, planning, executing and recording the suspect's actions.
Brain finger printing 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 Farwall brain finger printing. As with DNA and finger printing the results are the same whether the person has lied or told the truth at any time.

XVI. BRAIN-TO-BRAIN INTERFACE

The bidirectional interface between the brain and the computer would ultimately lead to the development of a 'Brain-to-Brain Interface' (BBI), in which neural activities from individual brains are linked and mediated by computers

XVII. Human-To-Human Brain Interface

The first human-to-human, brain-to-brain noninvasive interface has been created by researchers at the University of Washington. The system allows one researcher to remotely control the hand of another researcher, across the internet, merely by thinking about moving his hand. The researchers are already looking at a two-way system, to allow for a more "equitable" telepathic link between the two human brains, and the telepathic communication of complex information.

Despite the massive and mostly-not-understood complexity of the human brain, the UW brain-to-brain interface is actually quite simple, relying on tools that are regularly used in the fields of medicine and brain-computer interfaces (BCIs). The first human brain (the sender) is connected to a computer via an EEG-based BCI. The second human brain (the receiver) is connected to another computer via a Magstimtranscranial magnetic stimulation (TMS) machine — the same kind of TMS setup that has been somewhat successful in treating depression, and other mental maladies. When the sender plays a game and thinks about firing a cannon at a target, the EEG picks it up, sends the signal across the internet to the second computer, and the TMS stimulates the region of the receiver's motor cortex that controls hand movement. This causes the receiver's index finger to twitch, firing the cannon and blowing up the target. This process is almost instantaneous. TMS is a lot like transcranial direct current stimulation (tDCS), which we have written about extensively. Where tDCS passes an electrical current through your brain, affecting the neurons that the electrons travel through, TMS uses electromagnetic induction to create a similar effect. Both tDCS and TMS can be used to either stimulate regions of the brain, useful for brain-to-brain interfaces or increasing the activity of regions of the brain associated with depression, or to reduce the activity of a region, which might help with the treatment of other conditions, such as Parkinson's. Like tDCS, TMS is completely noninvasive, and so far it appears to be completely safe.

XVIII. Animal-To-Animal Brain Interface

Researchers have electronically linked the brains of pairs of rats, enabling the animals to communicate directly via implanted microelectrode arrays to solve simple behavioral problems (Pais-Vieira, et al., 2013). The authors of the study claim the achievement is the first of its kind, and could lead to the linking of multiple animal brains to form the first "organic computer" through which multiple animals could exchange, store, and process sensory and motor information.

The researchers trained pairs of rats to press one of two levers, with the correct one indicated by a flashing light above, to get a drink of water. When the encoder rat pressed the right lever and got its reward, a sample of the brain activity that coded for that behavior was translated into a pattern of electrical stimulation and delivered directly to the brain of the decoder rat. The decoder faced the same lever setup, but got no visual clues, so had to rely on cues transmitted from the encoder to guide it to the correct lever and the reward.

In trials, the decoder rats picked the right lever 70 percent of the time, a performance significantly better than chance, suggesting that the information was successfully transferred and understood.

The rats performed similarly well on a comparable test using tactile information—distinguishing between a narrow and wide opening using their whiskers. In these trials, the decoder followed the actions of the encoder 65 percent of the time; again, with accuracy better than chance.

The findings demonstrate that implanted microelectrodes and decoding methods can be used to directly channel behavioral information between two animal brains. This, the authors speculate, indicates that brain networks could allow multiple animals to synchronize their behaviors in response to directly transferred electrical cues. "So basically, we are creating what I call an organic computer," Nicolelis said in a press release. "Such a computer solves a puzzle in a 'non-Turing' way."

XIX. Human-To-Animal Brain Interface

Researchers at Harvard University have created the first noninvasive brain-to-brain interface (BBI) between a human… and a rat. Simply by thinking the appropriate thought, the BBI allows the human to control the rat's tail. This is one of the most important steps towards BBIs that allow for telepathic links between two or more humans — which is a good thing in the case of friends and family, but terrifying if you stop to think about the nefarious possibilities of a fascist dictatorship with mind control tech.

The human wears a run-of-the-mill EEG-based BCI, while the mouse is equipped with a focused ultrasound (FUS) computer-brain interface (CBI). FUS is a relatively new technology that allows the researchers to excite a very specific region of neurons in the rat's brain using an ultrasound signal. The main advantage of FUS is that, unlike most brain-stimulation techniques, such as DBS, it isn't invasive. For now it looks like the FUS equipment is fairly bulky, but future versions might be small enough for use in everyday human CBIs.With the EEG equipped, the BCI detects whenever the human looks at a specific pattern on a computer screen. The BCI then fires off a command to rat's CBI, which causes ultrasound to be beamed into the region of the rat's motor cortex that deals with tail movement. The researchers report that the human BCI has an accuracy of 94%, and that it generally takes around 1.5 seconds for the entire process — from the human deciding to look at the screen, through to the movement of the rat's tail. In theory, the human could trigger a rodent tail-wag by simply thinking about it, rather than having to look at a specific pattern — but presumably, for the sake of this experiment, the researchers wanted to focus on the FUS CBI, rather than the BCI.

XX. Conclusions

The brain is a remarkably complex organ, composed ofmany intersecting parts and layers. Fundamental to the study of memory and the brain is its division into left and right hemispheres and its division into cortical and subcortical areas. The left and right hemispheres of the cortex have slightly different functions. The right hemisphere is more likely to take on roles related to spatial memory, to imagery, and to music, whereas the left hemisphere focuses on language and verbal learning. The cortical areas of the brain tend to be involved in higher levels of memory processing, whereas the subcortical areas, such as the hippocampus, are more involved directly in encoding or, as in the case of the amygdala, emotion and emotional learning. Brain Fingerprinting is a revolutionary new scientific technology for solving crimes, identifying perpetrators, and exonerating innocent suspects, with a

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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

Moving forward, the researchers now need to work on the transmitting of more complex ideas, from human to rat. At some point, they'll also have to put the FUS CBI on a human, to see if thoughts can be transferred in the opposite direction. Finally, we'll need to combine an EEG and FUS into a single unit, to allow for bidirectional sharing of thoughts and ideas. Human-to-human telepathy is the most obvious use, but what if the same bidirectional technology also allows us to really communicate with animals, such as dogs? There would be huge ethical concerns, of course, especially if a dictatorial tyrant uses the tech to control our thoughts — but the same can be said of almost every futuristic, transhumanist technology.

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