How the Expression of DNA Evidence Affects Jurors' Interpretation of Probabilistic Fingerprint Evidence

by

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ABSTRACT

Deoxyribonucleic Acid (DNA) evidence has been shown to have a strong effect on juror decision-making when presented in court. While DNA evidence has been shown to be extremely reliable, fingerprint evidence, and the way it is presented in court, has come under much scrutiny. Forensic fingerprint experts have been working on a uniformed way to present fingerprint evidence in court. The most promising has been the Probabilistic Based Fingerprint Evidence (PBFE) created by Forensic Science Services (FSS) (G. Langenburg, personal communication, April 16, 2011). The current study examined how the presence and strength of DNA evidence influenced jurors' interpretation of probabilistic fingerprint evidence. Mock jurors read a summary of a murder case that included fingerprint evidence and testimony from a fingerprint expert and, in some conditions, DNA evidence and testimony from a DNA expert. Results showed that when DNA evidence was found at the crime scene and matched the defendant other evidence and the overall case was rated as stronger than when no DNA was present. Fingerprint evidence did not cause a stronger rating of other evidence and the overall case. Fingerprint evidence was underrated in some cases, and jurors generally weighed all the different strengths of fingerprint testimony to the same degree.

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Chapter 1: Introduction

The right to a fair trial is one of the fundamental rights that the United States court system is built upon. Questions often arise about how fair trial proceedings are if the people who are asked to deliver verdicts do not correctly understand the information provided to them, or, more importantly, misapply the information to produce false verdicts. In recent years, complex scientific data has found its way to the forefront of many criminal trials. The increased use of technology and statistics affects the way jurors make decisions. Jury members often believe they understand the scientific information provided to them, but do they truly apply this information to their decision making correctly? Is a juror able to render a proper verdict when presented with complex scientific information that could be misguided by opposing experts?

Two types of scientific evidence found in many criminal trials are DNA and fingerprint evidence. To date, there is no uniform way these types of evidence are presented to jurors. Forensic experts can express the same evidence in different ways, leaving it up to the jury to properly decipher the scientific material. The way in which the experts express their scientific findings can have dramatic effects on what the jurors conclude from the evidence (Koehler, 2000; Koehler, 2001; Koehler & Macchi, 2001; Newell, Mitchell, & Hayes, 2008;

Schklar & Diamond, 1999; Smith, Penrod, & Park, 1996; Vidmar & Diamond, 2001). DNA analysis and presentation has been subject to much skepticism and transformation over the years (Kaye, 1993; Koehler, 1993; Lindsey, Hertwig, & Gigerenzer, 2003; Mnookin et al., 2011; Thompson, 1997).

While DNA analysis is becoming more uniform in its presentation in court, fingerprint analysis and presentation is being called into question. There have been many arguments regarding how reliable fingerprint evidence is, along with its presentation in court as "matching" or being "consistent with" a known person (McQuiston & Saks, 2008). Many researchers in the fingerprint arena have been working on providing a more informative and uniform way to analyze and present fingerprint evidence during trials. The most promising presentation to date is the Probabilistic Based Fingerprint Evidence (PBFE) method, developed by the Forensic Science Service (FSS) (G. Langenburg, personal communication, April 16, 2011). This method is performed with a software program that, with the aid of a fingerprint examiner, allows certain configurations of minutiae (matching areas or points on a print) between a latent print (crime scene print) and reference print to be evaluated, which produces a likelihood ratio.

The purpose of this thesis research is to understand how jurors interpret the newly developed expression of fingerprint print evidence in probabilistic terms when accompanied by DNA evidence. This research also seeks to determine if the presentation of scientific evidence in this way affects jurors' ability to make proper decisions about the trial. It is important to address this concern because if jurors do not understand the probabilistic approach to stating fingerprint evidence in the accompaniment of DNA, then the approach may need to be revised before implemented. Last, this research will provide information about jurors' general views on complex scientific evidence. What are the motives behind their individual understanding? Does their understanding affect how evidence is weighed? Are there underlying impressions jurors have that cause them to weigh evidence in a certain way?

Chapter 2: Juror Evaluation of Complex Scientific Evidence: Past and Present

<u>*Evaluation of Complex Scientific Evidence*</u> - Jurors are often regarded as individuals who are intellectually incompetent in understanding much, if any, expert evidence (Vidmar & Diamond, 2001). There are many common prejudicial misconceptions about jurors, such as juries are comprised of uneducated individuals who could not find a way to get out of jury duty and jurors uncritically accept experts who present complex testimony that they are unable to understand (Diamond, 2006). These conceptions are harsh, but have occurred due to the problems jurors have with making systematic logical and mathematical errors when evaluating complex scientific evidence (Schklar & Diamond, 1999). Courts have displayed concern over these issues, and feel that jurors attach too much weight to extremely small probabilities often found in trial settings (Schklar & Diamond, 1999). There is a problem determining fact from fiction with juror decision-making because juries in the United States do not have to provide an explanation for their verdict and do not reveal any information about how they arrived at their decisions during trial (Diamond, 2006). Researchers have been trying to fill this gap and get a view of juror deliberations. Many studies have shown juries to both understand and misunderstand complex scientific evidence.

Koehler, Chia, and Lindsay (1995) found that extremely small statistical numbers, regardless of their importance in the trial, influence juror decisions. In this study, participants were presented with varying estimates of probability that a match was declared between crime scene evidence and the defendant, even though the defendant was not the true source of the evidence. Participants were presented with an extremely small Random Match Probability (RMP) estimate (1 in 1 billion), a large Likelihood (LE) estimate (2 in 100), or a combination of both (Koehler, et al, 1995). In the first study, those who received separate RMP and LE estimates found the defendant guilty as often as participants who received the combined RMP and LE estimate (1 in 1 billion). In their second study, participants who received separate RMP and LE estimates convicted the defendant more often than participants who received the combined RMP and LE estimate (1 in 1 billion). Those who received the combined RMP and LE estimate of 2 in 100 convicted significantly less than participants who received the combined RMP and LE estimate of 1 in 1 billion. Jurors were overly influenced by the extremely small estimate.

Schklar and Diamond (1999) expanded on the study by examining whether participants would view statistics that were extremely discriminating but error prone (RMP of 1 in 1 billion, LE of 2 in 100) differently than a test that is not as discriminating but error free (RMP of 2 in 100, LE of 1 in 1 billion). Combined, these statistics offer the same ratio. Participants who were given small RMP and large LE estimates tended to convict the defendant less often than participants who were given large RMP and small LE estimates, even though they should have both been given the same weight. Half of the participants were provided with an explanation of how to combine RMP and LE estimates, but this was not shown to aid juror comprehension.

Additional studies have shown that jurors have difficulties understanding the technicality of the language used by expert witnesses. In ForsterLee, Horowitz, Athaide-Victor, and Brown (2000), participants viewed a videotape of a trial involving health problems of four plaintiffs potentially caused by the dumping of dangerous chemicals into drinking water. The plaintiffs differed in degrees of illness and participants were influenced by the technicality of the language used by experts. The more technical the language, the more jurors were not able to differentiate between more or less deserving plaintiffs during the compensation part of the trial (ForsterLee, et al, 2000).

A similar study was performed by Diamond and Casper (1992). Participants watched a videotape of an antitrust trial. It contained all aspects of a regular trial including opening statements, direct and cross examination, closing arguments, and instructions. Different experts used two models. The first model was a yardstick model where damage estimates were based on performance of a similar company who was not affected by the price fixing agreement. The second model was a statistical model that used a regression model analyzing past performance to project what costs would have been without the price fixing agreement. It was found the statistical evidence was harder to understand than the yardstick evidence and that the yardstick evidence was viewed as clearer evidence overall.

Other studies have found that when presented with complex evidence, jurors tend to use other cues to determine verdicts. Ratneshwar and Chaiken (1991) provided participants with either a highly complex or easily comprehensible situation. They found that participants usually processed the easily comprehensible evidence, but not the complex evidence. When presented with the complex evidence, participants tended to rely on the level of expertise of the source of the information. When participants heard information they did not have the skill level to understand, it forced them to rely on other aspects of the expert testimony.

To test this theory, Cooper, Bennett, and Sukel (1996) had participants watch videotapes of trials that varied in level of expertise and scientific evidence (high credentials/high complexity, moderate credentials/high complexity, high credentials/low complexity, moderate credentials/low complexity). The mock civil trial was based on exposure to the chemical PCB, which was said to cause the plaintiffs illness. Participants found in favor of the plaintiff when the case was presented with high complexity and a highly credentialed expert witness (91%) than when the same case was presented with high complexity and a moderately credentialed expert witness (64%). Similar studies have found the same results. The expert's ability to convey information, the reputation of the expert, and the credentials of the expert are all factors when jurors are faced with highly complex evidence (Champagne, Shuman, & Whitaker, 1992; Irkovic & Hans, 2003; Shuman, Whitaker, & Champagne, 1994).

Problems with understanding evidence become more complex with the presence of an opposing expert. Researchers have found that jurors become skeptical of all expert testimony when there is an opposing expert, instead of being sensitized to the flaws of the other's expert testimony (Levett & Kovera, 2008). Thompson and Cole (2006) discuss the *prosecutor's fallacy* and the *defense attorney's fallacy* that arise when jurors attempt to understand complex scientific evidence on both sides of the spectrum. The *prosecutor's fallacy* occurs when a juror understands a characteristic being found in 2% of the population as meaning there is only a 2% chance that the defendant is not the perpetrator and a 98% chance that the defendant is guilty. This misconception causes a juror to incorrectly favor the prosecution. The *defense attorney's fallacy* occurs when a juror understands a characteristic being found in 2% of the population as meaning that 2% contains thousands of people in a large population and there is no relevance in the defendant's membership to such a large group of people. This misconception causes a juror to incorrectly favor the defense.

Nance and Morris (2002) found an additional fallacy. They found that participants viewed the conditional probability that a suspect would match if he were not the source and the probability of the suspect's guilt as equal entities. When participants were told the defendant and the perpetrator matched on a characteristic found in 4% of the population, they incorrectly concluded that there was a 4% chance that the defendant was the perpetrator. Additional studies have shown similar results. Wells (1992) presented participants with different types of information bearing on the likelihood that a bus belonging to a certain company was responsible for killing a dog. Participants did not have good reasoning skills with appropriating probabilities into verdicts. Many participants reached an incorrect decision by holding the bus company liable instead of determining if the company bus killed the dog.

Although these studies have found that jurors can have a great deal of difficulty understanding probabilistic and statistical evidence, there has been little data showing that jurors are overly impressed by expert jargon or simply in awe of experts that they are too overwhelmed or are uncritical of the testimony at hand (Vidmar & Diamond, 2001). However, these studies all show that there is room for improvement in the presentation of complex testimony.

DNA Match Statistics - DNA analysis is the most trusted form of forensic evidence to date (Liberman, Correll, Miether, & Krauss, 2008; Mnookin et al., 2011; Smith, Penrod, & Park, 1996). Although the methods are clear, there is currently no uniform way to state DNA evidence in a courtroom setting. Testimony with DNA match presentations have been transformed from "matching" or being "consistent with" a known person to being presented in a statistical manner. Experts present DNA evidence in both frequency (1 in 1,000) and probability (0.1%) formats. The wording and use of both formats are left to expert preference.

DNA match statistics can be presented in many different ways, and jurors often weigh evidence based on the Exemplar Cueing Theory (Koehler, 2000; Koehler & Macchi, 2004). This theory is based on the assumption that people tend to evaluate the significance of low probability events in a way where they are able to imagine examples of the event. Target and frame effects play an important role in this theory (Koehler, 2001; Koehler, 2000; Tversky & Kahneman, 1973). There are two types of targeting approaches. Multi-target approach takes the “target” of the DNA match away from the main suspect and projects it onto a much larger reference population (i.e. 1 in every 1,000,000 people in the United States would also match). The single-target approach keeps the “target” of the DNA match on the main suspect (i.e. the chance that the suspect would match by coincidence if he were not the source is 1 in 1,000,000) (Koehler, 2001). There are also two types of framing: frequency and probability. Frequency is framed as 1 in 1,000,000. The same number in a probability frame is 0.000001. These numbers are mathematically the same, but psychologically different. Jurors have been shown to have a flawed perception of understanding these chances (Krauss & Sales, 2001; Levett, et al, 2005; Newell, Mitchell, & Hayes, 2008; Smith, Bull, & Holliday, 2011).

Koehler (2000), referencing Exemplar Cueing Theory, determined that statistics tend to be more persuasive when framed in a probabilistic, single-target format and highlights a particular suspect’s chance of matching the evidence. Probability single-target frames do not include a reference or broader class of people to think about, which causes jurors to concentrate largely on the suspect at hand. According to Koehler (2000), match statistics should be stated as follows: "the probability that the suspect would match the blood drops if he were not the source is 0.01%" (p. 1278).

To test this theory, Koehler (2001) created three experiments. In the first, mock jurors were presented with a summary of the Clinton-Lewinsky scandal. The summary stated that a dress worn by Ms. Lewinsky did contain "some genetic material (i.e. semen) that matched the DNA of President Clinton" and that "a DNA expert reports that his tests could not rule out Mr. Clinton as a possible source of the recovered genetic material" (p. 498). Half of the participants read "the probability that Mr. Clinton would match the semen stain if he were not its source is 0.1%" (single-target, probability frame) (p. 499). The other half of the participants read "1 in 1,000 people in Washington who are not the source would also match the semen stain" (multi-target, frequency frame) (p. 499). Results showed that participants in the single-target probability frame thought it was more likely that Clinton was the source of the DNA than participants in the multi-target frequency frame.

In the next experiment, Koehler (2001) took the target and frame effects a step further. Some mock jurors in this experiment were provided with both a single-target probability frame and multi-target frequency frame. Mock jurors were provided with a case summary of a murder trial in Houston. The DNA match statistic was fixed at 0.001 or 1 in 1,000. The five conditions were as follows: single-target, probability frame; single-target frequency frame; multi-target probability frame; multi-target frequency frame; dual presentation (single-target probability frame and multi-target frequency frame). Participants in the single-target probability condition gave the highest estimates for source and guilt, while participants in the multi-target frequency frame gave the lowest. The dual presentation participants gave estimates that were in between both of the above conditions. Results showed that providing jurors with dual perspectives seems to eliminate the most juror error.

In the third and final experiment, Koehler tested target and frame effects for extremely small incident rates. Rates of 1 in 1,000, 1 in 1,000,000, and 1 in 1,000,000,000 were used using the same Houston crime scene information from the second experiment (in probabilistic terms: 0.1, 0.0001, and 0.0000001, respectively). It was found that target and frame effects became smaller as the incident rates became smaller. Participants were not able to distinguish between 1 in 1,000,000 and 1 in 1,000,000,000. This is a possible ceiling effect on the value of statistical DNA evidence.

In a follow-up experiment, Koehler and Macchi (2004) examined ratio bias. This is the idea that large ratios (i.e. 10/100) are more difficult to comprehend than smaller ratios (i.e. 1/10). Incident rates that contained numerators greater than or equal to 1 provided exemplars and appeared to make the evidence seem progressively weaker. The authors suggested it could possibly be useful to provide statistical evidence to jurors in multiple ways to minimize types of bias, which has been the method adopted by many DNA experts during testimony.

Fingerprint Analysis Speculation - Fingerprint analysis has recently undergone the scrutiny that DNA evidence experienced years ago. The major landmark case that brought this evidence into question was the Brandon Mayfield case (Cole, 2005; Spinney, 2010). On March 11, 2004, terrorist explosions occurred through Madrid, Spain's commuter trains, killing 119 people and wounding 2,000. Spanish investigators were able to locate an abandoned set of detonator caps inside a plastic bag near one of the crime scenes. Investigators were able to lift a single, incomplete fingerprint off of the plastic bag. Spain encouraged the help of international agents, and on May 6, 2004, the FBI arrested Oregon lawyer Brandon Mayfield, stating his print was a "match" to the one found on the plastic bag. Approximately two weeks later, the FBI was forced to release Mayfield after the Spanish police arrested an Algerian national whose print was a stronger match. The FBI admitted they had made multiple errors in the fingerprint analysis. This case caused fingerprint analysis and its reliability to be called in question.

Another blow to the reliability of fingerprint evidence occurred a few years after the Mayfield case. In February of 2009, the National Academy of Sciences (NAS) released a report on the forensic sciences that concluded: "With the exception of DNA analysis,…no forensic method has been rigorously shown to have the capacity to consistently, and with a high degree of certainty, demonstrate a connection between evidence and a specific individual or source" (Mnookin, et al, 2011, p. 729). These two landmark events provided the backbone for the start of vigorous research in the area of fingerprint analysis.

The majority of the research concentrated on the ACE-V method (Analysis, Comparison, Evaluation, Verification) used by all fingerprint examiners to examine fingerprint evidence. Researchers suggest strict guidelines be enforced when using the ACE-V method (Cole, 2008; Haber & Haber, 2007; Koehler, 2008a; Sweinton, 2004). Currently, ACE-V is conducted in a way that is individualized by different laboratories. A detailed ACE-V manual and report form should be created so there is uniformity among laboratories. Along with this, there should be standard training programs and proficiency measures to avoid the possibility of making erroneous individualizations. ACE-V has yet to be systematically tested for validity. Examiners in the same laboratory that have some knowledge of the case at hand often perform the verification stage of ACE-V, which creates a bias (Koehler, 2008b; Langenburg, Champod, & Wertheim, 2009). This calls for a double-blind method of examination. Neither the administrator nor the examiner verifying should know details of the case in question. This double blind method would also be useful for proficiency tests for fingerprint examiners.

The Automated Fingerprint Identification System (AFIS) has also been called into question. The computer program provides a search of fingerprints among a database of millions of ten-print cards and provides a ranked list of top candidates based on similarities. Often, the technology is not useful on its own. Due to quality problems in a lot of latent prints, the program alone would provide erroneous results. A common method of analysis is for the fingerprint examiner to manually mark minutiae before beginning the search in AFIS, which has been shown to increase accuracy in the program (Jain & Feng, 2011; Puertas, et al, 2010). Many critics are still skeptical of how useful and objective AFIS is due to the necessary human step (Busey & Prada, 2010).

Overall, there has been a strong call for some type of error rate attached to fingerprint results. Researchers desire a type of threshold to help examiners explain the significance of their observations

(Collins, 2009). The Scientific Working Group for Friction Ridge Analysis (SWGFAST) has responded to these demands by proposing certain measures for rates of errors, suggesting technical reviews of fingerprint examinations, and providing a standardized sufficiency graph (SWGFAST, 2011). The group does stay on the side of caution with a minutiae threshold, though, because there are many different numbers of minutiae that can provide a significant result.

Fingerprint Match Statistics - Forensic examiners, including fingerprint examiners, are presently unable to produce RMPs due to there being no cataloged fingerprint examination history to attribute possible error rates. If two markings (one being the *latent print* from the crime scene, one being the *ten print* provided by the suspect) are undistinguishable, they are said to "share a common origin" "to the exclusion of all others in the world" and that they have "identified the source" (McQuiston & Saks, 2008, pp. 1159-1160). The conclusion of this type of "match" is impossible. This information is solely based on the fingerprint examiner's opinion that individualization has been met (Thompson & Cole, 2006). Fingerprint experts manually match certain markings between the latent and suspect prints and provide their own opinions. These conclusions can differ between different experts. This subjective way of displaying evidence has been shown to provide high estimates of source probability (McQuiston & Saks, 2008). These opinions tend to increase jurors' confidence in their understanding of the evidence. Because of this, there has been a strong demand for fingerprint expert testimony to be provided in a more probabilistic manner.

Bayesian model represents the application of probability theory (Evett et al., 2000). The model reveals the importance of the likelihood ratio, which concentrates on three key principles for the proper interpretation of forensic evidence:

> (1) Interpretation of scientific evidence is carried out within a framework of circumstances. The interpretation depends on the structure and content of the framework. (2) Interpretation is only meaningful when two or more competing propositions are addressed. (3) The role of the forensic scientist is to consider the probability of the evidence given the propositions that are addressed. (Evett et al., p. 235)

The Forensic Science Service (FSS) has developed a verbal convention for likelihood ratios:

$>10^6$	Extremely Strong
10^5 to 10^6	Very Strong
10^3 to 10^5	Strong
10^2 to 10^3	Moderate
>1 to 10^2	Limited
1	Inconclusive
0	Exclusion

The way these ratios would be stated in court is: "It is 10,000 times more likely to observe this configuration of minutiae if the suspect is the source of the fingerprint found at the crime scene than if some other, randomly selected, unrelated person is the source of the fingerprint" (G. Langenburg, personal communication, April 16, 2011). Over the past few years, researchers at FSS have developed a statistical software program that allows certain configurations of minutiae (points) in a latent print and reference print to be evaluated, which produces the outcome of a likelihood ratio (Forensic Science Service (FSS), 2010). This ratio frames the expert testimony based on the likelihood the defendant's print would match. The larger the ratio, the more likely the *latent print* belongs to the defendant. The software is currently in the final stages of development and a workshop has been developed called *Probability Software and Fingerprint Comparison Technology Transition Workshop*. It is currently being taught to fingerprint examiners all over the United States, with sponsorship being provided by the National Institute of Justice (NIJ) and the National Forensic Science Technology Center (NFSTC). There are three main objectives to the workshop. The first is to provide a support system for the fingerprint examination process by introducing a degree of objective evaluation. This step would be in addition to individual expert interpretation and would add a technological comparison that could either back the original opinion or aid with reevaluating the evidence. The second is to determine if a probabilistic approach could enhance the impact of fingerprint evidence by allowing latent prints that have been deemed to be of "no value" to be examined.

It is possible that the computer programs could pick up additional information that the human eye misses. The third is to investigate if using a common framework, for example, DNA and fingerprints, could combine evidence from different areas of expertise. Uniformity in these areas could aid with juror interpretation. The goal of the FSS software is to provide an "objective" quantification of probability to enhance the fingerprint examiner's conclusion.

This software will provide the likelihood ratio by calculating a within-finger variability and between-finger variability. These values will provide a fraction (numerator and denominator, respectively), and will use a database of several thousand minutiae configurations. The software requires the examiner to input the corresponding minutiae from the latent print and suggested match print. It does not locate the match, so AFIS still serves an important function during analysis. The software is also extremely user-friendly. It can run on most existing operating computer systems and can be well integrated in the current fingerprint examination process. This software has been the most prominent step forward in the area of fingerprint analysis.

The Present Study - This literature outlines major concerns with juror understanding of complex scientific evidence. It is important to know whether or not jurors are able to comprehend complex evidence, even if it is somewhat overwhelming to understand. The problems with probabilistic statistics are evident, but it is important to comprehend how jurors make decisions based on this type of evidence. The purpose of this study is to measure how jurors understand probabilistic fingerprint evidence in general, and more importantly, how they understand it in the presence of other types of evidence (in this case, DNA evidence).

More specifically, this study examines how the presence or absence of DNA evidence will affect the perceived weight mock jurors attach to fingerprint evidence. Prior studies have performed this type of analysis with different types of evidence independent from one another. A major goal of this research is to grasp how mock jurors will understand a multitude of evidence presented together, as this is likely seen in many criminal trials. Also, by taking away external expert cues that have been displayed in previous studies (credentials, education, verbal cues), it can be determined how jurors regard the evidence itself.

It is hypothesized that probabilistic fingerprint evidence will be weighed more heavily in the presence of DNA evidence regardless of whether the DNA evidence is strong or weak because it is currently the most highly regarded scientific evidence. It is also predicted that jurors will rate probabilistic fingerprint evidence more conservatively than they rate "match" fingerprint evidence. However, it is still expected that the probabilistic fingerprint evidence will be overweighed at all levels. Jurors will likely perceive all the varying degrees of fingerprint evidence to be a strong determining factor, which will cause them to deduce that the case, including all the other evidence, must also be strong.

This research will also explore whether factors such as educational background and science and math backgrounds affect how jurors interpret probabilistic fingerprint and DNA evidence. By recognizing what influences juror decisions with these types of evidence, what goes on during jury deliberation will be distinguishable. It is important to interpret whether or not jurors grasp probabilistic fingerprint evidence to determine if it should be implemented in real court settings. If jurors are unable to properly evaluate the fingerprint evidence, improvements should be made on the probabilistic approach before implementation.

Chapter 3 – Methodology

Participants - Four hundred eighty-five undergraduate students from Arizona State University (ASU) participated in exchange for course credit.

Design – The research design was a 3 (DNA presentation/strength: 0.0001% or 1 in 1,000,000 match, 0.1% or 1 in 100 match, no DNA) x 4 (Fingerprint presentation/probability likelihood ratio strength: 10 million likelihood, 10 thousand likelihood, 100 likelihood, match) fully randomized between-groups design.

The case participants read consisted of a one-page summary of a murder trial in which DNA and fingerprint evidence, except for the no DNA condition, recovered from the crime scene matched the defendant (see Appendix A for complete summaries). The case involved a robbery and murder of a convenience store clerk. A hair was found inside the mask with a pulp in which DNA could be extracted. The surveillance camera was not working at the time of the robbery, and an eyewitness was unable to identify the perpetrator due to a mask being worn. The analyses of the fingerprint evidence, and in most cases the DNA evidence, linked suspect Aaron Robinson to the crime.

Independent Variables – The first variable was *DNA presentation/strength*. Participants either read that: A) no DNA was able to be extracted from the crime scene sample; B) DNA was found at the crime scene, matched the defendant, and "The probability that the suspect would match the DNA found in the hair if he were not the source is 0.1% or 1 in 1,000"; or C) DNA was found at the crime scene, matched the defendant, and "The probability that the suspect would match the DNA found in the hair if he were not the source is 0.0001% or 1 in 1,000,000".

For the second variable, fingerprint presentation/probability likelihood ratio strength was manipulated. Participants read that: A) A latent print was lifted from the scene, was matched to the defendant, and was presented as: "The latent print found at the crime scene is a match to Mr. Robinson's print"; B) A latent print was lifted from the scene, was matched to the defendant, and was presented as: "It is 100 times more likely to observe this configuration of minutiae if the Mr. Robinson is the source of the fingerprint found at the crime scene than if some other, randomly selected, unrelated person is the source of the fingerprint"; C) A latent print was lifted from the scene, was matched to the defendant, and was presented as: "It is 10,000 times more likely to observe this configuration of minutiae if the Mr. Robinson is the source of the fingerprint found at the crime scene than if some other, randomly selected, unrelated person is the source of the fingerprint"; or D) A latent print was lifted from the scene, was matched to the defendant, and was presented as: "It is 10 million times more likely to observe this configuration of minutiae if the Mr. Robinson is the source of the fingerprint found at the crime scene than if some other, randomly selected, unrelated person is the source of the fingerprint".

Dependent Variables - Mock jurors estimated the strength of the case against the defendant, the strength of the DNA evidence (if applicable) and the strength of the fingerprint evidence. The mock jurors also answered general questions about the accuracy and reliability of both DNA and fingerprint evidence. Other questions were answered about general understanding of probabilities, math and science knowledge, and other related general material that could be applied to the mock juror's understanding of forensic evidence. Jurors also provided verdicts and sentencing, along with their own definitions of how DNA and fingerprint evidence is analyzed (See Appendix B for complete questionnaire).

Procedure - The study was performed completely online using the online survey program Survey Monkey. Mock jurors first read the consent letter, then a case summary, which the survey program selected at random. Mock jurors then answered the series of questions summarized above, along with general demographic information. The participants were debriefed when they finished the questionnaire.

Chapter 4 – Data Analyses and Results

Participants were 74% female with a mean age of 24.04 (*SD* = 6.596). The participants were 58.8% Caucasian, 20.0% Hispanic/Latino, 4.7% Asian, and 3.3% African American, while 13.2% left the answer blank or chose another ethnicity. Participant education levels were: 7.6% Freshman, 11.1% Sophomore, 30.3% Junior, 50.7% Senior, with 0.2% Unidentified. Participant ethnicities and education levels were representative of ASU's student population.

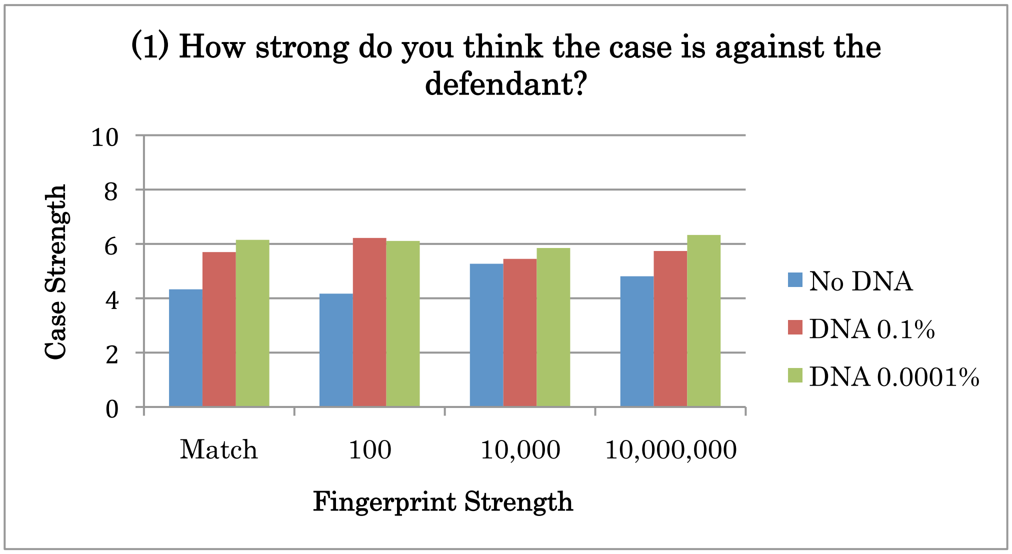
Case Specific Dependent Measures

A 2-way multivariate analysis of variance (MANOVA) was performed to test the effect of DNA evidence and fingerprint evidence on ten primary dependent measures: strength of case (*How strong do you think the case is against the defendant?),* likelihood of defendant being guilty (*Based on the information you read, what is the likelihood the defendant is guilty of murdering the convenience store clerk?*), certainty the correct suspect was apprehended (*How certain are you that the police apprehended the correct suspect in this case?*), verdict confidence (*How much confidence do you have in the verdict you chose?*), verdict choice (*Do you think the defendant is guilty or not guilty of committing murder?*), likelihood of the head hair belonging to the defendant (*What do you think is the likelihood that the head hairs found in the mask at the crime scene belong to the defendant?*), strength of DNA evidence (*How strong do you think the DNA evidence is against the defendant?*), likelihood of the fingerprint in the mask belonging to the defendant (*What do you think is the likelihood that the fingerprint found in the mask at the crime scene was left by the defendant?*), accuracy of eyewitness account (*How accurate do you think was the eyewitness's account of the crime?*), and accuracy of surveillance video (*How reliable do you think the surveillance video is in identifying the defendant?*). The omnibus test of the main effect of DNA evidence was statistically significant, $F(17, 904) = 8.12$, $p < .001$; Wilk's $\lambda = 0.741$, $\eta_p^2 = .14$. The omnibus test of the main effect of fingerprint evidence was not statistically significant, $F(26, 1320) = 1.14$, $p = .283$; Wilk's $\lambda = 0.935$, $\eta_p^2 = .02$. The interaction between DNA evidence and fingerprint evidence was also not significant, $F(53, 2309) = 1.14$, $p = .235$; Wilk's $\lambda = 0.875$, partial $\eta_p^2 = .02$.

Given these results, univariate analyses of variance (ANOVA) were run to test the impact of the DNA evidence on the ten primary dependent measures. The results for these ten questions were grouped by strength of the case overall, strength of fingerprint evidence, strength of DNA evidence, and strength of other evidence.

Strength of Overall Case – An ANOVA examined the influence of fingerprint evidence and DNA match on the strength of the case overall (*How strong do you think the case is against the defendant?*), based on a ten-point scale from low to high strength. There was a significant main effect of the strength of DNA match on the strength of the overall case, $F(2, 460) = 17.31$, $p < .001$; $\eta_p^2 = .07$. Tukey's HSD test showed when participants were presented with the higher strength DNA match (0.0001% or 1/1,000,000) they perceived the overall case as being stronger ($M = 6.11$, $SD = 2.31$) than when presented with the lower strength DNA evidence (0.1% or 1/1,000) ($M = 5.75$, $SD = 2.13$), $p = .04$. When presented with lower strength DNA evidence, they perceived the overall case as being stronger then when presented with no DNA match ($M = 4.69$, $SD = 2.14$), $p < .001$. (See Figure 1)

Figure 1. Overall case strength



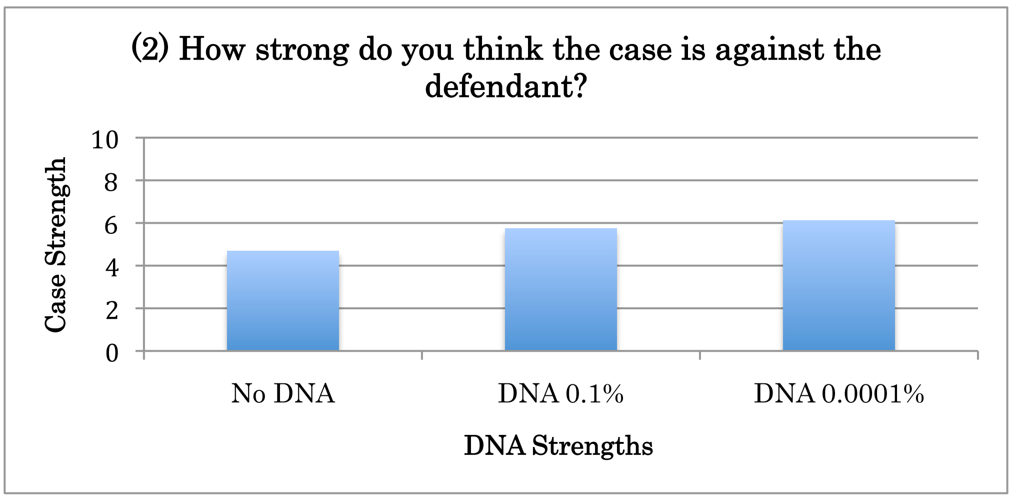


Figure 1. Graph 1 displays the relationship between overall case strength and different strengths of both DNA and fingerprint evidence. The interaction between the two types of evidence is not significant. When no DNA was present, varying strengths of fingerprint evidence were not significantly different from each other. The higher strength fingerprint evidence was underweighted. Graph 2 isolates the varying strengths of DNA matches. The strength of the case significantly increased as DNA match levels increased.

Next, participants were asked about the likelihood of the defendant being guilty (*Based on the information you read, what is the likelihood the defendant is guilty of murdering the convenience store clerk?*), based on a ten-point scale from low to strong likelihood. There was a significant main effect of the strength of the DNA match on the likelihood of the defendant being guilty, $F(2, 460) = 23.22$, $p < .001$; $\eta_p^2 = .09$. When participants were presented with the higher DNA match, they perceived a stronger likelihood of the defendant being guilty (M = 6.65, SD = 2.21) than when presented with the lower DNA match (M = 6.02, SD = 2.07), $p = .024$. When presented with the lower DNA match, they perceived a stronger likelihood of the defendant being guilty than when presented with no DNA match (M = 5.01, SD = 2.10), $p < .001$.

Then, participants were asked about the certainty the correct suspect was apprehended (*How certain are you that the police have apprehended the correct suspect in this case?*), based on a ten-point scale from low to strong certainty. There was a significant main effect of the strength of DNA match on the level of certainty the correct suspect was apprehended, $F(2, 460) = 22.24$, $p < .001$; $\eta_p^2 = .09$. When participants were presented with the higher DNA match, they were more certain the correct suspect was apprehended (M = 7.08, SD = 2.41) than when presented with the lower DNA match (M = 5.55, SD = 2.39), $p = .037$. When presented with the lower DNA match, they were more certain the correct suspect was apprehended than when presented with no DNA match ($M = 4.41$, $SD = 2.42$), $p = .037$, $p < .001$.

Next, participants were asked about verdict confidence (*How much confidence do you have in the verdict you chose?*), based on a ten-point scale from low to strong confidence. There was a significant main effect of the strength of DNA match on verdict confidence, $F(2, 460) = 11.80$, $p < .001$; $\eta_p^2 = .05$. When participants were presented with the higher DNA match, they had greater confidence in their verdict ($M = 6.86$, $SD = 2.07$) than when presented with the lower DNA match ($M = 6.17$, $SD = 2.16$), $p = .010$. When presented with the lower DNA match, they had greater confidence in their verdict than when presented with no DNA match ($M = 5.74$, $SD = 2.09$), $p = .010$, $p < .001$.

Participants were also asked to choose a verdict (*Do you think the defendant is guilty or not guilty of committing murder?*). A chi-square analysis showed DNA match strength and fingerprint strength conditions had a significant effect on verdict choice, χ^2 $(11) = 43.23$, $p < .001$. When participants were presented with a fingerprint match (*"The latent print found at the crime scene is a match to Mr. Robinson's print."*), 76.1% thought the defendant was guilty when also presented with the higher DNA match, 69.7% found the defendant guilty when presented with the lower DNA match, and 47.6% found the defendant guilty when presented with no DNA. Guilt verdicts were roughly similar for the three DNA conditions when also presented with the lowest strength fingerprint evidence (*"It is 100 times more likely to observe this configuration of minutiae if the Mr. Robinson is the source of the fingerprint found at the crime scene than if some other, randomly selected, unrelated person is the source of the fingerprint."*). When presented with the moderate strength fingerprint evidence (*"It is 10,000 times more likely to observe this configuration of minutiae if the Mr. Robinson is the source of the fingerprint found at the crime scene than if some other, randomly selected, unrelated person is the source of the fingerprint."*), participant guilty verdicts did not strongly differ between the lower DNA match and the no DNA match, but participants convicted at the highest rate when coupled with the higher DNA match. When presented with the highest strength fingerprint evidence (*"It is 10 million times more likely to observe this configuration of minutiae if the Mr. Robinson is the source of the fingerprint found at the crime scene than if some other, randomly selected, unrelated person is the source of the fingerprint."*), participant verdicts did not strongly differ between any of the DNA conditions. Participants were sensitive to the differing fingerprint strengths when no DNA match was present when rendering a verdict (31.9% fingerprint 100, 56.8% fingerprint 10,000, and 62.8% fingerprint 10,000,000 respectively). (See Figure 2).

Figure 2. Guilty Verdicts

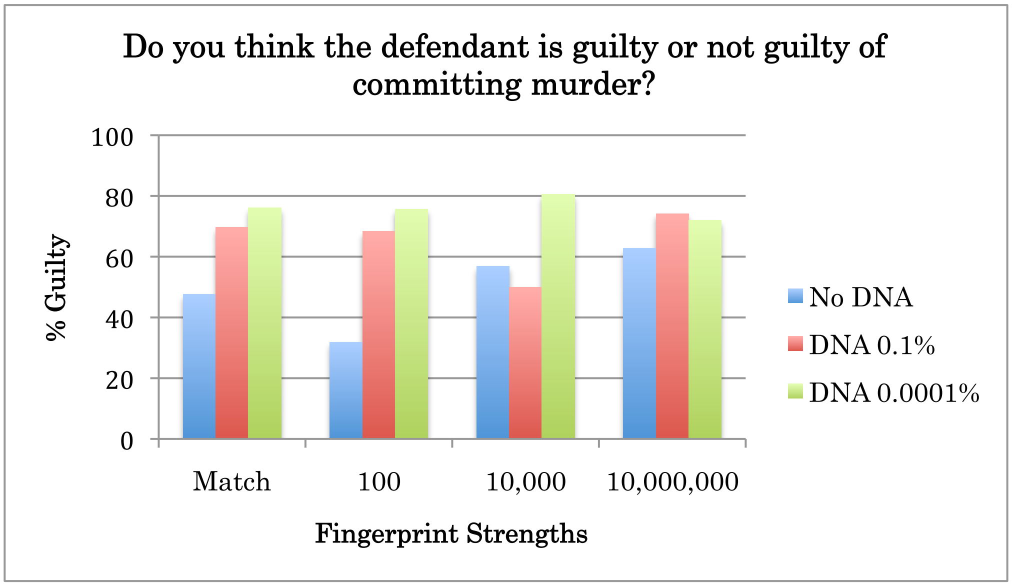
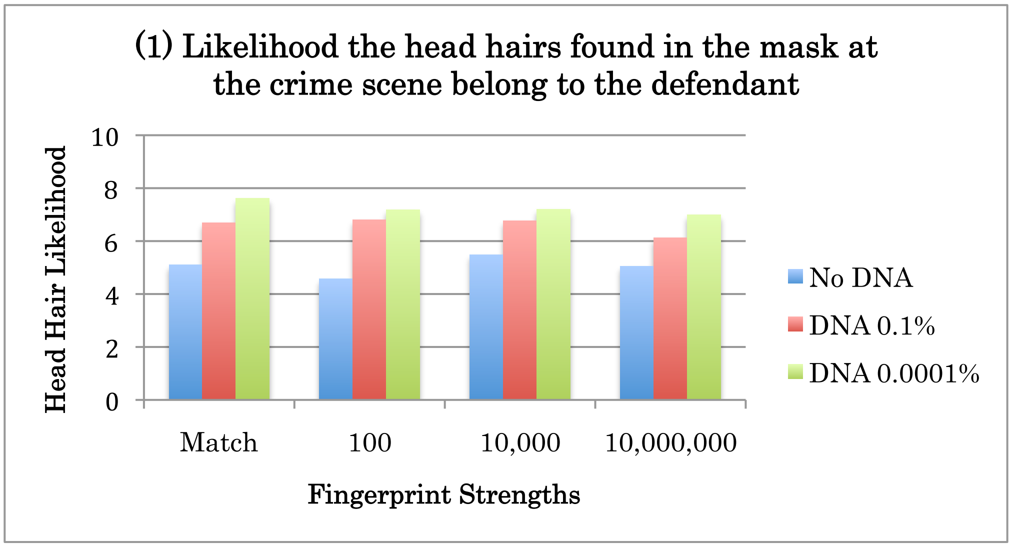


Figure 2. The graph displays the percentage of guilty verdicts for each condition. The higher strength DNA match rendered more guilty verdicts, excluding when coupled with the higher strength fingerprint evidence. When no DNA was present, participants rendered more guilty verdicts when the fingerprint evidence strength increased.

<u>*Strength of DNA Evidence*</u> – An ANOVA examined the influence of DNA match on the likelihood of the head hair from the crime scene belonging to the defendant (*What do you think is the likelihood that the head hairs found in the mask at the crime scene belong to the defendant?*), based on a ten-point scale from low to strong likelihood. There was a significant main effect of the strength of DNA match on the head hair likelihood, $F(2, 460) = 31.35$, $p < .001$; $\eta_p^2 = .12$. Tukey's HSD test showed when participants were presented with the higher DNA match, they believed there was a stronger likelihood that the

head hair belonged to the defendant ($M = 7.24$, $SD = 2.6$) than when presented with the lower DNA match ($M = 6.61$, $SD = 2.32$), $p = .057$. When presented with the lower DNA match, they believed there was a stronger likelihood that the head hair belonged to the defendant than when presented with no DNA match ($M = 5.09$, $SD = 2.31$), $p = .057$, $p < .001$. (See Figure 3).

Figure 3. Head Hair Likelihood



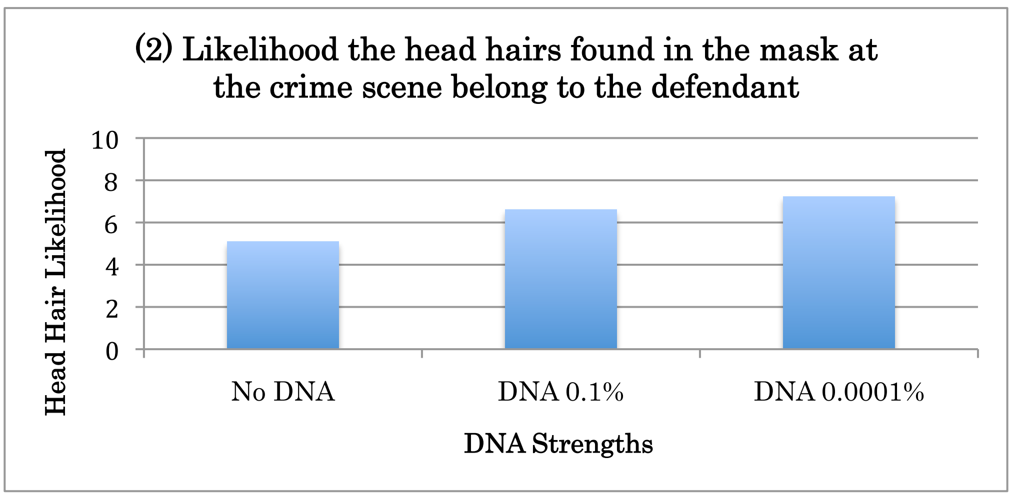


Figure 3. Graph 1 displays the likelihood the head hairs belong to the defendant within each condition. The higher DNA match rendered the highest likelihoods within all the varying strengths of fingerprint evidence. When no DNA was present, there were no significant likelihood differences between any strengths of fingerprint evidence. The higher strength fingerprint evidence was underweighted. Graph 2 isolates the varying strengths of DNA matches. The likelihood significantly increased as the strength of DNA match increased.

The participants were also asked to rate the strength of the DNA evidence against the defendant (*How strong do you think the*

DNA evidence is against the defendant?), based on a ten-point scale from low to high strength. There was a significant main effect of the strength of DNA match on the rating of its strength, $F(2, 460) = 53.15$, $p < .001$; $\eta_p^2 = .19$. When participants were presented with the higher DNA match, they rated the strength of the DNA evidence higher ($M = 7.08$, $SD = 2.75$) than when presented with the lower DNA match ($M = 6.41$, $SD = 2.61$), $p = .060$. When presented with the lower DNA match, they rated the strength of the DNA evidence higher than when presented with no DNA match ($M = 4.06$, $SD = 2.74$), $p < .001$.

Strength of Fingerprint Evidence – An ANOVA examined the influence of DNA evidence on the likelihood of the fingerprint from the crime scene belonging to the defendant (*What do you think is the likelihood that the fingerprint found in the mask at the crime scene was left by the defendant?*), based on a ten-point scale from low to high likelihood. There was a significant main effect of the strength of DNA match on the fingerprint likelihood, $F(2, 460) = 5.80$, $p = .003$; $\eta_p^2 = .03$. Tukey's HSD test showed when participants were presented with the higher DNA match, they found there was a stronger likelihood that the fingerprint belonged to the defendant ($M = 6.86$, $SD = 2.44$) than when presented with the lower DNA match ($M = 6.45$, $SD = 2.36$), $p = .060$. When presented with the lower DNA match, they found there was a stronger likelihood that the fingerprint belonged to the defendant than when presented with no DNA match (M = 5.89, SD = 2.44), $p < .001$. (See Figure 4).

Figure 4. Fingerprint Likelihood

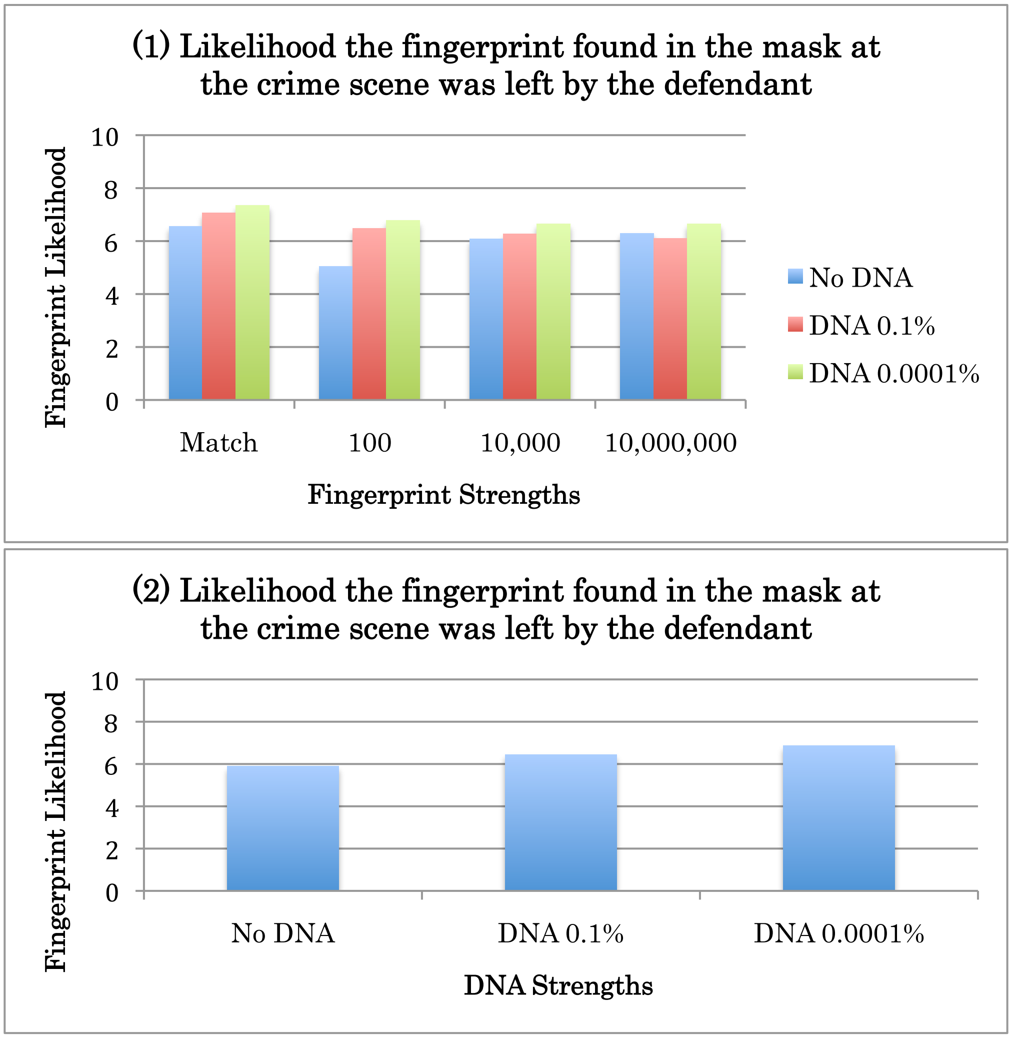


Figure 4. Graph 1 displays the likelihood the fingerprint belonged to the defendant within each condition. The higher DNA match rendered the highest likelihoods within all the varying strengths of fingerprint evidence. When no DNA was present, there were no significant likelihood differences between any strengths of fingerprint evidence. Graph 2 isolates the varying strengths of DNA matches. The likelihood significantly increased as the strength of DNA match increased.

Strength of Other Evidence – The influence of DNA evidence on the accuracy of the eyewitness account was also examined (*How accurate do you think was the eyewitness's account of the crime?*), based on a ten-point scale from low to high accuracy. There was not a significant main effect of the strength of DNA match on the accuracy of the eyewitness account, $F(2, 460) = 0.42$, $p = .659$; $\eta_p^2 = .002$.

The participants were also asked about the accuracy of the surveillance video in identifying the defendant (*How reliable do you think the surveillance video is in identifying the defendant?*), based on a ten-point scale from low to high reliability. There was a significant main effect of the strength of the DNA match on the accuracy of the surveillance video, $F(2, 460) = 3.46$, $p = .032$; $\eta_p^2 = .02$. Tukey's HSD test showed when participants were presented with the higher DNA match, they found the surveillance video to be less accurate ($M = 3.52$, $SD = 2.91$) than when presented with no DNA evidence ($M = 4.39$, $SD = 3.13$), $p = .027$.

General Accuracy Dependent Measures

A 2-way MANOVA was performed to test the effect DNA evidence and fingerprint evidence on general accuracy dependent measures: general accuracy of fingerprint examinations (*In general, how accurate do you think are the results of fingerprint comparisons?*), general accuracy of DNA examinations (*In general, how accurate do* *you think are the results of DNA analyses?*), how accurately DNA is presented during trial (*How accurately do you feel DNA evidence is presented in trials?*), and general reservations about science (*Do you have general reservations about science?*). The omnibus test of the main effect of DNA evidence was statistically significant, $F(8, 888) = 3.90$, $p < .001$; Wilks' $\lambda = 0.93$, $\eta_p^2 = .34$. The omnibus test of the main effect of fingerprint evidence was not statistically significant, $F(12, 1175) = 1.90$, $p = .07$; Wilks' $\lambda = 0.93$, $\eta_p^2 = .03$. The interaction between DNA and fingerprint evidence was also not statistically significant, $F(24, 1550) = 1.00$, $p = .46$; Wilks' $\lambda = 0.95$, $\eta_p^2 = .01$. Given these results, ANOVAs were run to test the impact of DNA evidence on these general accuracy measures.

When examining the effect of fingerprint and DNA evidence on participant assessment of general accuracy of fingerprint examinations (*In general, how accurate do you think are the results of fingerprint comparisons?*), based on a ten-point scale from low to high accuracy, there was a significant main effect on strength of DNA evidence, $F(2, 460) = 4.57$, $p = .011$; $\eta_p^2 = .02$. When participants were presented with the higher DNA match, they found general fingerprint examinations to be more accurate ($M = 6.79$, $SD = 2.12$) than when presented with lower DNA match ($M = 6.60$, $SD = 2.12$), $p = .057$. When presented with the lower DNA match, they found general fingerprint examinations to be more accurate than when presented with no DNA match ($M = 6.03$, $SD = 2.20$), $p < .001$.

Participants were asked to assess the general accuracy of DNA examinations (*In general, how accurate do you think are the results of DNA analyses?*), based on a ten-point scale from low to high accuracy. There was a significant main effect on strength of DNA match, $F(2, 460) = 8.84$, $p < .001$; $\eta_p^2 = .04$. When participants were presented with the higher DNA match, they found general DNA examinations to be more accurate ($M = 8.23$, $SD = 1.92$) than when presented with the lower DNA match ($M = 7.86$, $SD = 2.16$), $p = .032$. When presented with the lower DNA match, they found general DNA examinations to be more accurate than when presented with no DNA match ($M = 7.24$, $SD = 2.30$), $p < .001$.

Participants were also questioned about how accurately DNA is presented during trial (*How accurately do you feel DNA evidence is presented in trials?*), based on a ten-point scale from low to high accuracy. There was a significant main effect on strength of DNA match, $F(2, 473) = 7.82$, $p < .001$; $\eta_p^2 = .03$. When participants were presented with the higher DNA match, they found DNA to be more accurately presented during trial ($M = 7.61$, $SD = 1.95$) than when presented with the lower DNA match ($M = 6.95$, $SD = 2.19$), $p = .045$. When presented with the lower DNA match, they found DNA to be more accurately presented during trial than when presented with no DNA match ($M = 6.64$, $SD = 2.54$), $p = .045$, $p < .001$.

Participants were also asked about general reservations about science (*Do you have general reservations about science?*), based on a ten-point scale from few to many reservations. There was a significant main effect on strength of DNA evidence, $F(2, 460) = 8.84$, $p = .005$; $\eta_p^2 = .01$. When participants were presented with the higher DNA match, they had fewer reservations about science ($M = 3.10$, $SD = 2.18$) than when presented with the lower DNA match ($M = 3.26$, $SD = 1.96$), $p = .042$. When presented with the lower DNA match, they had fewer reservations about science than when presented with no DNA match ($M = 3.84$, $SD = 2.09$), $p < .005$.

Correlations

Pearson correlation coefficient was computed to assess the relationship between age and general reservations about science (*Do you have general reservations about science?*). There was a negative correlation between the two variables, $r = -.06$, $N = 484$, $p < .001$. As age increased, reservations about science decreased. The relationship between college level and general reservations about science was also assessed. There was a negative correlation between the two variables, $r = -0.11$, $N = 485$, $p = .013$. As college level increased, general reservations about science decreased.

The relationship between hours of general crime-themed shows watched (*How many hours do you spend per week watching general crime-themed programs (i.e. Law and Order SVU, Law and Order LA, NCIS)?*) and self-reported understanding of forensic processes (*How strongly do you understand the processes that forensic scientists use to analyze different types of evidence?*) was computed. There was a positive correlation between the hours of general crime-themed shows watched and the self-reported understanding of forensic processes, $r = 0.19$, $N = 484$, $p < .001$. As hours of crime-themed shows watched increased, participant understanding of forensic processes increased. There was also a positive correlation between the hours of crime-themed shows watched and the self-reported understanding of DNA evidence (*How well do you feel you understand the process of analyzing and comparing DNA evidence?*), $r = 0.15$, $N = 484$, $p = .001$. As hours of crime-themed shows watched increased, participant understanding of DNA evidence increased. Also, there was a positive correlation between the hours of crime-themed shows watched and the understanding of fingerprint evidence (*How well do you feel you understand the process of analyzing and comparing fingerprint evidence?*), $r = 0.16$, $N = 485$, $p < .001$. As hours of crime-themed shows watched increased, participant understanding of fingerprint evidence increased. Similar relationships were found with forensic themed shows.

Also, participants were asked to provide probability percentages for events that occur 1 out of 1,000 times (*If there is a 1 out of 1,000 chance that an event will occur, what is the percentage (0-100%) of probability the event will occur?*) and 1 out of 1,000,000 times (*If there is a 1 out of 1,000,000 chance that something will occur, what is the percentage (0-100%) of probability the event will occur?*). The percentage of participants that provided the correct percentage for the 1 out of 1,000 probability was 65.8% (313 of 476 participants). Participant answers ranged from 500% to 0.001% (correct answer 0.1%). The percentage of participants that provided the correct percentage for the 1 out of 1,000,000 probability was 53.8% (255 of 474 participants). Participant answers ranged from 10,000% to 0.0000001% (correct answer 0.0001%). While there were no significant results between different DNA match strengths and fingerprint strengths, more participants provided the correct answer for the lower probability question compared with the higher probability question. (See Figure 5).

Figure 5. Probability Percentages

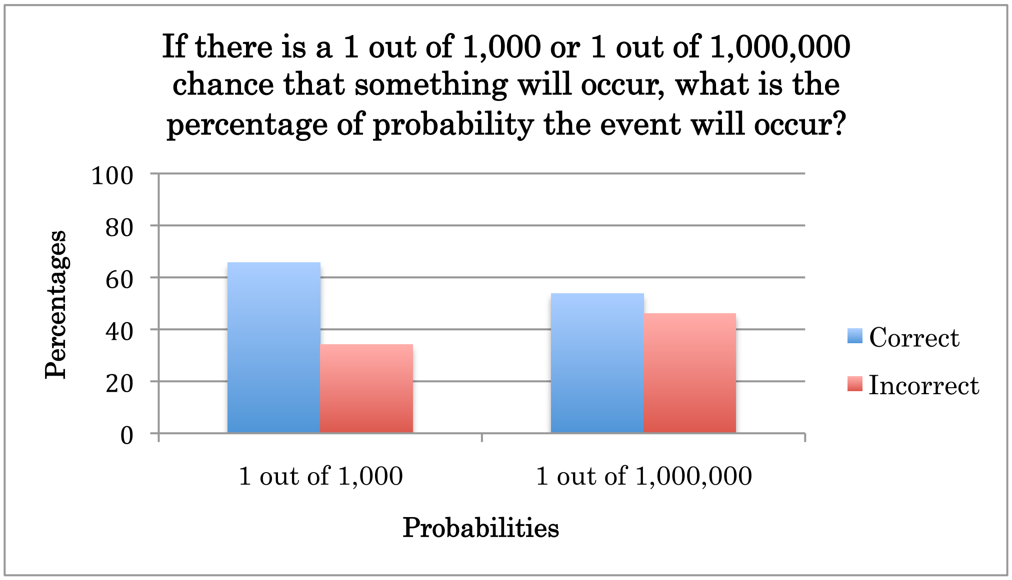


Figure 5. Participants provided more correct probability percentages when answering the 1 out of 1,000 chance compared to the 1 out of 1,000,000 chance.

The relationship between math and science courses taken and whether or not participants provided the correct probability was examined. There was a positive correlation between number of math and science courses and getting 1 out of 1,000 probability correct, $r = 0.09$, $N = 476$, $p = .044$. The more math and science courses the participant took, the more likely they were to provide the correct probability. A similar relationship was found with the 1 out of 1,000,000 probability, $r = 0.14$, $N = 474$, $p = .002$.

Chapter 5 – Discussion

The results were inconsistent with the initial predictions. The presence of DNA evidence did not increase the mock jurors perceptions of the strength of the fingerprint evidence. Mock jurors tended to under weigh the probabilistic fingerprint evidence, regardless of the level of DNA match that was presented with it. Jurors did not rate probabilistic fingerprint evidence more conservatively than fingerprint match evidence. The only significant difference between varying fingerprint strengths was found in the amount of guilty verdicts when no DNA match was found. Mock jurors rendered more guilty verdicts as the fingerprint strength increased.

Mock jurors were able to differentiate between the different strengths of DNA matches for the majority of questions asked about the case (strength of case, likelihood of guilt, strength of DNA evidence, strength of fingerprint evidence, reliability of surveillance video), but there were no significant differences between the fingerprint strengths. Fingerprint "matches" were rated the same as the different strengths of probabilistic fingerprint evidence. The results show that participants have problems understanding fingerprint testimony when provided in probabilistic form. For some of the case dependent measures, participants provided similar ratings between the lower and higher strength DNA matches (these items were marginally significant). This is important to report, because past studies have reported that participants were able to readily differentiate between these different DNA match levels (Koehler, 2001; Koehler, 2000). It is possible that the presence of other important evidence (in this case, fingerprint evidence) blurred the lines between these DNA match strengths. Past studies have concentrated on one certain type of evidence and did not include other types of evidence important to the case (Koehler, 2001). This study concentrated on two major types of evidence (DNA and fingerprint) for the participants to provide conclusions about.

Notably, participants rated the likelihood that the fingerprint found in the mask at the crime scene was the defendant's as higher when presented with higher DNA matches. There was no significant difference in the fingerprint likelihood between the varying strengths of fingerprint evidence. Participants were not able to differentiate between the varying probabilities of fingerprint evidence. It has been shown through past studies that jurors have problems with probabilistic evidence (Koehler & Macchi, 2004; Schklar & Diamond, 1999). This may be due to participants misunderstanding of what a likelihood ratio is. The large numbers could be confusing, especially when DNA evidence is presented in such small fractions. With participants being able to distinguish the differences between varying strengths of DNA matches, it might be helpful to provide fingerprint evidence in multiple ways to provide the most accuracy (Koehler, 2001).

With regards to general questions, participants rated the general accuracy of DNA and fingerprint examinations to be higher when presented with higher DNA matches. Also, participants had fewer reservations about science when presented with higher DNA matches. Again, no significant results were found between the varying strengths of fingerprint evidence. Similar results have been found in previous studies (Carlson & Russo, 2001; Shelton, 2008). Jurors have expectations to be provided with strong scientific evidence. They tend to rate evidence as more accurate when presented with stronger scientific evidence. Also when people have fewer reservations about science, they tend to be less skeptical about scientific evidence in court.

Another interesting find concerned the verdict. When no DNA was present, participants were able to differentiate between the varying strengths of fingerprint evidence. Participants rendered more guilty verdicts as the strength of the fingerprint evidence increased. Participants were also wary of the fingerprint “match”. They rendered a guilty verdict when provided with a fingerprint “match” at a higher percentage than the lowest probabilistic fingerprint evidence, but a lower percentage than the moderate probabilistic fingerprint evidence.

This indicates that participants did properly weigh the fingerprint "match" evidence. However, once DNA match evidence was introduced, participants were no longer able to differentiate between the fingerprint strengths. The mere presence of a DNA match, whether high or low, affected the verdict. When presented with the highest DNA match and the highest strength fingerprint evidence, participants rendered less guilty verdicts. These results are similar to those found in other studies (Koehler, 2011a). Jurors can be apprehensive about rendering a guilty verdict even when presented with strong matching evidence.

These results display the difficulties jurors could have when faced with many different types of evidence. It seems to become complicated for jurors to weigh all the evidence properly, which may cause them to be apprehensive about providing a guilty verdict. Also, it has been found that participants are affected by error rates (Koehler, 2011a). Since error rates were not explicitly stated in this study, it could have caused slight confusion about rating the different types of evidence. It could also be possible that participants in this study were not provided with enough additional context about the evidence, so they did not feel comfortable convicting the defendant. There was no voir dire in this case. The participants were not provided with opening and closing statements, live witnesses, instructions, objections, or deliberations with other jurors that would be present in a normal courtroom setting. Without these contextual clues, participants may not have been completely convinced the evidence in front of them was linked to the defendant enough to be certain of guilt. This also highlights the limitations of an online study comparative to a live study that can provide all of these contextual clues.

Some reasons as to why participants made certain decisions was explored. It was found that as age increased, reservations about science decreased. Also, as college level increased, reservations about science decreased. With age, people seem to understand and become more comfortable with science. Also, as people become more educated they become more comfortable with science. These results may not generalize as well to the overall population that could serve on a jury. The participants in this study were from a concentrated age group. Also, they were all enrolled in college level courses, which means they have an overall higher education status than the general population. These results can still be useful to display that with more knowledge comes stronger understandings about science. Something could be implemented in the court system to educate jurors about different practices in science to make them more comfortable with the scientific information they could be presented with in the courtroom. This could be implemented by providing a short overview of different forensic processes that would be seen during the trial. Also, something as simple as a pamphlet explaining the different processes could help a juror more readily follow along with the scientific testimony.

In regards to the "CSI effect", this study found that people who watched more forensic and crime themed shows found themselves to better understand the process that forensic scientists use to analyze and compare DNA evidence, fingerprint evidence, and other types of forensic evidence. Similar results have been found in previous studies (Schweitzer & Saks, 2007; Shelton, 2008). Jurors who watch more crime shows may be overconfident about their understanding of forensic processes, which could in turn produce an overconfidence in their understanding of trial information and verdicts; however, in this study, there was no significant relationship found between the hours of forensic and crime themed shows watched and verdict confidence. Participants who watched more crime shows felt they had a better understanding of the forensic process, but this did not lead to greater confidence in their processing of the evidence at hand to provide a verdict.

This could provide evidence that the "CSI effect" is more of a belief than actual problem (Podlas, 2006). People often rely on television to provide education because they have little to no personal experience with the legal system. This could be attributed to a "tech effect" more so than the "CSI effect" (Shelton, 2008, p. 375). This theory explains that people have stronger understandings of forensic processes due to the changes in culture and the advancements made in technological and informational distribution. Information is readily available on television, computers, phones, and other electronic media. People are only a few seconds away from information. Although all the information may cause a greater confidence, no evidence has been found that it provides overconfidence. So, while participants did believe themselves to have a better understanding of forensic processes, there was no further evidence to show that it affected any aspects of the case at hand.

In regards to difficulties in understanding statistics, an alarming number of participants were unable to provide correct probability percentages for a 1 out of 1,000 chance or a 1 out of 1,000,000 chance. It has been shown in the past that many people of varying intelligence levels are often confused by probabilities and other elementary statistical procedures (Koehler, 2011b). Although many participants did not seem to understand how to compute probabilities, many were still able to weigh DNA evidence properly. It is possible that people may recognize extremely small numbers as being a strong likelihood of guilt. This line becomes blurred with likelihood ratios, which are much larger numbers. It seems that some participants became confused with the probabilities and provided numbers much larger than one hundred. Participants may be confusing likelihood ratios and probability percentages, or thinking of them as the same thing. To correct this issue, it may be useful to provide court prepared instructions of the differences between likelihood ratios and probability percentages and how to mathematically calculate them. It has been shown when provided with court prepared notes, participants had higher scores on objective measures of facts in the law when compared with participants who just took notes themselves (Kelly, 2010). Mandated court prepared notes could be extremely useful to future trials.

Future Research – Future research investigating DNA evidence and its impact on probabilistic fingerprint evidence should include written notes that explain the differences between likelihood ratios and probability percentages. It would be interesting to see if these notes would aid in a greater understanding of the probabilistic fingerprint evidence. Also, it may be useful to provide more contextual clues surrounding the case (objections, rulings, deliberations). Deliberations could be the most insightful. If participants are able to discuss the evidence with other participants, it could produce a stronger understanding of the evidence. Also, because some are better at math and statistics than others, it could be useful to have someone explain the evidence to a juror who does not fully understand it. An in-person mock trial situation would be best to examine this information and would be a closer approximation of actual jury procedures than the online case reading provided in this study.

An additional direction would be to provide more detail about both the DNA and fingerprint evidence. For example, including more information about the fingerprint, such as if it was full or partial and the clarity of the latent print, could help participants distinguish the differences between the strengths of the fingerprint evidence. More contextual information could lead to a better understanding of the evidence.

A final suggestion would be to provide other stronger types of evidence along with the DNA and fingerprint evidence. An example of this would be if the eyewitness were able to describe the perpetrator and possibly identify him or her in a lineup. In addition, there could be trace evidence, such as a shoe print or tire mark, that could link the suspect to the scene. Multitudes of evidence are often presented during trials, some evidence stronger than others. It would be interesting to investigate if participants are able to weigh evidence better when presented with more evidence, or if it would impede their understandings of individual pieces of evidence.

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APPENDIX A

CASE SUMMARIES

DNA 0.0001%, Fingerprint 10,000,000 Scenario

State v. Robinson

This matter concerns the case of State v. Aaron Robinson. Mr. Robinson has been accused of murdering Charles Greene during an attempted robbery of a convenience store.

According to a reliable eyewitness account, the perpetrator, wearing a mask to cover his face, entered the convenience store at approximately 10:20 pm on October 12, a year ago, pulled out a gun, and demanded the money from the register. The clerk resisted and a struggle ensued, during which the store clerk pulled off the perpetrator's mask. The perpetrator then shot and killed the clerk, Mr. Greene. The surveillance video from the convenience store was not functioning at the time of the robbery. The eyewitness was able to give the police a thorough account of what happened, but had not seen the perpetrator's face. The mask worn by the perpetrator was recovered from the store and sent to the crime laboratory for analysis.

The mask recovered from the crime scene was examined for traces of biological material belonging to the perpetrator. The mask contained head hairs believed to have been left behind by the perpetrator. DNA was extracted from the roots of the hairs.

The mask was also examined for traces of other forensic evidence. A latent print was lifted from the mask, which was believed to belong to the perpetrator.

During routine interviews of people who live in the neighborhood, the police identified several potential suspects. All of the suspects agreed to provide DNA and fingerprint samples to police for comparison with the DNA extracted from the head hairs and the latent print recovered from the mask from the crime scene. DNA tests were performed using the DNA profile from the suspects and the profile of the DNA extracted from the hairs found in the mask at the crime scene. A fingerprint examiner compared the fingerprint samples taken from suspects and the latent print from the crime scene. Based on the results, one of the suspects, Aaron Robinson, was arrested and charged with murder.

At trial, the prosecution called upon the forensic DNA expert who testified *"The probability that the suspect would match the DNA found in the hair if he were not the source is 0.0001% or 1 in 1,000,000".*

The prosecution also called upon the fingerprint examiner who testified that the results of the fingerprint comparison revealed *"It is 10 million times more likely to observe this configuration of minutiae if the Mr. Robinson is the source of the fingerprint found at the crime scene than if some other, randomly selected, unrelated person is the source of the fingerprint".*

The defense argued that the fingerprint evidence has little meaning because it is merely circumstantial. The defense also argued that other forms of direct evidence were missing (such as a lineup identification, or the murder weapon) that would link Mr. Robinson to the crime.

DNA 0.0001%, Fingerprint 10,000 Scenario

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The defense argued that the fingerprint evidence has little meaning because it is merely circumstantial. The defense also argued that other forms of direct evidence were missing (such as a lineup identification, or the murder weapon) that would link Mr. Robinson to the crime.

DNA 0.0001%, Fingerprint 100 Scenario

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The prosecution also called upon the fingerprint examiner who testified that the results of the fingerprint comparison revealed *"It is 100 times more likely to observe this configuration of minutiae if the Mr. Robinson is the source of the fingerprint found at the crime scene than if some other, randomly selected, unrelated person is the source of the fingerprint".*

The defense argued that the fingerprint evidence has little meaning because it is merely circumstantial. The defense also argued that other forms of direct evidence were missing (such as a lineup identification, or the murder weapon) that would link Mr. Robinson to the crime.

DNA 0.0001%, Fingerprint Match Scenario

State v. Robinson

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The prosecution also called upon the fingerprint examiner who testified that the results of the fingerprint comparison revealed, *"The latent print found at the crime scene is a match to Mr. Robinson's print".*

The defense argued that the fingerprint evidence has little meaning because it is merely circumstantial. The defense also argued that other forms of direct evidence were missing (such as a lineup identification, or the murder weapon) that would link Mr. Robinson to the crime.

DNA 0.1%, Fingerprint 10,000,000 Scenario

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The prosecution also called upon the fingerprint examiner who testified that the results of the fingerprint comparison revealed *"It is 10 million times more likely to observe this configuration of minutiae if the Mr. Robinson is the source of the fingerprint found at the crime scene than if some other, randomly selected, unrelated person is the source of the fingerprint".*

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The defense argued that the fingerprint evidence has little meaning because it is merely circumstantial. The defense also argued that other forms of direct evidence were missing (such as a lineup identification, or the murder weapon) that would link Mr. Robinson to the crime.

DNA 0.1%, Fingerprint 100 Scenario

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DNA 0.1%, Fingerprint Match Scenario

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No DNA, Fingerprint 10,000,000 Scenario

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The defense argued that the fingerprint evidence has little meaning because it is merely circumstantial. The defense also argued that other forms of direct evidence were missing (such as a lineup identification, or the murder weapon) that would link Mr. Robinson to the crime.

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No DNA, Fingerprint 100 Scenario

State v. Robinson

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According to a reliable eyewitness account, the perpetrator, wearing a mask to cover his face, entered the convenience store at approximately 10:20 pm on October 12, a year ago, pulled out a gun, and demanded the money from the register. The clerk resisted and a struggle ensued, during which the store clerk pulled off the perpetrator's mask. The perpetrator then shot and killed the clerk, Mr. Greene. The surveillance video from the convenience store was not functioning at the time of the robbery. The eyewitness was able to give the police a thorough account of what happened, but had not seen the perpetrator's face. The mask worn by the perpetrator was recovered from the store and sent to the crime laboratory for analysis.

The mask recovered from the crime scene was examined for traces of biological material belonging to the perpetrator. No biological material was found from which DNA could be extracted.

The mask was also examined for traces of other forensic evidence. A latent print was lifted from the mask, which was believed to belong to the perpetrator.

During routine interviews of people who live in the neighborhood, the police identified several potential suspects. All of the suspects agreed to provide fingerprint samples to police for comparison with the latent print recovered from the mask from the crime scene. A fingerprint examiner compared the fingerprint samples taken from the suspects and the latent print from the crime scene. Based on these results, one of the suspects, Aaron Robinson, was arrested and charged with murder.

At trial, the prosecution called upon a fingerprint examiner who testified that the results of the fingerprint comparison revealed *"It is 100 times more likely to observe this configuration of minutiae if Mr. Robinson is the source of the fingerprint found at the crime scene than if some other, randomly selected, unrelated person is the source of the fingerprint".*

The defense argued that the fingerprint evidence has little meaning because it is merely circumstantial. The defense also argued that other forms of direct evidence were missing (such as a lineup identification, or the murder weapon) that would link Mr. Robinson to the crime.

No DNA, Fingerprint Match Scenario

State v. Robinson

This matter concerns the case of State v. Aaron Robinson. Mr. Robinson has been accused of murdering Charles Greene during an attempted robbery of a convenience store.

According to a reliable eyewitness account, the perpetrator, wearing a mask to cover his face, entered the convenience store at approximately 10:20 pm on October 12, a year ago, pulled out a gun, and demanded the money from the register. The clerk resisted and a struggle ensued, during which the store clerk pulled off the perpetrator's mask. The perpetrator then shot and killed the clerk, Mr. Greene. The surveillance video from the convenience store was not functioning at the time of the robbery. The eyewitness was able to give the police a thorough account of what happened, but had not seen the perpetrator's face. The mask worn by the perpetrator was recovered from the store and sent to the crime laboratory for analysis.

The mask recovered from the crime scene was examined for traces of biological material belonging to the perpetrator. No biological material was found from which DNA could be extracted.

The mask was also examined for traces of other forensic evidence. A latent print was lifted from the mask, which was believed to belong to the perpetrator.

During routine interviews of people who live in the neighborhood, the police identified several potential suspects. All of the suspects agreed to provide fingerprint samples to police for comparison with the latent print recovered from the mask from the crime scene. A fingerprint examiner compared the fingerprint samples taken from the suspects and the latent print from the crime scene. Based on these results, one of the suspects, Aaron Robinson, was arrested and charged with murder.

At trial, the prosecution called upon a fingerprint examiner who testified that the results of the fingerprint comparison revealed, *"The latent print found at the crime scene is a match to Mr. Robinson's print."*

The defense argued that the fingerprint evidence has little meaning because it is merely circumstantial. The defense also argued that other forms of direct evidence were missing (such as a lineup identification, or the murder weapon) that would link Mr. Robinson to the crime.

APPENDIX B

DEPENDENT MEASURES QUESTIONNAIRE

Please respond to the following questions by thinking about the information presented in the trial synopsis you just read. Keep in mind that you should imagine yourself to be a juror deciding the merits of this case, even though you have limited information on which to base your decision.

1. How strong do you think the case is against Aaron Robinson (the defendant)?

1 - Weak Case 2 3 4 5 6 7 8 9 10 – Very Strong

2. Based on the information you read, what is the likelihood the defendant is guilty of murdering the convenience store clerk?

1 - Not Guilty 2 3 4 5 6 7 8 9 10 – Strong Likelihood of Guilt

3. How strong do you think the DNA evidence is against the defendant?
1 - Weak 2 3 4 5 6 7 8 9 10 - Strong DNA Evidence 0 – N/A

4. Assume the defendant was found guilty. What type of sentence would you advocate for him?

Light Sentence (1-5 years)
Moderate Sentence (6-15 years)
Long Sentence (16-25 years)
Life Sentence
Death Penalty

5. How certain are you that the police have apprehended the correct suspect in this case?

1- Uncertain 2 3 4 5 6 7 8 9 10 – Extremely Certain

6. What do you think is the likelihood that the head hairs found in the mask at the crime scene belong to the defendant?

1- Hairs are not his 2 3 4 5 6 7 8 9 10 –
Strong Likelihood

7. What do you think is the likelihood that the fingerprint found in the mask at the crime scene was left by the defendant?

1-Not his Fingerprint 2 3 4 5 6 7 8 9 10 –
Strong Likelihood

8. Rank the evidence in order of importance in determining the guilt or innocence of the defendant:

DNA	1	2	3
Fingerprint	1	2	3
Eyewitness	1	2	3

9. Do you think the defendant is guilty or not guilty of committing murder?

Guilty
Not Guilty

10. How much confidence do you have in the verdict you chose?

1 – No Confidence 2 3 4 5 6 7 8 9 10 –
Strong Confidence

11. In general, how accurate do you think are the results of fingerprint comparisons?

1 – Not Accurate 2 3 4 5 6 7 8 9 10 –
Very Accurate

12. How accurate do you think was the eyewitness's account of the crime?

1 – Not Accurate 2 3 4 5 6 7 8 9 10 –

Very Accurate

13. In general, how accurate do you think are the results of DNA analyses?

1 – Not Accurate 2 3 4 5 6 7 8 9 10 – Very Accurate

14. How accurately do you feel DNA evidence is presented in trials?

1 – Not Accurate 2 3 4 5 6 7 8 9 10 – Very Accurate

15. How reliable do you think the surveillance video is in identifying the defendant?

1 – Not Reliable 2 3 4 5 6 7 8 9 10 – Very Reliable

16. Do you have general reservations about science?

1-No Reservations 2 3 4 5-Some Reservations 6 7 8 9 10-Strong Reservations

17. Approximately how many college level science and math courses have you taken?

State Number of courses

18. Are fingerprints infallible evidence?

Yes
No
Not Sure

19. How well do you feel you understand the process of analyzing and comparing fingerprint evidence?

1 – No Understanding 2 3 4 5 – Moderate Understanding 6 7 8 9 10 – Strong Understanding

20. Is any degree (low to high probability matches) of DNA evidence enough to convict?

Yes
No
Not Sure

21. How well do you feel you understand the process of analyzing and comparing DNA evidence?

1 – No Understanding 2 3 4 5 – Moderate Understanding 6 7 8 9 10 – Strong Understanding

22. How accurately do you feel fingerprint evidence is presented in trials?

1 – Not Accurate 2 3 4 5 6 7 8 9 10 – Very Accurate

23. Is DNA infallible evidence (always correct when a DNA match is made between defendant and crime scene)?

Yes
No
Not Sure
N/A

24. If there is a 1 out of 1,000 chance that an event will occur, what is the percentage (0- 100%) of probability the event will occur?

State Probability

25. How many hours do you spend per week watching forensic themed shows (i.e. CSI, CSI Miami, CSI New York)?

State Hours

26. How many hours do you spend per week watching general crime-themed programs (i.e. Law and Order SVU, Law and Order LA, NCIS)?

State Hours

27. In general, do you feel there are major deficiencies in the way forensic evidence is collected?

1 – No Deficiencies 2 3 4 5 6 7 8 9 10 – Major Deficiencies

28. How strongly do you understand the processes that forensic scientists use to analyze different types of evidence?
1 – Do Not Understand 2 3 4 5 6 7 8 9 10 – Strongly Understand

29. Do you consider fingerprint examinations to be more subjective (the conclusion given by the examiner is based on his own interpretation/opinion based on his experience conducting forensic analyses) or objective (the conclusion given by the examiner is based on scientific data)?

More Subjective
More Objective

30. Is any degree (low to high level matches) of fingerprint evidence enough to convict?

Yes
No
Not Sure

31. If there is a 1 out of 1,000,000 chance that something will occur, what is the percentage (0-100%) of probability the event will occur?

State Probability

32. Write a description about how you think forensic fingerprint experts examine fingerprint evidence.

Write Description

33. Write a description about how you think forensic DNA experts examine DNA evidence.

Write Description

Biographical Questionnaire Please take a moment to respond to the following questions.

34. Today's Date:

State Date

35. Age:

State Age

36. Sex:

Male
Female

37. What ethnicity do you consider yourself?

State Ethnicity

38. Year in school:

Freshman
Sophomore
Junior
Senior
Graduate Student

APPENDIX C

INSTITUTIONAL REVIEW BOARD (IRB) APPROVAL LETTER

ARIZONA STATE UNIVERSITY
RESEARCH AND ECONOMIC AFFAIRS

Office of Research Integrity and Assurance

To:	Dawn Mcquiston-Surrett FAB
From:	Mark Roosa, Chair Soc Beh IRB
Date:	11/10/2008
Committee Action:	**Exemption Granted**
IRB Action Date:	11/10/2008
IRB Protocol #:	0811003445
Study Title:	Assessing the Persuasiveness of DNA Evidence in the Courtroom

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.