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Will DNA Replace Fingerprints in the 21st Century?

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Introduction

There has been much comparison of DNA profiling with traditional fingerprint identification. In an effort to gain acceptance within the courts and the public at large, DNA analysis is often referred to as "DNA fingerprinting". In the popular media and even within crime labs, it has been suggested that DNA will someday become the replacement for fingerprints. The goal of this paper is to provide a comparative analysis of these two superstars of forensic science. How fingerprints are compared and identified to an individual and how DNA profiles provide identifications based on statistical probabilities will be compared. Through this analysis, hopefully we will be able to answer the question: "Will DNA replace fingerprints in the 21st Century?"

Before these two identification technologies can be compared, a basic overview of the individualization concepts that are used in all areas of criminalistics should be explained.

The features of all things capable of being compared for the purpose of individualization can be divided into two broad categories (Tuthill, 2004). The first category is class characteristics. Class characteristics are repeatable features that are common to things (people, objects, plants, etc.) within a given group. The second category is individual characteristics. Individual characteristics are the unique features on things that allow us to individualize one thing from another.

Fingerprint Identification

The earliest known use of fingerprints occurred during the pre-Christian era in China. Fingerprints were impressed into clay tablets and placed on contracts. It is generally believed that the Chinese understood the unique nature of fingerprints. In a medical book on human anatomy, written by Dr. J. C. A. Mayer in 1788, fingerprints were illustrated and the text stated that the arrangements of the skin's ridges (fingerprints) are never duplicated in two persons (Moenssens, 1971). Scientists and medical researchers have now verified this statement over three centuries.

The use of fingerprints to solve crimes was first suggested by Dr. Henry Faulds in a letter to the scientific journal *Nature*, in 1880. In 1892, bloody fingerprints found at the scene of a double murder in Argentina were identified to the killer. This was the first documented crime

solved through the use of fingerprint evidence (Clements, 1987). In the United States the first court acceptance of fingerprints occurred in *People v. Jennings*, 254 Ill. 532, in 1911. Fingerprint evidence has now enjoyed over one hundred years of judicial acceptance in the courts of the world.

The overall formation of the fingerprint patterns are influenced by heredity and follow a genetic master plan. The individual ridges within the overall pattern are affected by their environment during development. These environmental influences cause biological variation. Biological variation is also known as the natural law of variation and is sometimes stated as "Nature never repeats". Biological variation results in the random development of the ridges into unique formations and appearance. Once formed, the ridges are permanent and unique (Cummins & Midlo, 1943).

The general pattern appearing on the bulb of the fingers are class characteristics. There are three basic fingerprint patterns which can be further divided. The three fingerprint pattern types are loops, whorls, and arches. Loops account for sixty to sixty-five percent of all fingerprint patterns; whorls, thirty to thirty-five percent of the patterns; and arches for about five percent of the patterns (Federal Bureau of Investigation, 1984).

The features that are compared to identify fingerprints are the unique arrangement and appearance of the individual ridges of the fingerprints. These detailed features are the "individual characteristics" of fingerprints and are identified by doing a side by side comparison of the fingerprint impressions. When the features are in agreement, an identification is made. If the features are different they can be eliminated as coming from the same source (Leo, 2004). Since unique features are being directly compared, an individualization or elimination can be determined. There is no need for population studies or statistical analysis, because the objects being compared possess unique individual characteristics.

Fingerprint evidence is found on objects that have been touched. The ideal surface to obtain fingerprint evidence is a smooth, non-porous object like glass. However, through the use of chemicals and forensic light sources, such as LASER, fingerprint evidence can be found on a wide variety of surfaces.

Fingerprint evidence can be directly compared with known suspect's fingerprints or searched through automated fingerprint information systems. Fingerprints are the standard used to establish a person's identification in every country in the world. In addition to being the most common form of physical evidence found at crime scenes, fingerprints are used to establish a person's identity for employment, security clearances, and to establish and track a person's criminal history.

DNA PROFILING

The discovery of deoxyribonucleic acid (DNA) as the carrier of genetic information took place in 1911. It was not until 1985, when a researcher by the name of Alex Jeffreys, along with his colleagues at Leicester University, discovered that the DNA structure of certain genes are unique to each individual (Nickells & Fischer, 1999).

One year later in 1986, a DNA profile was matched to a suspect in a double murder in England. This was the first use of DNA in a criminal investigation. In 1988, the first criminal case involving DNA was admitted into a United States court in *Andrews v. State*, 533 S.2d 841 (3rd DCA 1988). As of November 2003, over thirty-five states have admitted DNA evidence in one form or another and more that twenty-five states have admitted population frequency data or statistics (Kreeger and Weiss, 2003).

DNA among human beings is 99.5% identical. With the exception of identical twins, the other .5% is unique (Inman & Rudin, 1998). DNA is found in all cells. DNA evidence can be found in biological evidence left at crime scenes. Blood, semen, hair, skin, and saliva are examples of the types of biological material that could contain DNA.

Before a comparison can be made, a DNA profile must be extracted from the biological evidence or from a sample taken from a known individual. This is done through a process known as electrophoresis. DNA profiling is still an emerging technology. The standard profiling technique used from 1985 to the mid-1990s was done through a process called restriction fragment length polymorphisms (RFLP). RFLP profiling has been replaced by a technique known as short tandem repeat (STR). Another process developed in the mid-1990s, called polymerase chain reaction (PCR) allows very small samples of DNA to be replicated or copied. PCR does not work with RFLP, but does with the newer Profiling technique STR (Saferstein, 2003). It should be noted that every time the DNA profiling procedures are changed or a new statistical model is created, the court acceptance process starts over.

Once a DNA profile has been extracted from a sample, the results are recorded on a film called an autorad along with any other profiles that are to be compared (Houde, 1999). Also recorded on the autorad are markers that are known locations. These locations have been determined by population studies that has determined how often they occur in a given population, such as within a certain ethnic or gender group. Markers are class characteristics. The extracted DNA markers from the evidence sample and any other sample that they are being compared with are known as loci and the loci is compared to see if, and how often, they appear at the same locations. Based on how many loci match and their locations with the known markers, a statistical analysis is done to determine how often the combination of loci could be found in a population. Once a DNA profile has been extracted, it can be compared with known suspects or checked against a data base.

In the United States, thirteen markers are used and have been standardized for use in the national data base called CODIS. CODIS is an acronym for the Combined DNA Index System

(Saferstein, 2003).

Currently, there are various profiling systems in use throughout the world. However, these systems are not interchangeable as the DNA profiling procedures are different within the various systems (Interpol, 2003). As DNA data bases have grown, population statistical models have had to be refined to correctly reflect the population frequencies. Since DNA profiles contain class characteristics only, population studies must be done to determine how often each of these markers occur in a population. As more markers are in agreement the statistical odds are multiplied. However, the calculated population frequencies are only an estimate, which can be off by an order of magnitude in either direction, and when the data bases grow, more loci are needed to support a strong inference of a common source (Meonssens, 2000). "In fact, confidence in the results of statistical techniques that eliminate a person as a source of a sample is much higher than in results used to calculate the odds that a person was a probable source (Bradley, 2004)".

DNA is an emerging technology. DNA is not used for personal identification purposes, such as, employment, security clearance, or to track a person's criminal history.

Direct Comparisons of DNA with Fingerprints

Data Bases

It is estimated that fingerprint files contain the fingerprints of between 5 to 15% of the world's population. This would include between 250 million to 900 million individuals, based on an estimated world population of between 5 to 6 billion people (Interpol, 2000).

According to Interpol, as of 2002, there was 3,320,000 criminal DNA profiles in data bases throughout the world (Interpol, 2003) . In the United States, the FBI National DNA data base (CODIS) as of February, 2005, contains 2,176,610 criminal profiles. In comparison, the FBI IAFIS fingerprint data base contains over 47 million criminal offenders alone (FBI, 2005). The State of California fingerprint file includes over 14 million individuals.

Identifications

According to Interpol, millions of fingerprints are searched through the automated fingerprint systems of the world every second. Many thousands of individuals are identified by fingerprints each day. Thousands of crimes are solved by fingerprint evidence found at crime scenes each day.

Since the inception of the CODIS data base in 1994, over 20,000 DNA matches have been effected (FBI, CODIS, 2005). From October 2000 to April 2005, there have been 473 DNA matches for the entire State of California (CA DOJ, 2005). In comparison, on any given month in Los Angeles County alone, over 500 latent prints are identified to criminal offenders,

this is in addition to the thousands of arrestees that are identified by their fingerprints each month.

It has been suggested by the uninformed that fingerprint identification would "be more scientific" if done as a statistical probability as is done with the class characteristics of the DNA markers. The limitation of a DNA profiling match is illustrated when a fingerprint profile is done is a similar way to DNA profiling. A fingerprint profile could be done using a calculation of the frequency of how often each of the fingerprint patterns (class characteristics) could appear on each of the ten fingers within a population could be made. The results would provide a statistical probability of how often two people in the population would have the same patterns on all ten fingers. This in itself would not provide an individualization, but only a statistical probability as is done with DNA. Fingerprint identification uses a direct comparison of the unique features present in the print to establish an individualization. The features of every fingerprint or area of friction skin is never duplicated on another area of friction skin, therefore, when a match is found it is 100% conclusive.

Evidence Collection

The amount of time and training needed to teach a law enforcement officer or technician to preserve and collect evidence for DNA analysis or fingerprint analysis is similar. The development of latent prints found on items of evidence can be as simple as the application of fingerprint powder or as complex as the use of Laser or vacuum metal deposition. Care must be taken to avoid the destruction of fingerprint evidence while handling objects. Fingerprints can deteriorate or evaporate over time.

The collection of a biological sample for DNA analysis must be done in a way that will avoid contamination. Cross contamination with other evidence items can compromise DNA evidence. Biological evidence can deteriorate or decompose if not properly preserved before or after collection.

Laboratory Analysis

Once developed, fingerprint evidence can be directly compared with the known fingerprints of an individual or searched through computer data bases. The comparisons can be done in an office environment, using a magnifying glass. Once fingerprint evidence has been developed and collected, there is no chance of contamination. Most police agencies collect latent print evidence and many agencies have their own fingerprint examiner to analyze their own prints. Even after one hundreds years of use and despite the low cost and the obvious benefits of fingerprint evidence, fingerprints are still not collected at many crime scenes because of costs and resources.

DNA evidence must be extracted from any crime scene samples collected and processed

in a contamination free environment. The process is costly and can take from hours to days to extract a DNA profile. The process is complex and is usually done only in major regional, state, or federal crime labs.

Privacy Issues

When fingerprint identification was first being used, there were a number of court challenges to the issue of privacy and whether or not the government could take your fingerprints and keep them on file. For, the last 95 years, this has been debated in the courts and the conclusion has been that the taking of fingerprints for both criminal and non-criminal uses are not evasive. Fingerprints only provide identification, nothing further.

DNA includes a person's genetic makeup. Information about a person's family medical history is stored in a person's DNA. Many States have established DNA data bases that only include convicted criminals to avoid the privacy issues that are associated with a person's DNA.

The following newspaper editorial provides a good example of the public debate over government access to a citizen's DNA. The editorial appeared in the California *Inland Valley Daily Bulletin, Sunday,* February 13, 2005.

DNA data base law works, but it has a major flaw!

It didn't take long for Proposition 69 to prove its worth in the Inland Valley. Still, we think the new law has a terrible flaw.

In November, voters passed Proposition 69, requiring all felons to submit DNA to a statewide database. Two months later, Los Angeles County sheriff's deputies arrested a suspect in a 2 ½ year old Pomona murder case thanks to that law and the database it expanded.

Detectives had turned up no major leads in the August 2001 kidnap and stabbing death of Christina Burmeister of Cerritos, a 20 year old student at Cal Poly Pomona.

Burmeister set out for a sorority event at a Pomona fraternity house. Her body was found the next morning inside her pickup truck on a Highway 39 turnout in San Gabriel Canyon.

Authorities found a discarded cigar butt with her body, but it wasn't until the passage of Proposition 69 that the piece of evidence yielded a breakthrough.

Deputies arrested James Winslow Dixon Jr., 32, on Jan. 14, but withheld information about the arrest until Monday because they were seeking at least one more suspect in Burmeister's murder. The state has held a DNA profile from Dixon, described as a former Monrovia gang member, since he was released from prison in 1993.

Authorities were unsure then whether Dixon met the criteria for offenders who should go into the database. But Proposition 69's passage cleared that up by making it mandatory

that all convicted felons' DNA go into the database. Dixon's DNA was entered and it matched DNA taken from the cigar butt found in Burmeister's vehicle.

Proposition 69 worked exactly as envisioned in this case, allowing authorities to crack a crime that had so far proved unsolvable. We applaud that aspect of the law, and the work of law enforcement authorities in implementing it.

But the law has an Orwellian flaw.

Unfortunately, the law doesn't stop at collecting DNA from all convicted felons. It mandates that, by 2009, all adults and juveniles who are ***arrested*** on a felony charge – not just those who have been ***convicted*** – will be sampled and placed in the "all-felon" database.

That raises major invasion of privacy issues.

We have no objections to taking the fingerprints of anyone arrested for a crime, because fingerprints are not useful for anything else about the person.

That's not so with DNA, which holds a person's complete genetic profile. That sort of information could have huge implications for a person's medical insurability, and no doubt for many other aspects of life in the future that we haven't imagined yet.

We consider it an unreasonable search and seizure, a violation of our constitutional personal protections, for an innocent person to have to yield that information. And since Americans are innocent until proven guilty, they should not give up the right to DNA privacy unless and until convicted of a felony.

We wouldn't care to be falsely arrested in a case of mistaken identity, and then have our complete personal genetic information placed alongside that of murderers and rapists in a criminal computer database widely accessible by local law enforcement agencies and linked to the federal government. In that large a network, some information is bound to fall into the wrong hands from time to time.

That database of criminals is no place for innocent people.

Conclusion

DNA and fingerprint evidence, both play important roles in the solution of crimes. The courts have on numerous occasions referred to fingerprints as the "gold standard" for forensic evidence. Nothing indicates that this will change. DNA evidence is still tackling the hurdles of the court system. Fingerprints evidence is well established in the courts.

The criminal justice system needs every available tool to combat and solve crime. It is this author's opinion that the question of DNA replacing fingerprints is not or should not be an issue. Both of these tools compliment one another. Unfortunately, in today's world of limited funds, these tools sometimes have to compete for funding to accomplish their mutual mission. Because of this, competition and sibling rivalries often occur within crime labs and sometimes the end result is a dysfunctional family.

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