Principles of Evidence

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Principles of Criminal Evidence

Introduction

Any legal action requires evidence, especially in a criminal proceeding. In some systems, evidence is gathered and evaluated by the court, providing less opportunity for litigants to challenge or analyze evidence. In systems which are more adversarial, there are more opportunities to challenge evidence. In either system, though, the judges, prosecutors, defense attorneys and representatives of the injured parties can all benefit from a deeper understanding of evidence. That deeper understanding of evidence permits the practitioner to describe the evidence more clearly, understand the weakness or strength of evidence, and to test the evidence in court. It is particularly important that the judge, prosecutor, defense attorney and others have a similar vocabulary and similar understanding when discussing evidence. If people can all describe the weakness or strength of particular kinds of evidence using the same language and principles, then it allows the adjudication of a case to be done with clarity and a depth of fairness.

Principles of evidence are often more familiar to lawyers in common-law countries, especially those with juries. The court uses exclusionary evidentiary rules to prevent juries from hearing and being prejudiced by improper evidence. In inquisitorial systems, instead, the principle of "free proof" has dominated and there has not been a tradition of excluding evidence. This does not mean that inquisitorial systems do not have traditions or guiding principles of evaluating evidence. Indeed, both systems strive for judges or juries to consider a wide degree of evidence which is

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1 In fact, many inquisitorial systems developed in the wake of canon law, which assigned weight or priorities to different kinds of evidence. The idea of "free proof" rejected those strict categories from canon law. Some inquisitorial systems also had constraints on the use of certain classes of evidence. See Jackson J. and Summers S., The Internationalisation of Criminal Evidence, Beyond the Common Law and Civil Law Traditions, pp. 30-31 (Cambridge Univ. Press 2012). Canon law and the roots of inquisitorial legal systems were, at the time, progressive because it sought evidence and did not simply test innocence by subjecting the defendant to oaths or tests. However, it created capricious and strict evidentiary procedures. By 1215 the Fourth Lateran Council forbade trial by ordeal in European church courts, but courts had already begun adopting modes of proof in civil and criminal cases in accordance with ordo iudiciarius, or Romano-canonical procedure. This ordo required an accusation in writing, the presentation of legitimate witnesses, a conviction only after a confession or presentation of evidence, and a written court decision. The ordo also lead to inquisitorial procedure, most likely by Pope Innocent III (1198-1215) in Qualiter et quando (c.8)(1215), a document which compiled the developing procedural rules. Those procedural rules included the right of defendants to defend themselves with testimony, witnesses and exceptions, as well as the option for courts to give oaths and require compurgation. It also required substantial proof, although the system did permit brutal measures to obtain the proof. In Germany, for example, the standard of proof for a conviction was "certainty," with a high premium placed on confession. The procedural rules, the Constitutio Criminalis Carolina of 1532, permitted torture, but mandated that questioners solicit answers and did not provide them. See Shaffern, R. Law and Justice from Antiquity to Enlightenment, pp. 195-201. (Rowman & Littlefield 2009). However, by the time these procedural laws developed into the 1808 Napoleonic Code of Criminal Procedure in France and the 1877 Straffprozessordnung (StPO) in Germany, judicial inquiry was focused on obtaining evidence without such extreme measures.
relevant to the allegations. In any system, however, it is necessary for practitioners to have a common language and a common framework to understand and discuss evidence.

In this book, that vocabulary and those principles of evidence are examined and explored. It begins with basic principles of evidence and builds upon those principles to explain why they are important and how they can have a practical impact in criminal investigations, indictments and during a criminal trial. These principles are important for simple cases, but become critical while investigating, prosecuting, defending or adjudicating a complicated case.

One of the first questions that a practitioner needs to ask is what needs to be proven? If a prosecutor is investigating a crime, he or she needs to find evidence that is relevant to that crime, but may also need to find evidence that a victim was harmed. He or she may need to find evidence that supports the confiscation of property or an asset. He or she may need to find evidence to convince a court to order detention on remand. He or she may also find evidence to convince a court to issue a higher sentence for the defendant.

For a defense attorney, the goals are different. He or she may want to find evidence to support an alibi, or to show that a victim wasn't harmed. He or she may also want to find evidence that convinces a court to issue a lower sentence. For a judge, the goal is also different. He or she wants to evaluate the evidence to determine if it is relevant, believable and convincing. The judge may also realize that the criminal charges were not proven.

Thus, it is important to understand what needs to be proven. As he or she seeks evidence, a practitioner should realize that evidence is not simply a witness or document that you mechanically present to the court. A witness can describe an event. A document may also describe the event. A video of that event can also be available. If they describe something different, which one is more believable? If they all describe the same set of events, does that make the story more convincing?

Evidence can thus be obtained in a number of different ways, and each way can be more or less effective. It is important to understand that an investigation rarely uncovers "the truth." Rather, it uncovers different kinds of evidence that may tell different stories. It is up to the court to eventually decide which "truth" is the most probable.

As the practitioner gathers evidence and then evaluates it, he or she should understand how each piece of evidence can be more or less important. He or she should understand how relevant the evidence is to the case. Something that doesn't matter to the case is far less important than something that directly affects some decision by the court. The practitioner should understand how credible the evidence is. In other words, are there reasons to believe the evidence? Are there reasons to mistrust it? If evidence isn't trustable, it shouldn't be very important to a final decision by the prosecutor or the court. Finally, is the evidence convincing? Does the body of evidence as a whole compel the judge to decide in a certain way? Is it internally consistent and well-corroborated? Does it make sense?

A lawyer can often be faced with evidence that he or she believes isn't right. How do you challenge that evidence? One way to challenge the evidence is to find contradicting evidence. Another way to challenge evidence, however, is to examine its qualities. Can you question its credibility and make the
judge believe it less? Can you challenge whether it is even relevant? Can you make the evidence seem less convincing?

Another dimension of evidence is to consider what it proves. Some evidence provides direct proof of guilt or directly shows that someone was injured by the crime. Other evidence suggests that someone may be guilty, or proves something that supports a theory that someone is guilty. Direct evidence and indirect evidence are examples of how a judge determines whether something is more or less probable. This book will discuss direct and indirect proof and why it effects a judge's decision differently.

As a practitioner better understands the difference between direct evidence of guilt and evidence which supports an inference of guilt, it becomes easier to advocate for a court to consider evidence differently. There are many kinds of evidence which are inferential and indirect. This does not mean that they are irrelevant or should not be considered. However, the prosecutor, advocate and judge must understand how to evaluate that indirect evidence more closely.

Finally, this book will discuss how evidence can be presented to highlight whether the evidence is strong or weak. This is not just exploiting trial techniques. A practitioner who describes the quality of evidence clearly and accurately can present a clear and compelling reason for a judge to agree with that practitioner, which is the ultimate form of advocacy.
Part I

Understanding Evidence and its Qualities
The most basic questions that any lawyer can ask are: what must I prove? How can I prove it? These basic questions should guide the lawyer who wants to prove a civil case or the prosecutor who indicts a defendant. A judge should ask: what must be proven? Was it proven by the evidence in the case? It is from these basic questions that we begin to consider the subject of evidence.

a. Elements of Crime

A dead body is found on the street. Does this prove that a murder happened, or does it simply prove that a person has died? In order to prove that a murder happened, we generally have to show that a person has died and that another person has intentionally caused that person to die. For some charges of murder with higher penalties, we should also show that the defendant planned to kill the victim. Thus, we should show the effect, the causation, and the intention. In this case, the effect is that a person died. We also have to show that someone's action caused that person to die. A third thing to prove is that the defendant had intended to kill the victim. If we show that the defendant not only intended to kill the victim, but that the defendant had planned to kill the victim ahead of time, we can seek a higher penalty for the defendant.

Each one of these elements should normally be proven to the court in order to establish that the defendant is guilty of murder. Different kinds of evidence may be needed to show each element. For instance, the dead body and a medical exam can show that someone has died. The medical exam can show whether the person died because of an accident, an intentional wound, or natural causes. A witness or forensic evidence can show whether the defendant caused the intentional wound. The defendant's intention or motive could possibly be proven by his statements about the victim.
Thus, we can break down a criminal offence into discrete elements, such as a death, causation and the intent and motivation to kill. Those elements can be satisfied by different kinds of evidence. In fact, each element can be proven by several kinds of evidence or several sources of evidence. For instance, if you had five witnesses who saw the murder and would describe it similarly, you would certainly have them testify to show that the defendant caused the murder. If you had two text messages and a witness who would all explain the defendant's motive to kill the victim, you would also provide them to the court.

However, if the defendant had just bought a new car before the victim died, would that be important? Does it explain whether the victim died? Does it explain whether the defendant caused the death? It doesn't explain either one. Does the new car help explain that defendant's intention or motive to kill the victim? In very few scenarios does this seem likely.

What if a prosecutor fails to provide evidence of every element of a crime, but the judge is still convinced that the defendant is guilty? One could argue that convicting a defendant of a crime when the legal requirements for that criminal offence has not been met would violate Article 7 of the European Convention on Human Rights. That article forbids a state from punishing anyone for any act or omission which did not constitute a criminal offence under the law.

b. Damages

A prosecutor may also have to not only prove the elements of the crime, but it may be necessary to prove that the crime caused the victim or victims to suffer damages. Did the murder victim die suddenly and painlessly, or was it a painful and prolonged death? The victim is still dead, but the court may sentence the defendant more severely if the death showed that the defendant lacked humanity. If the court has to order restitution be given to the family of the victim, the level of the damages caused by the defendant must also be proven.

Thus, a prosecutor may need to show the court that the victim died, but after two days in the hospital where he suffered great pain before expiring. He would also prove the medical costs which were incurred and the cost of burial. The prosecutor may also show that the now-deceased victim was the sole person in a large family who worked, thus depriving a spouse and children of an income, a husband and a father. These are all losses that the family suffers because of the defendant's crime.

c. Aggravating or Mitigating Circumstances

Does every murder require the same punishment? Usually, the law provides a range of punishment. Sometimes, the law requires a judge to increase or decrease the punishment because of additional factors. We have already considered increasing the punishment because the defendant planned to kill the victim well before the actual murder. We consider people who have planned and prepared to murder someone to be more dangerous than someone who acted out of passion. Thus, a prosecutor might need to find evidence of that additional planning and preparation. Did the defendant purchase a gun just before the murder? Did he practice shooting the gun in the week before the murder?

Likewise, the defendant may have prolonged the murder and caused additional pain and suffering. He may have committed the murder in front of the victim's children. He may have used illegal or banned weapons. There are many possible reasons for a judge to find the defendant worthy of a greater punishment, and the prosecutor may need to find evidence to support those reasons.
However, just as the prosecutor may want to find evidence of aggravating circumstances, a defense attorney may want to present evidence of mitigating circumstances. These are factors that do not excuse the crime, but may make the defendant seem less blameworthy. These may give a judge a reason to sentence the defendant with a lower punishment. For instance, if the defendant shot the victim, but then tried to save his life. This show of immediate remorse does not excuse the defendant's actions, but may influence a judge to be more lenient.

d. Benefits or Instruments of Crime

The criminal law in many countries often requires the prosecutor to confiscate anything used to commit the crime or the material proceeds of a crime. The items used in the crime, often called the "instruments of the crime," can include a car used to escape from the crime scene, a weapon used during the crime, a building used to house the criminal activity, or any other asset which helped the defendant to commit the crime. A prosecutor must find evidence which links those assets with the commission of the crime.

For instance, if the defendant in the murder scenario above had used his new car to move the dead body, that new car would be an instrument of the crime. How would you prove that, however? Perhaps the physical evidence shows that the body was moved from the house where he was killed to a field outside of town. There is blood and hair that matches the victim in the trunk of the car. In addition, there are tire marks in the field where the body was found that match the tires on the defendant's car. Not only would the car be evidence in the criminal proceeding, but it would also be subject to confiscation.

The benefits of crime can be more difficult to prove, depending on the standards required by the local law. In general, a prosecutor should provide evidence that a crime occurred and that it resulted in a benefit or a profit. A simple example would be a bank robbery. After the bank robbery, the defendant has a bag full of cash. That bag of cash is evidence of the crime. But what if he uses that bag of cash to buy a new car? Then that new car is a benefit or profit from the crime, and should also be confiscated. But how would the prosecutor prove this? If the person who sold the car testified that he was given a bag of cash for the car, the proof would be simple. However, it is more likely that financial records would need to be used. This will be discussed later in the book.

e. Procedural Requirements

Some procedures in criminal law require the prosecutor to present evidence to the court. For instance, the prosecutor may need to present evidence to the court to justify an order to search someone's house or obtain an order for covert measures. The prosecutor may need to present evidence to the court to justify the imposition of pre-trial detention on remand. Often, these procedural requirements do not need conclusive evidence of guilt, but a reasonable suspicion or grounds. This is still an evidentiary burden for the prosecutor to satisfy.

For instance, many jurisdictions allow the court to order a defendant to be held in detention prior to the indictment, or detention on remand. This does not require the prosecutor to prove that a defendant committed the crime, but to give evidence which provides reasonable grounds to believe that it is likely that the defendant is guilty. But that is not enough. Often, the prosecutor also has to show evidence
which shows that the defendant is likely to flee from justice if he is released, or that he will threaten witnesses, destroy evidence or commit a similar crime.\footnote{For instance, Article 5(1)(c) of the European Convention on Human Rights permits a defendant to be held in detention after showing reasonable suspicion of having committed the offence or when it is "reasonably considered necessary to prevent his committing an offence or fleeing after having done so."}

The prosecutor thus has to provide evidence that not only gives reasonable grounds for the judge to think that the defendant might be guilty, but must also give evidence which satisfies one of the other requirements. He might offer evidence that the defendant has a passport and a plane ticket to another country for the coming week. He might offer evidence that the defendant has threatened a witness or has committed a series of similar crimes.

f. Burden and Standards of Proof

In this chapter we have briefly discussed what must be proven. We have not discussed who must provide the proof and how convincing that proof must be. These two factors are called the burden of proof and the standard of proof.

In most countries, the burden of proof is on the prosecutor who must provide evidence that overcomes a presumption that the defendant is innocent. The presumption of innocence is enshrined in Article 6(2) of the European Convention on Human Rights and Article 11(1) of the Universal Declaration of Human Rights. This requires the prosecutor to present evidence first. In some circumstances there may be a shifting burden of proof, sometimes called a reversed burden of proof. Even when the burden of proof shifts to the defendant, this does not relieve the prosecutor of an initial need to offer evidence.\footnote{See Grayson and Barnham v. the United Kingdom, 19955/05 and 15085/06, 23 September 2007 (Para. 37-51)(finding that a shifting burden of proof for confiscation which still requires the prosecutor to establish an initial criminal offence to comply with Article 6(1)).}

For instance, some countries have a shifting burden of proof that allows the confiscation of assets. If the prosecutor in those countries can show that a defendant, often a public official, could not afford a particular, expensive asset through legitimate income, the burden shifts to the defendant or the owner of the asset to show that he or she did obtain the asset legitimately. However, the prosecutor still had to provide evidence that the asset was far more valuable than the public official could legitimately afford. In order for a shifting burden of proof to comply with Article 6(1) of the ECHR, the prosecutor still has to provide evidence that a crime occurred.

Thus, the burden of proof is a clear concept, often requiring the prosecutor to offer some proof to the court first. However, the standard of proof is often a most abstract concept. The most basic standard of proof is "reasonable suspicion." For example, Article 5(1)(c) of the European Convention of Human Rights requires a "reasonable suspicion" that a person committed an offence before that person can be detained. This means that the evidence that a prosecutor provides must establish a "reasonable suspicion" that a crime was committed by the defendant. What does reasonable suspicion mean in this circumstance? Under Murray v. The United Kingdom, 14310/88 (GC)(28/10/1994) Para. 63, the Grand Chamber of the European Court of Human Rights considered that reasonable suspicion required the existence of facts or information which would provide a plausible and objective basis for a suspicion that the defendant committed the crime.
Thus, the most basic and minimal standard of proof requires "facts or information" which provides a basis for a suspicion that the defendant committed the crime. That basis must be "objective," which means that any reasonable person would conclude that the facts or information supports that conclusion. The basis must also be "plausible," which means that the conclusion must logical and possible. In other words, a reasonable suspicion requires the prosecutor to offer some evidence ("facts or information") which plausibly and objectively supports a suspicion of guilt. It cannot be speculative or not based on some evidence.

This is a subjective standard, which means that it is not exact or precise. It does require some evidence to be offered by the prosecutor, however. Some jurisdictions also have higher standards of proof, such as "grounded cause," "probable cause" or "well-grounded suspicion." These would require greater levels of evidence which demonstrate guilt with greater certainty.

g. What does proof really mean?

Historically, the proof of a crime was very straightforward. Early and Medieval European disputes were settled by a community's leader or the representative of a monarch. Allegations of wrongdoing against a person were supported by a witness who took an oath. This has been referred to as "irrational proofs," the allegation of a crime supported by an oath or an ordeal. An allegation could also be supported by "oath-helpers," people who are not witnesses but take the oath in support of the allegations. This was primarily a means to ensure that the community supported any final adjudication, rather than to determine accurate facts. Any material evidence, such as documents or physical evidence, had far less importance and simply supported the allegations by bringing the accuser "closer to the oath." The defendant could often only reply to the allegations by himself taking an oath and denying the charges.

Within the past few centuries, however, evidence became "rational." This means that it became logically related to the charges and, hence, the accuracy of the proof was far more important. The rationalism often led to the belief that courts examined evidence in pursuit of "the truth." Of course, the mechanism that could reveal the truth with ultimate accuracy would be a time machine, by which the judge and parties could travel back and observe the events without the filters, faults and biases of witnesses and evidence. The court could travel back many times, to many locations, and observe all the events from many different angles, listen to people as they speak and watch them as they act. That would give the court as close to 100% accuracy as could be possible.

As we move away from the accuracy of a time machine, what does proof mean? Are we accepting a lesser degree of accuracy? Does this mean that we are approximating the truth? Are we inferring the truth from facts which are incomplete? This is often the case in criminal trials. Many legal scholars consider that inferential reasoning is important to improving the evidence in legal systems. Some legal

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5 Id. at 220.
6 Id. at 222. The oath taking was often an alternative to feuds. Thus, community approval and peace within the community were more important than the accuracy of the proof.
7 Id. at 4.
8 See Twining, W. "Taking Facts Seriously - Again," Innovations in Evidence and Proof, Integrating Theory, Research and Teaching, pg. 68 (Roberts, P. and Redmayne, M. Eds.) (Hart Pub. 2009). Twining cites Jerome Frank, who said "90 per cent of adjudication and pre-trial work is more concerned with doubts and uncertainties" and
scholars even conclude that courts and practitioners are making decisions based on the probability that the facts support a conclusion.9

Thus, as we better understand evidence we see that we do not have the tools or the ability to find the truth. Rather, we have the tools and abilities to find evidence which helps the court infer the truth. This inference may be based on probability. If the court travelling back in a time machine to observe the crime provides the highest degree of certainty (it may not be 100%, but it would be high), speaking to witnesses and looking at other evidence provides some degree of certainty less than 100 per cent. In other words, we are making the best guess about the truth that can be made with the available evidence. Sometimes that proof assures the judge that guilt has been established with high enough probability to support a conviction. Sometimes the proof does not support a high enough probability, and the defendant is acquitted.

Some might wonder, though, whether having an eye-witness is similar to having a time-machine. After all, the person was present at the crime and is testifying about the event. As we will examine in the next chapter, however, witnesses are imperfect time machines at best. They only see one small slice of the event. They may not have been prepared to observe and remember everything. They may have limits on their observation or perceptions, such as poor vision. They may have biases or reasons to actively lie. Even if they saw the event perfectly, their memories may be imperfect and they may need to rely on other evidence to help them testify accurately.

Thus, proof and evidence should be seen as helping to improve the accuracy and probability of one story. The prosecutor may focus on finding evidence which improves the probability of a story where the defendant is guilty of a crime. The defendant may focus on evidence which decreases that probability, or by making the prosecutor's evidence seem less certain or trustable.

h. Conclusion

Before a prosecutor or a lawyer begins to collect evidence, he or she should be keenly aware of what must be proven. Each criminal offence can be broken down into elements which need to be proven, and often different sources of evidence should be used to prove each element. While the prosecutor can establish guilt by providing sufficient evidence to prove each element of the crime, this may not be sufficient. The prosecutor should also gather and present evidence that demonstrates that a crime requires higher

9 See Anderson, T., Schum, D. & Twining, W., Analysis of Evidence (2d Ed.). Pp. 246-251 (Cambridge Univ. Press. 2005). "There are no conclusions reached in legal disputes that can be stated with absolute certainty. Consequently, the use of probabilistic concepts is as common in inferences in law as it is in inferences in other contexts." Id. at 246. This is why we have standards of proof, such as reasonable suspicion or probable cause. Anderson, Schum and Twining list five basic reasons why decisions based on evidence are almost always probabilistic. First, the evidence is almost always incomplete. A judge always wishes he or she had some other piece of evidence to consider. Second, often evidence is inconclusive. This doesn't mean it isn't convincing, but it may support multiple conclusions. The criminal being seen in a red car does not conclusively mean that the suspect who owns a red car must be the criminal. Third, evidence can be ambiguous, which means that it doesn't actually support any one conclusion. A letter from one person to another may demonstrate a motive for a crime, but it may not. Fourth, a body of evidence may be dissonant, which means that the many different sources and items of evidence may not all support the same conclusions. Finally, the sources of evidence, such as witnesses or the source of a document, may not be fully credible. This means that there may be reasons to doubt the evidence.
punishment, establishes that the crime caused damage to the victim, establishes that assets should be confiscated, or supports a procedural requirement, such as detention on remand. Prosecutors also have the duty to find evidence that supports innocence, if it exists. The defense attorney should focus on evidence which supports an argument for innocence, a lower sentence, or to persuade the court to not order detention.

Each party should know what needs to be proven. Evidence should be related to those goals, and each party should be thinking about evidentiary issues as early as the criminal investigation. In many systems, the main trial provides almost no opportunity to adequately gather evidence or sufficiently challenge evidence. Thus, the prosecutor, defense attorney and even the representative of the victim should all consider how to obtain relevant evidence during the investigation, which will then improve their case at trial.

In the next chapter, the sources of evidence are discussed. Practitioners should be aware that evidence may have different qualities depending on the source, which will be discussed in later chapters. This is not an unusual revelation, as most people would give more credit to the video from a security camera over the testimony from a witness. In later chapters, we will discuss why we give more credit to some evidence over other evidence.
Review and Problem Set

**Review:**

Once an allegation is raised, the practitioner should determine what elements need to be proven. In order for a criminal offence to have been committed, certain conditions or acts must have occurred. These conditions or acts are the elements of that crime. A criminal offence will require certain actions to be committed and may also require the offender to have an intent to commit the crime. Evidence of those actions and conditions are required. Further, there are additional things that often must be proven, such as aggravating or mitigating circumstances which can justify higher or lower sentencing, links required to prove that property or funds should be confiscated, or conditions required for pre-trial detention to be ordered. In some systems the prosecutor must also establish jurisdiction. There must be evidence which satisfies all of these conditions.

**Problem Set:**

1. Article 249(1) of the German Criminal Code defines Robbery as:

   *Whoever, by force against a person or threats of imminent danger to life or limb, takes property belonging to another with the intent of appropriating the property for himself or a third person, shall be liable for imprisonment of not less than one year.*

   Identify the elements that need to be proven to establish the crime of Robbery in Germany.

2. Article 5 of the European Convention on Human Rights does not permit a person’s liberty to be deprived except under certain conditions. Article 5(1)(c) permits a person’s liberty to be deprived in accordance with the law following a lawful arrest when there is a reasonable suspicion that the suspect committed an offence and “when it is reasonably considered necessary to prevent his committing an offence or fleeing after having done so.”

   Identify what evidence might demonstrate that a suspect may commit another offence or may flee after committing an offence.
3. What reasons might justify an increased sentence for a criminal offence? What reasons might justify a lesser sentence for that same criminal offence? What evidence would you offer the court to demonstrate these aggravating or mitigating circumstances?
1. First Element: Using force against a person OR a threat of imminent danger to life or limb

   Second Element: Takes property belonging to another person

   Third Element: With the intent to appropriate the property for himself or a third person.

2. A reasonable suspicion that a person is likely to commit another criminal offence could include past convictions for similar crimes, statements made to others that the suspect intends to continue committing other crimes, or threats against witnesses. There are other possible sources of evidence, depending on the type of crime. A reasonable suspicion that a person may flee the jurisdiction after the crime could include preparation that the suspect has made (packing his luggage, buying a bus ticket, calling friends outside of the jurisdiction, renewing a passport) or constant travel out of the jurisdiction in the past for work or family.

3. Each legal system may have different requirements in the law to justify a higher or lower sentence. Some typical reasons to increase a sentence is if the criminal offence was committed with violence or while armed with a weapon, or if the offence was committed while using “hate speech” against a particular protected group. Other reasons can justify lowering the sentence, such as the defendant taking prompt action to prevent harm after the crime occurred, reporting the crime to police himself or herself, or pleading guilty.
Chapter 2
How is proof obtained?

Some practitioners view a trial as a review by the court of the evidence collected during the investigation, which then somehow determines the truth from it. However, all evidence is not the same. The source of evidence can often alter the quality of the evidence. Furthermore, if evidence is obtained with an understanding that it has different qualities and problems, the quality of the evidence can be improved long before the main trial. Thus, a prosecutor, advocate or pre-trial judge should all know how each source of evidence differs and why.

A prosecutor or advocate should also have a theory of the case. The prosecutor looks at the evidence and allegations and poses a hypothesis of how the defendant committed the crime. A defense attorney may offer an alternative theory which reduces his client's guilt. Evidence often supports a final conclusion or a final element that helps support one of those ultimate theories. For example, a witness may describe a criminal escaping in a red car. If the defendant has a red car, this doesn't prove that he is guilty, but it does support that theory.

The different sources of evidence can also support one another. These different sources can include witnesses, documents, physical evidence, and other types of evidence. The witness who described the criminal escaping in a red car is one source. The automobile registration documents which show the defendant owning a red car is another source. The physical red car can be a third source of evidence. The witness may have remembered poorly, though, or have had an obstructed view of the car. Maybe she isn't sure if the car was a Volkswagen or a Peugeot. Maybe she is biased against the defendant for some reason.
The registration documents are more likely to be unbiased and accurate. Hundreds of cars are registered every day and there is very little reason to intentionally change such records, especially if it is done well before the crime occurred. If the registration documents reveal that the defendant owns a red Volkswagen, then it is likely to be accurate.

The defendant's car is another source of evidence. It may have been registered as a red car, though, but perhaps it is now covered with weeks of dirt and is brown. Could that really be the car that the witness saw? Maybe it was in an accident and couldn't have been driven. That adds more information that confounds the prosecutor's theory, but helps the defense theory. But perhaps it is a bright red car and the witness recognizes it later. That information supports the prosecutor's theory.

Empirical research has shown that fact finders, such as judges and juries, as well as prosecutors and advocates, consider past events to be true by relating to the facts as a story, rather than evaluating the evidence and arguments critically. In other words, people tend to rely on stories to decide legal issues such as guilt or innocence. The prosecutor's theory of the case, if cohesive and supported by strong evidence, can be a compelling story that resonates with the judge or fact finder. Similarly, if the defense attorney can either present a story that supports innocence, or successfully questions the evidence that supports the prosecutor's story, then the judge may find the defendant not guilty. The psychological influence of stories on a fact finder does not relieve a practitioner of the need to understand evidence. In fact, the ability to present strong evidence which supports the story or to question that evidence depends on the lawyer having a deep understanding of evidence.

Thus, evidence doesn't exist in a vacuum. The source of the evidence often has an effect on how that evidence is perceived, or how much that evidence supports or undermines the prosecutor's theory of the case. It is worth discussing some of the most common sources of evidence.

a. Witnesses and Victims

Probably the most common source of evidence is from the statements and testimony of witnesses and victims. After all, they observed some important fact about the case and should be able to describe it. But how well do they really describe evidence? How well do they remember what happened? How much help do they need to accurately remember something?

1. Memories

Instead of thinking about witnesses and victims as homogenous sources of evidence, let's think of them as people who are trying to remember something. Some events are easier to remember because they are unusual. Some facts are simply too big to ignore, such as whether a person was killed. However, some events are difficult to remember because they are routine or unremarkable.

A witness who sees an unusual or unexpected event may be more likely to remember details of the event. For example, the witness may have observed a bank robbery, which doesn't happen to that witness every day. However, the event may have been unexpected, fast and full of confusion. The witness may have been afraid or affected by increased adrenaline. The witness may not have been able to observe everything clearly. Sometimes a witness' mind "fills in the gap" with information that they actually didn't

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10 Twining, Rethinking Evidence. Chapter 11. Fn. 34.
observe. Furthermore, some research on memory suggests that rather than remembering the event, a witness remembers the last time they described the event.\footnote{This process is called "memory reconsolidation" and occurs because memories are a combination of pathways in the brain and protein synthesis. The proteins are reformed everytime that memory is accessed. In fact, drugs can inhibit those proteins from being re-created, thus preventing a person from remembering that fact. When we are remembering an event, we are thus not remembering that event as it happened. We are re-accessing a memory which was formed and then reformed each time we try to recall the event. This leads to subtle changes each time. This can make them much less accurate, especially over time or as they are continually remembered. See Nader, K., Schafe, G. & Le Doux, J., "Fear Memories require Protein Synthesis in the Amygdala for Reconsolidation after Retrieval," \textit{Nature}, Vol. 406, Pp. 722-726 (August 17, 2000). \textit{See also} Nader, K. & Hardt, O., "A Single Standard for Memory: The Case for Reconsolidation," \textit{Nature Reviews: Neuroscience}, Vol. 10, Pp. 224-234 (March 2009) (arguing that memories are dynamic and, especially after protein reconsolidation, are unstable). Hardt, O., Einarsson, E. & Nader, K. "A bridge over troubled water: Reconsolidation as a link between cognitive and neuroscientific memory research traditions," \textit{Annual Review of Psychology}, Vol. 61, Pp. 141-67 (2010). As noted by neuroscientist Joseph Le Doux, "The brain isn't interested in having a perfect set of memories about the past. Instead, memory comes with a natural updating mechanism, which is how we make sure that the information taking up valuable space inside our head is still useful. That may make our memories less accurate, but it probably also makes them more relevant to the future." \textit{Quoted in} Lehrer, J. "The Forgetting Pill Erases Painful Memories Forever," Wired, (February 17, 2012). Since the testimony of a witness depends on the accuracy of their memory of a past event, a practitioner should be cautious in depending solely on the details of a witness unaided by any corroborating proof. Especially after being revisited many times, scientific studies suggest that those memories may no longer be accurate.} Thus, if a witness has retold the story and subtly changed it each time, it is possible that the testimony will reflect those changes. However, the witness will remain convinced that they are describing the actual event.

However, some important testimony will describe a routine or unremarkable event. A bank robbery has danger and is unusual. Let's suppose the allegation is corruption. A bank witness who simply describes whether a government official deposited cash into her bank account may not find such an act unusual. In fact, it's probably so routine that the witness would not specifically remember it without seeing the bank's deposit records. If the witness is asked whether they remember the transaction, they would truthfully say that they don't. This doesn't mean that the event didn't happen, nor does it mean that the witness can't testify.

As an example, think about what you had for breakfast this morning. It is recent and may even be the last mean you've eaten. Maybe you always have the same thing for breakfast, so it is easy to remember. It has become a routine. However, it is unlikely that this morning's breakfast is a strong memory. It is even less likely that you would remember a breakfast you had last week, or last month. If I asked you what you had for breakfast on March 14 of last year, it is extremely unlikely you would remember. However, if you always have the same breakfast every morning, you would be able to testify that you normally have an egg, toast and coffee. There would be a high probability that that would have been true.

The same technique could be used if a bank teller was asked about a specific transaction. She might explain how the transaction would normally be conducted. She might look at documents to confirm that the transaction happened as it normally would be conducted. The process might even spark a memory about the specific transaction. However, even if it didn't, there would be a high probability that the witness could explain what had happened.

If I asked what you had for dinner at a restaurant last night, you would probably have a good memory and could even describe what other people ate. However, if I asked you to tell me where you ate dinner on March 14 of last year, it is extremely unlikely you would remember a dinner you had last week, or last month. If you always have the same breakfast every morning, you would be able to testify that you normally have an egg, toast and coffee. There would be a high probability that that would have been true.
March 14 of last year, you would probably be unable to answer. However, if you looked at your email or text messages, you might find that you sent a message on March 14 to a friend asking to meet for dinner that evening. This message might allow you to remember that dinner and associate it with the correct date. Do you remember independently remember that the dinner happened on March 14? No, of course not. But by looking at your email, you are able to testify about the dinner. There would be a high probability that your testimony was true.

As an exercise, open your email and look at messages you sent or received last year. Many of these were important messages that you would have remembered with great detail a year ago. Perhaps you struggle today to even recall what the email was about. A person does not remember facts as if they were a computer. Most people store facts in diaries, calendars, email and other documents. They don't have to remember the facts, but they know how to retrieve the facts. If you look at several emails from a year ago, it's likely that you will begin to remember what the topic was about. However, if someone asked you to testify without even reviewing those emails, you might have falsely stated that you weren't involved. You wouldn't have been intentionally lying, but you wouldn't have been telling the truth.

Thus, when we consider witness testimony, we have to first understand that a witness is neither a computer nor an automatically truthful segment that a prosecutor can simply call to the court to testify. Memories sometimes do not work like that. Some events or facts are big or difficult to forget, but they may come with obstacles. Some events are routine or too commonplace to remember. However, if the witness testified about a routine process, such as the bank transaction or the routine menu for breakfast, it would provide a high probability of being the truth.

2. Basis for Testimony

Assuming that the witness has a good memory of the events, or could refresh their memory with documents or other evidence, that memory can only relate what the witness could observe. The basis for a witness to testify includes the witness' ability to observe events, any limitation that the witness might have to observe events, the speed or confusion of events, or the attention that the witness was paying to events.

The primary question for any witness is to ask: how do you know these facts? A witness to a bank robbery may explain that they were in the bank to conduct business when the robbery occurred. They are thus in a position to see what happened inside the bank. However, if the witness had been told to lay on

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12 This was originally called "transactive memory," "group memory" or "group mind" as you wouldn't recall the facts, but would know who in your group to ask (or what book to look in). Psychological research strongly suggests that people normally do not remember well any facts that they have assigned to a friend, computer or to some other storage device. See Wegner D. "Transactive Memory: a Contemporary Analysis of the Group Mind," Theories of Group Behavior (Mullen B. and Goethels G., Eds.) (Springer 1986). This is now being called "google memory" because people now turn to google (or their email or text messages) in lieu of committing a fact to memory. See Sparrow B., "Google Effects on Memory: Cognitive Consequences of Having Information at our Fingertips," Science, Vol. 333 Pp. 776-778 (August 5, 2011). See also Wegner D. and Ward A., "How Google is Changing your Brain," Scientific American, (Dec. 2013), Pp. 58-61 ("We found that those who believed the computer had saved the list of facts were much worse at remembering. People seemed to treat the computer like the transactive memory partners that we started studying decades ago: off-loading information to this cloud mind rather than storing it internally. Strikingly, this tendency persisted when people were explicitly asked to keep the information in mind. It seems that the propensity for off-loading information to digital sources is so strong that people are often unable to fix details in their own thoughts when in the presence of a cyberbuddy.")
the ground, she may not have seen much but would have heard everything. A witness who was across the street from the bank, however, may have limited views of the events inside the bank. She may see what happened outside of the bank, though. Both may be able to provide different levels of detail, viewpoints and kinds of information.

Not only should a practitioner wonder how a witness knows about the event, but also how well that witness could observe it. The witness who was blindfolded has an obvious limitation. What if she had eyeglasses? What if she had poor vision that she hadn't corrected with eyeglasses? For the witness across the street, were there trees between her vantage point and the bank? What if they took medicine which normally affects their attention or makes them sleepy?

The basis of someone’s testimony is not limited to their placement and ability to see and hear. A person who was the accountant for a company has a much better basis to know whether money was embezzled from a company than the janitor. They have better education, better knowledge about the topic, and constant access to the financial information. That accountant has a basis to know about the financial transactions of the company.

Not only do the memories of witnesses influence their testimony, but the basis that the witness has to testify can also influence their testimony. A witness may not tell you that they have difficulty seeing or that they take medicine which makes them sleepy, but this would be important to know. A witness who claims to identify a defendant as the bank robber is a critical witness. However, if that witness has poor eyesight and saw the bank robber from across a busy, tree-lined street, it does raise doubts whether the identification is accurate or reliable.

### 3. Bias

A person may have a perfect memory of an event, had an excellent view of the event, and could perceive it without any difficulty. However, a person may have a conscious or unconscious bias that could alter their perception or testimony. What could create such a bias? Some people have a bias against groups of other people. They may be more willing to blame a crime on a racial or ethnic group, or a gender. The witness may unconsciously consider the suspect to be a member of that group. The witness may also consciously want to blame that group.

Bias can be part of any testimony. An accountant is more disposed to see problems with money. An engineer is more disposed to see engineering problems. A lawyer is more likely to discuss the legal issues of an event. A police officer, doctor, or nurse will have similar bias. They may not see certain details as important because it doesn't conform with their normal interests or concerns. The degree of such bias may range from tiny to very relevant. For instance, an accountant may overhear a conversation about transferring funds. Because he is so interested in international transfers of money, he neglects to pay attention to why the funds are being transferred. This doesn't mean that he didn't hear that reason, but he just didn't focus on it. He thus wouldn't be able to testify about it. He may even say that it was never discussed. However, his testimony varies from what actually happened because of his bias towards his strong accounting interests. On the other hand, a police officer would have probably paid attention to the reason for the funds being transferred, but may not have paid as much attention to the technical details.
In other words, a witness' biases or interests may alter how they perceive events or how they remember them. It can be difficult for a practitioner to identify the bias that a witness might have. A person who has a bias against an ethnic group or gender will be reluctant to admit it, especially in court. A person who has an attention bias, such as the accountant, will also be reluctant to admit that he or she pays undue attention to one fact and neglected others. In their mind, they heard everything that was important and are testifying to everything that they know.

Witnesses can provide excellent information about the criminal offense, circumstances that mitigate or aggravating circumstances, assets to confiscate, damages or other important issues. However, it is important to know the limits of witness testimony. A lawyer can demonstrate how strong, reliable and relevant a witness' testimony is by supporting it with other evidence. A witness who not only remembers an event, but then can look at his email and confirm that he talked about it on a particular date and time lends much more credibility to the testimony. A witness who describes what is also on a videotape is likely to be seen as accurate.

A witness, however, can't be seen as automatically able to recall all facts and details without help. Memories can be inaccurate and people tend to rely on other people, notes or computers to store their memories for them. A witness may need help to recall an event accurately. While this also holds the risk of influencing their memories, there is mounting scientific evidence that the memory of a witness is also susceptible to error and gaps. For a strong case to be presented, that testimony should be combined with other evidence in order to provide as complete a picture as possible.

b. Documents

A witness can have reasons to be inaccurate or biased. Documents also are subject to having different qualities, depending on how it was made, why it was made, who made it, and whether it is relevant or consistent. For the purpose of this section, documents also include photographs or videos. It is important to understand what the document purports to be, how and why it was created, and to even dissect parts of the document. What kind of documents can serve as evidence?

1. Documents created Routinely

Of course, there are official documents that can establish a fact. A valid passport, for instance, can establish that a person has citizenship with that country. A certified judgment from a court can establish that a person was convicted of a crime. Official documents can show that a person was employed in an official position, that they entered or exited the country, or if they own a car. There are also business documents which can establish certain facts, such as telephone or bank records. These official or business documents are created as part of a normal routine and aren't normally prepared in order to specifically prove a fact at trial. Since they were created as part of a normal routine, and may have even been officially stamped or certified as official documents, there is a greater degree of belief that the document is unbiased and is accurate. When a business or government creates a normal document as part of a regular routine, this increases the credibility of the document.

However, in order to better understand the document, the routine should also be understood. For example, lets consider an allegation that the defendant fraudulently obtained a loan from a bank by claiming a falsely inflated income. The bank's loan documents would obviously be relevant. Did the
defendant complete an application? Did he or she sign the application? Did the bank ask any questions about the application? Did the bank official take notes or ask for proof of the income? If this is a routine procedure for every loan, then the bank official's note which further describes the defendant again claiming to have a high income is more credible because he asks this question of every person seeking a loan. What if the bank official said that it was unusual that he asked for more proof about the defendant's income, because he found it so difficult to believe him? Does this make the bank records even more important or relevant?

As another example, a hospital record may show that the victim arrived by taxi at the hospital with a stab wound at 11:30pm, stating that he was stabbed by the defendant a half-hour before. The hospital treats many people routinely and writes down their medical complaints and conditions each time. This is a routine. The nurse writing down the information has no reason to fabricate facts. Assuming she heard the information correctly and wrote it down accurately, there is a good reason to believe that the witness did make that statement at 11:30pm.

The routine or process can also be faulty. For example, the defendant has a stamp on his passport saying that he entered the country on March 1, 2013. However, the official border record doesn't show that he did enter. Which is correct? By asking more about the process, though, we find that a power failure on March 1, 2013 prevented any records being made by the border authority. Instead of having two contradictory documents - a stamped passport and a border record that doesn't show an entry - we have a much more consistent and believable body of evidence.

Thus, if the process behind the document is unreliable and faulty, it makes the official document less credible. A phone company may not be able to show calls received from outside of the country, for instance. Thus, you may not be able to trust the phone records to show all of the phone calls received by the defendant's phone. The border records mentioned above, if based upon an unreliable border management software, may not be a very reliable document. If the court's records are incomplete or computerized, very little credibility may be attached to an official document certifying that a person has never been convicted. A security camera may not give reliable information, for instance, if the time-stamp is incorrect.

Thus, an official document is really a reflection of a routine or process as well as establishing a fact. If it isn't challenged or inconsistent, the court will probably accept it as true. However, a practitioner can look more closely at the routine and procedure behind the document's creation. After such an understanding, the document may establish a fact even more strongly, or it might not establish the fact at all. The more routine, normal and reliable the underlying procedures are which created the document, the more likely the document is to truly establish a fact.

2. Documents created by a party or witness

Documents are not only created as part of an official or business routine. Often, the party or a witness also created the document. In the example above, the defendant submitted a written loan application to the bank in order to get the loan. He signed the loan application and the information was entered in his handwriting. The defendant created the document, but it was received by the bank official. Perhaps the bank official can even testify that he watched the defendant complete the application and sign it. In a
way, this document becomes part of the testimony of the defendant. If he submits to questioning, the defendant could be asked to identify his signature and whether he filled out the form.

Let's assume that the defendant also filled out a declaration of income, either because of taxes or because anti-corruption laws require it. The defendant has filled out an income on the declaration that is less than half of the income he claimed on the loan application. They both have the same signature and were both completed in the same month. Suddenly, these two documents appear to be conflicting statements by the defendant, and they support an inference that he lied on one of them.

A document by a witness can also be a routine act, such as sending an email, a text-message, uploading a photograph to Facebook, keeping a financial spreadsheet or writing a note in a calendar. As noted above, the witness' memory may treat that information differently. The witness may need to look at their email, computer accounts or text messages in order to fully remember the fact. Even if the witness doesn't remember, they can explain that they are the only person to use that email account, that they normally use that email, and that they believe the email to be one he or she wrote, even if they don't specifically recall doing so.

Like official or business documents created as part of a routine, some documents are created by witnesses, victims or defendants that are material to the criminal proceedings. They are created during everyday life and routines of those people, or were created during the excitement of the criminal offence being committed. They are also created contemporaneously, either as the event is taking place or soon after. This gives the documents an elevated degree of accuracy. There isn't a high likelihood that the documents were created in order to influence the criminal proceeding, and the documents may help improve the quality of the testimony of the witnesses or the statements of the defendant.

3. Documents created for litigation

Many documents are created routinely and as part of a normal day-to-day experience. Some are created as an event is happening, such as people taking photographs of a shooting in the street. However, if the document was created in preparation for the criminal proceeding, it may have additional motivations and bias. A medical exam meant to support a victim's claim may omit other possible reasons for the victim's medical issues, for instance. A defendant may try to offer character witnesses to tell the court that it would be out of character for him to have committed the crime. Evidence that was created by a party for the litigation often has some intentional or unintentional bias.

On the other hand, some evidence which is created in anticipation of the criminal proceeding may not have that bias. A police report, a forensic laboratory report, or information from an investigating agency may have been prepared with an expectation that it will be used in court. However, since the normal routines of the police, forensic laboratory or other agency is to prepare reports for courts, there isn't a high, specific motivation for the document to be biased. This doesn't mean it may not happen, but the risks are lower.

4. Mixed Documents

Many documents are actually a mixture of several kinds of documents. In fact, you may consider parts of one document to be a routinely created document and another to be one by the defendant or the witness. For instance, the defendant routinely sends money to the Ukraine by a wire service. The wire service has
a normal procedure and standard forms. Every time the wire service sends or received money, the same
thing is supposed to happen. Thus, the wire service officer should be able to explain the routine, testify
that the documents conform to the routine, and that this means that the defendant gave cash to the wire
service to send funds to the Ukraine.

But there's something else on the document. Part of the routine is for the defendant to fill out the
document. The defendant filled out the amount, the date, and to whom he was sending the money. He
also signed it. This makes the document both a routine business document and a kind of statement by the
defendant.

Another kind of mixed document might be records from the phone company of text messages. The
telephone company routinely collects the information electronically for a short period and a court ordered
it to disclose it. The record is, thus, a routinely collected business record. However, it is also a
contemporaneously recorded statement by a defendant or a witness. It might help the witness remember
the time that the crime took place, or what he told his wife about the crime after it happened. The
document has different qualities and can serve different roles as evidence.

c. Physical Evidence

Witnesses and documents usually provide information in a very recognizable, verbal or written manner.
Some evidence is just as important to criminal investigations and trials, but may need someone to explain
what the evidence means. After all, without any context, it may simply be an everyday object. A kitchen
knife sitting in your kitchen is not evidence. That kitchen knife found next to a dead body may be
evidence, especially if the person died of a knife wound. If there are traces of blood on the knife, it has
even greater evidentiary value. If that blood matches the victim, it is obviously quite relevant.

Thus, the physical evidence must also have a story that explains its significance. An Audi with many
bullet holes in the door and windshield tells a very stunning story all by itself. But did it belong to the
victim? Was it where the body was found? Did the police secure the car? Why is this bullet-ridden car
relevant to the case?

Beyond the physical evidence, the first additional fact to explain is how the physical evidence was found.
This can often be done by the police officer who collected the evidence, and should be accompanied by
photographs, a map of where it was found, and the correct method of collection to preserve other
evidence, such as fingerprints or DNA. This should all be recorded by the police officer overseeing the
collection of the evidence, which helps to tell the facts that explain why the evidence is relevant.

How do we know that this is the same evidence? Many jurisdictions require the police to keep a "chain of
custody" which ensures that the person who collects the evidence gives it to someone else who keeps
custody of it. An unbroken line between the crime scene to the forensic lab to the main trial helps assure
the court that the evidence being offered is the same, and that it hasn't been tampered with.

Thus, the physical evidence by itself only has some meaning. It is important that the context and meaning
of the evidence be properly proven as well. No judge will doubt that a bag full of bullets is being offered
as evidence in the court. But a judge might doubt that the bullets were properly collected, or even that
these are the right bullets. If the system requires the prosecutor to order the evidence to be collected, this
raises even more questions. Did the prosecutor have training in evidence collection? What makes him or her competent to do so? Were all the bullets collected at the scene?

This raises the question: Does physical evidence have any meaning if it isn't handled properly? Let's consider an example. At the scene of a murder, the police see a knife and one of the officers picks it up from the floor. This obscures the fingerprints. He then places it on a table, so that when the police officer in charge of the investigation sees it, it isn't where the murderer left it. The physical evidence is still relevant, as it was found at the crime scene and is stained with the blood of the victim. We know that it was used in the murder. But its evidentiary value has been diminished by the unprofessional acts of the police, as it may not prove the murderer and it may not explain how the murder happened. The evidence can still be used, but it certainly has far less meaning.

While physical evidence must be accompanied with additional information to explain its relevance, it may also be "mixed evidence." A search that obtains a smart mobile phone just provides the physical evidence: a phone. The police report explaining that it was found in the suit pocket of the defendant provides that additional information about why it is relevant. Its phone number and SIM card are also registered to the defendant, further solidifying the link between the defendant and the phone. Recently taken photographs found on the phone of the murder victim and her house are documentary evidence which help complete the story. It thus supports an inference that he took photographs of her and her house before she was murdered. While it doesn't prove that he murdered her, it is relevant evidence.

In the end, physical evidence can be relevant, believable and convincing proof, but it requires additional information to explain what it is, why it's relevant and how believable it should be. If this additional information is missing, then the murder weapon is just another kitchen knife. Physical evidence can also be mixed, and may include documentary or even testimonial evidence. A computer, phone, diary or camera at the crime scene can include very relevant statements, images or information, but if the court doesn't understand how that computer or phone was obtained, it also makes the information less relevant or compelling. Sometimes that additional information comes from a police officer or his or her report. However, sometimes takes an expert to analyze physical evidence and present that additional information.

d. Expertise

An expert provides powerful evidence in court. They are often seen as neutral parties who are well educated, experienced and are providing the court with important, often decisive answers. However, an expert can also be biased, conduct faulty analysis, make mistakes or offer opinions which are beyond their expertise. If the opinion offered by an expert is given absolute reverence, however, none of these faults will ever be examined.

1. Bias towards a party or unassailability?

It has long been understood that an expert who is hired by a party has a conscious or unconscious bias to render an opinion helpful to that party.13 Some states required consensus to appoint an expert in civil cases, or the appointing of an odd number of experts in order to have a majority opinion by experts.14 In

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14 Id. at 37-38. The French Civil Code, for example, required the parties in a civil case to agree to an expert; otherwise, the court would appoint the expert. An odd number of experts, often three, were appointed "in order
criminal cases, there has been a stronger tradition in Europe for courts to appoint experts. While this removes the risk of strong bias towards a party, it does create an aura of unassailability.

When a court appoints an expert, there is a risk that the prosecutor or defendant won't challenge the expert. The expert will either be seen as neutral or as having been appoint by the court, which the prosecutor or defendant won't wish to offend. In such circumstances, the court transfers its decision-making power to the court's expert because the judge may not be able to understand or challenge the reasoning of the expert. The court may not know whether the expert conducted the correct analysis or whether the expert even used the correct methodology. The court won't know the latest scientific reasoning. The parties and the court may not have the knowledge to challenge the expert's methods and reasoning.

2. Bias towards a methodology

An expert may not just have a bias towards a party, but may favor one method over another. This may be decisive in a case. Let's consider a medical expert in a criminal case appointed by the judge. This expert is a professor at the medical school and has published extensively on the relevant topic, strongly preferring a particular method (Method A). The expert examines the victim using Method A. That method results in an opinion that supports the defendant's guilt. Does this expert have any bias?

Let's consider a second expert. This expert also teaches at the medical school and has published extensively on the topic. However, he has been arguing in the scientific press for Method B, claiming that it is more accurate and has fewer results that are false. Because the first expert has made a reputation based on Method A, he is unwilling to even consider Method B. However, many other medical experts consider Method B to be very reasonable. In other words, the scientific methodology has not been decisively settled. The expert is appointed by the court and examines the victim using Method B and issues an opinion that supports the defendant's innocence. In his report, he mentions that Method A is an alternative, but that it is not as accurate.

Neither expert has a bias towards or against the defendant. Instead, the experts have a bias towards a particular method which may give certain results. The analysis matters. The expert's analysis is very important. Scientific journals are filled with disagreement over methodology and conclusions. If a court selects one expert, that selection may also include an opinion based upon a particular methodology. If the court selects another expert, it may result in another opinion based upon another methodology or analysis. If the expert is appointed by the judge, a party may be reluctant to challenge the expert's opinion or methodology.
3. Bias towards Productivity

Even experts who are appointed by the court have an intrinsic bias to remain the court-appointed expert, so that he or she will unconsciously try to please the judge. For example, Annie Dookhan, a chemist who tested drug samples for a state laboratory in Boston, Massachusetts was recently sentenced to jail for 3-5 years. For two years she improperly handled the drug samples, forged signatures and falsified test results in over 40,000 drug cases. She also falsified her educational credentials and lied under oath. She claimed that her conduct was meant to improve her job performance, as she processed over twice the number of cases as other chemists in the state-run laboratory. As of October 17, 2013, 349 defendants have already been released due to the misconduct. Ms. Dookhan was a government employee at a government-owned forensic laboratory, but rather than being neutral, she was clearly biased towards providing convictions and improving her productivity at work.\(^\text{18}\)

4. Mistakes and Errors by the Expert

Similarly, if an expert is solely appointed by a court, there is no quality control of that expert's work. If that expert submits a paper to a scientific or professional journal, other experts will review that work and comment on it. In the courtroom, there would be no other expert who can review the work and point out mistakes, errors, or differing interpretations. One benefit of having multiple experts is that they will review each other's work.

5. Opinions not based on expertise

What makes an expert different from a normal witness? An expert has special training, experience, knowledge and capability to analyze evidence and give an opinion. Without that background, the opinion has no more validity than the opinion of another person. This information is important. What education does the expert have? Is it relevant to the opinion being given? After receiving that education, has he or she obtained sufficient experience in the field? Did the expert analyze the evidence? Has the expert performed that analysis before? How many times?

An expert can also offer many different opinions to the court within one report or testimony. Were all of those opinions based on his education, experience and the analysis that he conducted? For example, a body is found in the plaza next to the building in which he lives. His apartment is on the 7th floor. The body is taken to the medical examiner, who examined the body. The medical examiner is a trained physician with 10 years’ experience as a doctor and 4 years as the medical examiner. She conducts an autopsy using accepted practices. Based on her training, experience and the analysis she conducted, she can render an opinion about the wounds and the fall was the cause of death.

However, what if she gives the court the opinion that the body was found too far from the building for the death to be an accident or suicide? She asserts that he must have been thrown from the balcony and the death was therefore murder. Does her education in medical school give her any basis to say this? Did her experience as a doctor or medical examiner prepare her to make this conclusion? Did she conduct an

cases, the appointment of one expert versus another effectively decides the case, without any mention of alternative analysis.

experiment or perform calculations to make this very important conclusion? In this case, there are two pieces of evidence being offered, both of which must be evaluated separately. She does have the education, experience and analysis to give an expert opinion that the deceased was killed by the fall to the ground. She does not necessarily have the education or experience in physics to give an expert opinion on how far he would travel into the courtyard if he had jumped or fallen. She had not conducted an experiment to determine how far he would have travelled, or had performed any calculations about the effect of gravity, wind or air resistance. At most, she could say that she'd never seen a person who fell from the seventh floor fall so far away from the building, but she would not have a strong scientific basis to give an expert opinion. Thus, the court could accept her opinion about the death, but may reject the opinion that it was a murder.

6. Did the Expert examine Evidence Sufficiently?

In order to give an expert opinion about a matter in a case, the expert usually must examine other evidence. A medical examiner will conduct an autopsy of a body, obtain samples from the body and conduct laboratory tests. A financial examiner will review financial records, bank records and transactions to determine whether money had been laundered. A fingerprint expert will have scrutinized the fingerprints of the suspect and those collected from the scene of the crime. A computer forensic expert will have received a computer or hard-drive and will have retrieved data from it. Unless the expert is giving general testimony about normal practices or technical information in the field, he or she should have been given an opportunity to examine the underlying evidence.

As an example, a person is injured by machinery in a small workshop. The court appoints an expert to determine if the machinery was dangerous. The expert never looks at the machinery in the workshop, but gives his testimony based on similar machines about which he is familiar. Is the expert's opinion valid? What if the machinery in the workshop had been modified with additional safety devices? It might be much safer than the machines the expert has seen. What if the machinery was in very bad repair? It might be far more dangerous than those other machines. Since the expert had never seen the machine that the case was about, how relevant is the testimony?

An expert may also not have access to all the information they need. A forensic accountant may be reviewing the financial records from all the banks in your country, but he sees that money is transferred to another bank outside of your country. He asks the prosecutor to obtain those bank records, but that country refuses to supply them. The accountant suspects that the funds are being laundered through that bank account, but he can't definitively say. He can offer an opinion, but he should qualify that opinion by stating that he has not seen all of the relevant evidence.

7. Methodology

Assume that the expert has the necessary education, experience and knowledge to analyze the evidence. Assume that the expert has access to all the underlying evidence that she needs. She will only give an expert within the boundaries of her expertise. However, how is she going to analyze the evidence? Is the method generally accepted within her field? Is it based on scientific or technically accepted practices? Are there other methods or tests which she could also have done? While some forms of analysis are very normal and routine, some might be outdated or controversial.
This is often where the evidence from an expert can become weak or strong. Let's use the example of the medical examiner who proclaims the body in the courtyard to be the victim of murder. She explains in great detail the autopsy, the x-rays, the laboratory test results and documents it with pictures and analysis. The person died because of the fall and not because of poisoning, illness or other causes. But then she explains that the person must have been thrown from the balcony. She cannot describe her analysis. She has no experiment or laboratory test to support the conclusion. She doesn't point to signs of a struggle, bruises from being pushed, or other physical signs. She just says it was too far from the building.

On the one hand, there is a very strong analysis based on standard scientific methods to conclude that the death was from the fall. On the other hand, there is absolutely no methodology to support the opinion that the death was murder. An expert's analysis may lie somewhere between these two extremes.

For instance, a forensic accountant may rely on normal accounting rules to identify whether money in a bank account was the proceeds of a crime. The accounting rules in many countries are "first in, last out," which means that once the proceeds of the crime are deposited into a bank account, it is assumed that the bank account is tainted until the last euro is removed. Some accounting rules may call for "first in, first out," which means that if 1000 euro of tainted money is deposited into an account, the first 1000 euro to be withdrawn then removes that taint. A simple change in the method used to evaluate the accounting can absolutely change the result of the analysis.

Thus, the methods used by the expert should be well-accepted in the field. They shouldn't be outdated, but they also shouldn't be so new that the methods are untested or unaccepted by others in the field. If there are several types or methods of analysis that could be conducted, the expert should be asked whether both were considered. She should explain what methods were used, what other methods were available, and why the methods used were selected. If the other methods might give different results, for instance, why should the court believe this method over another?

8. Conclusion

If the expert has created a written report, it should explain the choice of the analysis as well as the methodology and results. The written report gives the prosecutor or defense attorney an opportunity to review whether the expert is appropriate. Does the expert, in other words, have the right education and experience? The written report allows the practitioner to determine the opinions being given, and whether they are within the scope of the expert's competence. The expert may be giving more than one opinion, and each of those opinions should be supported by the education, experience and analysis of the expert. Did the expert have adequate access to the evidence to conduct his or her analysis? Finally, the practitioner can determine what kind of analysis was done and can even ask another expert to read it. Does it make sense? Are there mistakes or errors? Was there another kind of analysis that could have been done? Would that other analysis give a different result?

Finally, an expert has been asked to give a specific opinion to the court based on his or her expertise. That opinion should be the result of time and effort to look at evidence and apply scientific or technical skills. They should not be giving their own personal opinions, as it will be given greater weight than it should be given. Importantly, it is not the expert's role to give an opinion about the guilt or innocence of a defendant.
e. Substitute Evidence

Some evidence cannot be transported into the courtroom. The evidence may be too big, such as a car or a bullet-ridden house. The evidence may be dangerous, such as explosives, chemicals or biological materials. The original evidence may be unavailable, such as original documents in another country. However, criminal trials occur based on such evidence. Many times, there is a photograph or a copy of the original evidence. There may even be a laboratory report, police report or other report to describe the evidence.

There are obvious concerns that a practitioner has with substitute evidence. The most obvious is accuracy and credibility - does the photograph really depict the authentic evidence? Is the photograph really of the right evidence? Thus, the photograph or copy of the document needs to have a foundation. Who took the photograph and under what conditions? Multiple photographs of the crime scene by the police photographer are often clear evidence of where the evidence was found and what it looked like. The foundation can be explained in a police report stating who took the photographs, from what positions, and at what time. What if the photographs were taken by a passing neighbor from her mobile phone. How would you know that these photographs were accurate or hadn't been tampered?

Perhaps a clearer example is with a copy of a document. A copy of an original document can be certified by a notary, a court or another official. Thus, a neutral and unbiased party has certified that it the copy is the same as the original. It should also certify that it is a complete copy, and that pages aren't missing.

Thus, substitute evidence can be treated with the same belief and trust as an original, but only if there is sufficient additional information. That information has to answer questions about who made the photograph or copy and whether it is an accurate representation of the original document or scene. It can also answer questions about the condition or position from which the photographs were taken, or that there aren't missing pages. Thus, substitute evidence can be trustworthy evidence, but only with additional information that creates a foundation for that trust and understanding.

f. Summary Evidence

This book has alluded to the idea that evidence should support an inference of some greater conclusion, such as guilt or innocence. However, evidence by itself may not support that inference or conclusion. Evidence seen together, however, can suddenly illuminate that inference very brightly. Summary evidence is a separate document that takes information from other sources of evidence and presents it in one place. This can include a map of the crime scene, a chart showing phone calls or money transfers, or a list of border crossings. As long as the original evidence is reliable and credible, the summary evidence is also reliable and credible. Often the person who creates the summary evidence should also explain which evidence provided the information on the chart.

These are all summary documents which do not replace the original pieces of evidence, but provide the additional information that comes from looking at all the relevant information in one place. What is that additional information? Usually, summary evidence shows a pattern that is difficult or impossible to see when the original evidence is seen in its original format. Without that pattern, it may be difficult to support the inference of innocence or guilt.
However, the opposing party could still challenge the basis of the summary evidence. Was the document created accurately? Was there other relevant information that was not placed on the chart which could present a different pattern? Is it presented in a way which creates an unwarranted conclusion? Looking at the example below, there is a simple summary of four key events which suggest that the defendant killed the victim. Each event is from a different source of evidence - phone records, testimony, the medical exam, a video camera and a bank card statement. Each suggest evidence which helps build a case, but they don't clearly present the pattern. The pattern suggested by the table below is actually new information, or at least a much clearer presentation of information which is much harder to see.

<table>
<thead>
<tr>
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<tr>
<td>12:44</td>
<td>Defendant pays for fuel</td>
<td>Defendant's Bankcard Statement</td>
</tr>
</tbody>
</table>

This simple chart shows only four events, but the implication is clear: within the time of one hour, the defendant called the victim, the victim was killed, and then the defendant purchased fuel at a nearby petrol station. Does this prove that the defendant killed the victim? No, but if there is other evidence or motive, then the inference can be very strong.

Summary evidence is particularly useful when weaving together many events from different sources of evidence, such as in money-laundering cases. If money is moved through four or five different bank accounts or through wire transfers, the evidence may be contained in a dozen or more documents. A chart which shows all of those transfers can demonstrate a pattern that would otherwise require hours of careful review of the bank records. As long as the summary evidence is accurate and complete, the evidence has the same credibility as the underlying, official bank records. But the evidence on the chart which shows the pattern becomes far more convincing and relevant.

**g. Conclusion**

There are numerous ways to obtain evidence. With each source of evidence, there is a different set of problems which can arise. Sometimes evidence is a combination of these different types of evidence. In order to better analyze the evidence, the practitioner should be able to identify the source of the evidence and the different strengths and weaknesses of each kind of evidence. Further, a practitioner should be able to identify that evidence being offered may include more than one type, and should be broken-down into those different types in order to better analyze the credibility, relevance and persuasiveness of the evidence as a whole.
Review and Problem Set

Review:

A practitioner should be able to categorize evidence by its source, since the source of the evidence can affect its quality. Evidence can be obtained from witnesses, documents, physical evidence, experts and from “inferential sources,” which include summaries of other evidence. Those summaries can show a pattern that isn’t obvious from the evidence collected as a whole.

Each source of evidence can have different qualities or concerns. For instance, a witness may have a poor memory. He or she may be able to refresh that memory if they review their email, diary or text messages. A witness may not have had a clear view of the crime, or may be biased in some way. On the other hand, documents do not have memories nor do they have obstructed views of the crime. Instead, the qualities of a document are based on whether it is authentic or if the process which created it was accurate and reliable.

A practitioner cannot treat one type of evidence the same as another type of evidence. Instead, he or she must consider the limitations that the source of evidence can create.

Problem Set:

1. A witness sees a murder from their vehicle at night, but there were truck lights facing the witness. What limitations does this source of evidence have?

2. A witness will testify about a fatal car accident that he saw. However, the driver of the car owes the witness money for a business loan long before the accident. Does this source of evidence (the witness) have a limitation?

3. The prosecutor offers the court a bank document. The defendant questions whether the bank document is accurate. How can the defense attorney challenge the bank document?

4. An expert testifies that he is very experienced and has the highest number of convictions resulting from his testimony. Is it possible that this expert has a bias?
1. The witness may not have perceived the murder very accurately because of the lights shining in her eyes. However, the witness may be able to say that the truck lights illuminated the scene of the crime for her to see. The conditions described by the witness may affect her ability to perceive, and the practitioner should question her further on this topic to clarify whether or not she could see.

2. The witness may have a bias. This bias doesn’t disqualify him or her as a witness, but should be clarified. The witness may have a pre-existing business relationship with the defendant. If the defendant is sentenced, the witness’ business may suffer. He may not be able to repay the loan. There are many reasons for the witness to want to describe the accident in the way most favorable to the witness. If the practitioner asks the witness to describe the business relationship and how it would be affected if the defendant were unable to repay the loan, the court would then be aware of that bias and might consider the witness to be less credible.

3. The bank document may have been issued by a bank as a result of a judicial order. It would thus have been legally obtained. The practitioner could question the bank official who issued the bank document. Was the information in the bank document generated by a person (such as a deposit) or automatically (such as by a wire transfer)? Did the person who entered the information ever receive discipline for poor performance? Is the computer system generally reliable? How many complaints has the bank received about inaccurate statements? Is the bank system audited? Did the auditor ever find mistakes? If the error rate of the bank’s computer system is high, then this may cast doubt on the bank document. If not, it may make the bank document look more credible.

4. If the expert testified that he has helped obtain convictions, this may indicate a bias towards the prosecution and a lack of objectivity. The practitioner might question the expert about any bonuses or awards he had received for cases with convictions. The practitioner might probe the expert about how proud he is about the convictions he helped receive, or if there are any convictions of which he’s particularly proud. If the expert appears to be biased towards the prosecution, he may not be seen as neutral and his opinion may be less credible.
As noted in the previous chapters, not all evidence is the same. Some evidence appears to prove a case much better than other. But why is this so? The source of the evidence can affect the quality of the evidence, so that a videotape of a bank robbery is seen to be more accurate than the testimony of one of the bank tellers who was frightened and forced to lie on the floor. Both the video and the testimony, though, tell part of the same story. The testimony of the bank teller may not be as coldly accurate, but it can be much more convincing to a judge because she conveys the dangerousness of the robbery.

The practitioner should identify each kind of evidence, and can even break down some evidence into different types. The witness who relies on a document to remind her of the time of the robbery is not just relying on her own memory, but on another document. Is that document more reliable? Does that strengthen her testimony?

a. Inference and Probability

We are thus able to break down the evidence into each component, or quantum of proof. We can consider what each quantum of proof will prove. Many times it won't prove the ultimate conclusion needed by the court, but will prove some relevant fact. Once we combine those relevant facts, those facts all support some inference. In our minds, we calculate whether that inference has a high probability or a low probability. If we think that the inference has a high probability, we will be convinced that the evidence has proven something. If we think that the inference has a low probability, we will not believe the evidence to have proven its objective fact.
Let's look at a previous example.

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In this example, there are seven quanta of evidence: (1) the defendant's mobile phone record, (2) the victim's mobile phone record, (3) the neighbor's statement that she heard gunshots at 12:30, (4) the medical examiner's opinion that the murder occurred at 12:30, (5) the nearby petrol station's video showing the defendant arriving at 12:40, (6) the defendant's bankcard statement showing he bought fuel at the petrol station at 12:44 and (7) the pattern presented by the summary chart. Each one of those quanta of evidence proves a fact and some inferences. The combination of these facts supports a larger inference. Let's examine the facts proven, and then discuss the inference.

(1) The defendant's mobile phone record shows that he called the victim for two minutes. This phone call was 20 minutes before the victim's murder. It actually establishes a few facts and inferences. Strictly speaking, it establishes a fact: someone used the defendant's mobile phone to call the victim's mobile phone for two minutes. We can infer that the defendant was the one who called and that the victim was the one who answered, but we do not know this. We can infer that the defendant and victim knew each other enough to talk for two minutes. We can infer that the victim was alive at 12:10.

(2) The neighbor's testimony establishes a fact: that the neighbor believed that she heard gunshots coming from her neighbor's house. She believes that it was at 12:30 because she had just turned on a television show that starts at 12:30. She is unfamiliar with firearms and can't be sure she heard gunshots or something else. She is also not sure if she heard the gunshots from the neighbor's house, but knows she heard loud sounds from nearby. If we believe the neighbor, then this supports an inference that gunshots were fired in her neighbor's house. Since the victim died of gunshots, there is a strong inference that these shots were those that killed him.

(3) The medical examiner's report gave the opinion that the victim died instantly of gunshots, and that the rigor mortis in the body had suggested that the time of death was around 12:30. The medical examiner qualified that opinion by saying that estimating the time of death is not necessarily exact. By itself, we have a weak inference that the time of death was at 12:30, but when combined with the neighbor's testimony, we have greater confidence in that estimate. The inference is stronger because there are two independent sources of evidence which support the time of death being at 12:30.

(4) The video camera at the petrol station is aimed at the petrol pumps. There is a time-stamp. When the time-stamp reads 12:40, a BMW with the defendant's license plates is seen pulling quickly alongside the pumps. The defendant is seen getting out of the car to smoke while the attendant fills the tank.
seen giving the attendant his bank card to pay for the fuel, and then he leaves. While this is very accurate, we have to assume that the time stamp is correct. We have to have other information to know that the petrol station is less than a half-kilometer from the defendant owns a BMW with that license plate. We can see that the defendant is on the video. We can infer with fairly strong certainty, though, that the defendant did arrive at this nearby petrol station at 12:40. This inference is made stronger by the next quanta of evidence.

(5) The defendant's bank card shows that he bought fuel at this nearby petrol station at 12:44. This fits with the video from the petrol station and confirms the time stamp on the video. By itself, we would have to infer that the defendant himself used the bank card, but with the video tape we have much greater confidence because it shows him using the card to pay for the fuel.

(6) The pattern shown by the summary evidence is based upon the above inferences: First, that the defendant and the victim did have a 2 minute telephone conversation at 12:10. Second, that the victim was killed 20 minutes later in his house due to a gun shot. Third, that the defendant pulled quickly into a nearby petrol station ten minutes after the victim was murdered and smoked a cigarette while getting fuel. This pattern does not prove that the defendant killed the victim, but it does support the inference that he knew the victim, contacted him just before his death, and was seen in the area just after his death. It supports the inference that he had the opportunity to murder the victim, but doesn't prove his guilt.

Each of these quanta of evidence establishes a small part of the greater story. Each of those smaller inferences support a greater inference, which can be called an objective. What are those objectives? In an earlier chapter we discussed what the prosecutor needs to prove. What are the elements of the crime? Does the prosecutor need to prove that assets are connected to the crime? Does the prosecutor need to establish aggravating circumstances to justify that the court sentence the defendant to a higher prison term? Does the defense attorney need to show mitigating circumstances to justify a lesser sentence? Each quantum of evidence should help establish an inference which affects these greater objectives.

b. Moving From Evidence to Objective

There must be a logical chain of thinking in evidence. One quantum of evidence establishes one fact. Other evidence establishes other facts. Together, those facts allow the judge to make an inference. In a simple case or a case with extensive direct evidence, the facts may allow the judge to simply infer guilt or innocence. In more complicated cases, or cases with indirect evidence, the judge has to make many more logical inferences between the evidence presented and the final objective\(^\text{19}\), such as finding the defendant guilty.

In order to be found guilty of a criminal offence, the court must be convinced that all of the elements of that crime have been proven. In our simple hypothetical example of a murder, the court must be convinced that the (1) defendant has taken an action, (2) that action caused the victim to die and (3) the defendant had the intention to kill the victim. In order for the court to sentence the defendant more heavily if found guilty, the prosecutor should also prove that the defendant had pre-planned the murder.

\(^{19}\) In more formal terms, the final objective of the evidence is also called the "ultimate probandum." The intermediate fact or inference are called the "penultimate probandum." See Anderson, T., Schum, D. & Twining, W., *Analysis of Evidence* (2d Ed.), Pp. 114-122 (Cambridge Univ. Press. 2005).
These four elements are the final objectives of any evidence. Very rarely will one quantum of evidence prove all of these things, and if it did, it would be extremely rare that a sole piece of evidence would be so credible and convincing. In most cases, these four elements are proven with different quanta of evidence from many different sources. How do we logically move from the evidence to satisfying the final objectives of proving these four elements?

Remember that each of quanta of evidence in our scenario just establish one or several minor facts. As those facts are presented to the judge, he or she makes an inference. Those facts may allow the judge to make a single inference. For example, he could infer from those minor facts that the defendant's actions caused the victim to die. Those facts may require the judge to make several inferential leaps. This should become clear with an example.

Recall our previous hypothetical.

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As we noted in the last chapter, there are six quanta of evidence here which allowed five minor facts to be established. First, that the defendant knew the victim and called him for 2 minutes at 12:10. Second, that the victim's phone was answered, from which we infer that at 12:10 the victim was still alive. Third, from the neighbor's statement and medical examiner's report, the victim died instantly of gun shots which happened at 12:30. Fourth, the defendant was at a nearby petrol station ten minutes later.

From this pattern, we cannot prove any of the elements of the crime. It doesn't show that the defendant took any action which might have killed the victim. It doesn't show that any such action caused the victim to die. It doesn't show that the defendant intended the victim to die, or planned his death beforehand. Does this mean that the evidence in the chart isn't relevant or material to the case?

Actually, the chart permits the judge to infer an important intermediate fact: the defendant had contact with the victim and was nearby at the time of death. He had the opportunity to murder the defendant. This intermediate fact raises the probability that the defendant could have murdered the victim, but by itself is very weak evidence of guilt. In fact, it doesn't prove any of the elements. Let's add some other evidence to the scenario, which we will call the "Case of the Desert Eagle."

*The autopsy report concludes that the victim died from four gunshots from a .44 caliber pistol. The defendant recently purchased a .44 Magnum caliber "Desert Eagle" pistol. The defendant no longer has the pistol, but the evening after the murder, police found a "Desert Eagle" pistol in a dumpster near the petrol station. The ballistics tests match that of the bullets from the victim's body. There are no fingerprints found on the weapon and the pistol's serial number had been filed off.*
What does this new evidence establish? Breaking down the evidence, we can see that each quantum of evidence fails to prove the defendant's guilt, but they are credible and accurate, each allows a fact to be inferred.

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Fact Inferred:</th>
<th>Intermediate Inference/Fact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autopsy Report</td>
<td>Victim killed by four gunshots from .44 pistol.</td>
<td>This pistol was the murder weapon</td>
</tr>
<tr>
<td>Ballistics Report</td>
<td>Desert Eagle pistol matches the bullets which killed victim.</td>
<td></td>
</tr>
<tr>
<td>Police Report</td>
<td>Desert Eagle pistol found near Petrol Station</td>
<td>The murderer made efforts to hide the weapon and keep it from identifying him</td>
</tr>
<tr>
<td>Police Report</td>
<td>Desert Eagle pistol has serial number filed off and has no fingerprints.</td>
<td>The Defendant had a matching pistol, but doesn't now.</td>
</tr>
<tr>
<td>Firearms Registration</td>
<td>Defendant recently purchased a Desert Eagle.</td>
<td></td>
</tr>
<tr>
<td>Defendant's statement</td>
<td>He claims to have lost his Desert Eagle.</td>
<td></td>
</tr>
</tbody>
</table>

This evidence also does not prove that the defendant took any action that killed the victim. However, we would never believe that this evidence was not relevant. If this doesn't prove his guilt, why do we think it is relevant? Because they all support inferences that raises the probability that the defendant is guilty. What are those intermediate inferences or intermediate facts?

What else can we say? In our previous chart, we were able to infer the intermediate facts that the defendant knew the victim, called the victim, and was in the area. This leads to the next-level inference that the defendant had the opportunity to kill the victim.

We can look at the chart above and we find three intermediate facts: we have the murder weapon, the murdered attempted to hide and obscure his connection to the weapon, and the defendant had such a weapon but "lost" it.
We also have another inference that we can make.

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</tr>
</thead>
<tbody>
<tr>
<td>Police Report</td>
<td>Desert Eagle pistol found near Petrol Station</td>
<td>Defendant had the opportunity to throw his Desert Eagle pistol into the dumpster</td>
</tr>
<tr>
<td>Bank Card and Video Camera</td>
<td>Defendant was at Petrol Station 10 minutes after the murder.</td>
<td></td>
</tr>
</tbody>
</table>

The defendant was seen at the petrol station just after the murder. The murder weapon was found at a dumpster next to the petrol station. The defendant cannot produce his Desert Eagle pistol now. This does not prove that the weapon was his, but we can make the inference that he had the opportunity to throw his pistol into the dumpster. We cannot infer with absolute certainty that he actually did throw his pistol into the dumpster.

We thus have several intermediate facts that we have established. The defendant knew the victim and called him just before his death. The defendant was nearby and had the opportunity to kill the victim. He had a pistol identical to the murder weapon. He had the opportunity to throw the weapon into the dumpster at the petrol station. The murderer took steps to file off the serial number, wipe away the fingerprints and throw away the pistol. Does this suggest that it was a pre-planned murder?

Have any of these intermediate conclusions proven an element of the crime? To prove murder in our hypothetical, we have to show (1) defendant has taken an action, (2) that action caused the victim to die and (3) the defendant had the intention to kill the victim. In order for the court to sentence the defendant more heavily if found guilty, the prosecutor should also prove that the defendant had pre-planned the murder.

<table>
<thead>
<tr>
<th>Element of the Crime</th>
<th>Inferences or Evidence Supporting this Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defendant took Action</td>
<td>We can infer that he had the opportunity to shoot the victim. He had a weapon. He called the victim. At the time of the murder, he was in the area of the murder and where the pistol was found.</td>
</tr>
<tr>
<td>Action Caused the Death of the Victim</td>
<td>The Murder Weapon killed the victim with four shots</td>
</tr>
<tr>
<td>Defendant Intended the Action to Kill Victim</td>
<td>The murderer fired four times</td>
</tr>
<tr>
<td>Defendant Planned the Death Ahead of Time</td>
<td>The pistol had the serial number removed</td>
</tr>
</tbody>
</table>

As you can see, we are not proving the elements of the crime with the evidence. Instead, the evidence is allowing the prosecutor or judge to make intermediate inferences. Those inferences then make the final objective more or less probable. We cannot say with absolute certainty that the defendant shot the victim. However, as we make each inference from the evidence, we are finding it less and less probable. The evidence is obviously critical to establishing the case, but we are calculating the probability of guilt based upon all of the inferences we make from the evidence.

A defense attorney would concentrate on these inferences, pointing out that the prosecution hasn't proven that the pistol found in the dumpster belonged to the defendant. He would certainly point out that there
hasn't been any direct evidence that he shot the victim, such as an eyewitness. The attorney would argue that nobody saw him even near the victim's house, and there's no evidence that he shot the weapon or had a motive to do so.

This prosecution would be based on indirect evidence, or circumstantial evidence. If there was direct evidence of the defendant's guilt, the judge would simply need to believe the evidence in order to conclude that guilt had been proven. However, with indirect proof, the judge must be convinced that the probability of the defendant's guilt is so high that no other conclusion is rational. This requires the evidence to allow inferences which not only support a high probability that the elements of guilt have been met, but also the evidence must also support inferences that alternative explanations have a very low probability.

**c. Direct Evidence and Indirect Evidence**

In many cases, the quantum of proof leads directly to the ultimate objective without any need to draw an intermediate inference. For example, an eyewitness who sees the murder and can identify the murderer has direct evidence. We do not have to make any inferences between the testimony and the final objectives: proving the elements of the crime. However, this does not mean that the direct evidence is believable or accurate, only that we are not making any intermediate inferences.

When the judge has to make intermediate inferences between the proof and the ultimate objective, this means that the evidence is indirect. Not only do we have to consider the quality of each quantum of evidence, but how logical or strong are the inferences that must be made. However, indirect evidence and direct evidence can be used together to not just minimally prove the elements of the criminal offence, but also can make the proof more convincing.

For example, think about a closed box. Your ultimate objective is to determine what is inside. If you were to open the box and look inside, that would give you direct evidence. However, if you were unable to open it, you would then try to find indirect evidence. You would pick it up to see if it was heavy or light. You might shake the box to hear what the item inside sounds like.

What if your friend tells you that she saw a jar of honey placed into the box before it was sealed. This is direct evidence, but you may not believe the person or think it was accurate. If you pick up the box, though, it has the weight of a jar of honey. It feels like a jar moving around inside when you shake the box. This is indirect evidence.

Between the direct evidence and indirect evidence, you can believe that there may really be a jar of honey inside. Each of the evidence supports the other evidence, making it all more convincing. However, you are not 100% sure. That level of certainty would only come by opening the box. However, you have reached a level of probability where you believe your conclusion because you find the direct and indirect evidence seem to be telling the same story.

The direct evidence from your friend may provide you with a certain degree of probability. For the sake of this example, because you are not sure that your friend accurately remembers what is in the box, you think there is a 60% chance that there is a jar of honey in the box. The indirect evidence raises your certainty because it corroborates your friend's assertion. You now think that there is a 90% chance that the box contains a jar of honey.
However, let's change the example. Your friend still says that she saw a jar of honey placed into the box, leading you to think there is a 60% chance that she is right. But when you pick up the box it isn't heavy enough to contain a jar of honey. When you shake the box, it sounds like a book may be inside. Instead of increasing your certainty, the new information contradicts her statement. You believe that there is a low probability that the box contains a jar of honey.

In the first example, the direct and indirect evidence corroborated each other. They both supported the same inference - that the box had a jar of honey - and this made it seem much more probable. By looking at the indirect evidence, you feel more confident about the direct evidence. In the second example, the direct and indirect evidence do not corroborate each other. They support different inferences which are incompatible. You are glad you did not only rely on the direct evidence, as it just doesn't seem possible.

Each quantum of evidence can have different sources and can prove different things. That evidence may provide direct proof of a final objective, such as an element of the criminal offence. On the other hand, it may support intermediate inferences and is thus indirect proof. However, each direct and indirect quantum of evidence may have different qualities which makes it more or less useful as proof.
Evidence, Intermediate Inferences and Final Objectives

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<th>Evidence</th>
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<th>Final Objective (ultimate probanda) (i.e. elements of crime)</th>
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<tr>
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Review and Problem Set

*Review:*

The practitioner should consider what needs to be proven. These are your ultimate objectives, including the elements of the crime and other things to prove, such as a basis for detention, confiscation or sentencing. What is available to prove these things? Evidence. However, sometimes evidence doesn’t directly prove all of the ultimate objectives. Sometimes the court must make inferences between the collected evidence and the objectives. The evidence should support these intermediate inferences logically. Logical deduction and inference is discussed in a later chapter.

A quantum of evidence, or a single piece or aspect of evidence, can prove several things. It might directly prove one element, but also support an inference of another element. “Evidence” can also be broken down into separate quanta. A pistol found in the garbage actually has a number of “quanta.” What kind of pistol is it? Where was it found? When was it found? What caliber is it? Does it have fingerprints? Does it have a serial number? Each of those quanta can help prove something different in the case.

An inference is an assessment of probability that something is true, based on known facts. As evidence is collected, the body of evidence may affect the probability that something is true. For instance, if many witnesses and documents support, or corroborate, a particular inference, it is more likely to be true. If there are conflicting witnesses, then the inference may not be as likely to be true. This will be discussed as “probative strength” or “probative value” in Chapter 4. The body of evidence thus creates a web of evidence and inferences which, if considered logically, results in a decision by the court based on evidence and inferences. Some cases are simple and can be quickly and directly proven. Others are more complex and require a greater web of evidence and inferences in order to demonstrate guilt or liability.

*Problem Set:*

1. A child is taken from a house without the parents’ knowledge and is missing. The door was not forced open, and some of the child’s favorite toys are also missing. Do these facts support an inference? What is that inference?

2. A pedestrian is hit by a car and killed. The driver has a vendetta against the pedestrian, but claims it was an accident. The hood is dented and the windshield is cracked. The pedestrian’s cell phone is found 3 meters away. There are dark skid marks at the scene of the accident. What evidence supports the inference that it was an accident, and why? Does this directly prove innocence?
3. Can evidence directly prove one crime, and indirectly prove another? Can you give an example?

4. Must all criminal offences be proven only with direct evidence?
1. The evidence strongly supports the inference that the child knew the person who took her. The door was not forced open, which suggests that the child opened the door for someone she trusted. It also appears that the child was given the chance to take her toys with her, so that also suggests that it was someone who knew the child. Either the abductor knew the child well enough to take her favorite toys, or he gave the child time to collect her toys.

2. While the vendetta between the driver and the deceased pedestrian suggests that the death was premeditated, the dark skid marks supports the inference that it was an accident. Specifically, it supports the inference that the driver braked hard to avoid hitting the pedestrian, thus causing the skid marks. Another inference, albeit a weaker inference, could be made from the cell phone being thrown far from the accident. It supports an inference that the pedestrian was on the phone and may not have paid attention to traffic.

3. Evidence can directly prove one crime and indirectly prove another. For instance, a handgun used in a murder can directly prove that the defendant killed the victim. The pistol matches the bullets from the victim, the defendant has powder residue on his hand and the pistol was found in the defendant’s jacket less than 20 minutes after the murder.

If that handgun had also been reported as stolen a year earlier, it can serve as indirect proof that the defendant stole the handgun as well. One does not require an inference (the pistol found on the defendant directly links him to the murder) while the other does require an inference (there is nothing directly linking him to the theft).

4. If direct evidence establishing the elements of a criminal offense are available, it should definitely be used. As more indirect evidence is used in a case, the court must rely more heavily on “probability” to make its judgment. While a criminal case can be proven using indirect evidence, it is not ideal.
In the previous chapters, we have learned to break down a body of evidence into discrete parts. First, we identified what we needed to prove with the evidence, which begins with establishing the elements of the criminal offence, but can include other objectives. We also looked at the burden of proof and the standard of proof. Next, we considered the source of the evidence, such as witness testimony, documents or physical evidence. The source of the evidence may result in the evidence having different qualities and requires the practitioner to treat the evidence differently.

In the previous chapter, we examined the logical process of proof. The evidence collected prove certain facts and allow certain inferences to be made. Those inferences are probabilistic, which means that we do not have 100% certainty, but believe that the inference can be made with some lesser degree of probability. If the proof is indirect, we have called these "intermediate inferences" although many academics call them "intermediate probanda" and "penultimate probanda." Proof is direct if the inference or fact established by the evidence helps establish the final objective (or "ultimate probandum"). We also saw that direct evidence and indirect evidence can be seen together to either support each other and raise the certainty, or to conflict and make the conclusion less certain.

All of these inferences and final conclusions depend on the evidence collected in the investigation. The quality of that evidence can affect the intermediate inferences or the facts established. We have seen several examples of this already. In the last chapter, the example of a box that may, or may not, contain a jar of honey demonstrated that a witness' testimony may not be credible. She had stated that she had seen a jar of honey placed in the box before it was sealed. In the first example, the weight and feel of the box
supported the possibility that a jar of honey was in the box. In the second example, the box was too light and when it was shaken, it sounded like a book, not a jar of honey. In the first example, the doubts about her credibility were less because her story was corroborated by the other evidence. In the second example, her credibility was more doubtful because the other evidence conflicted with her story.

Most practitioners use shorthand to encapsulate the entire process of evaluating evidence. They may call this evidence "weak" or "strong." Often this means that they have subconsciously considered the qualities of the evidence. They can even call the entire case "weak" or "strong," which means that they have subconsciously evaluated the qualities of the evidence, the inferences made, and how well the facts and inferences support the final objectives.

A practitioner needs to have the vocabulary and concepts to be able to describe the qualities of each quantum of evidence. Only then can the practitioner use investigative and trial skills, and the judge evaluate and adjudicate, based on these qualities. Those qualities will influence how much probability or weight that the judge gives to the evidence, how influential it is in the case, and whether it is even considered.

In general, each quantum of evidence has three major characteristics, regardless of its source or type. The first characteristic of evidence is its relevance or materiality. The relevance of the evidence is entirely dependent on what needs to be proven. The second characteristic is the evidence's credibility. This describes whether the evidence should be believed or deemed accurate. The last characteristic is the evidence's probative force or weight. The probative force describes how convincing the evidence is, especially within the body of evidence in the case.20

a. Relevance

In a criminal case, or any legal action, evidence should contribute to deciding the case. This requires the judge and practitioner to understand what needs to be proven, which we have identified as the final objectives and the intermediate inferences. Remember that these objectives and inferences do not only include the elements of the crime, but also mitigating or aggravating circumstances, confiscation proceedings, sentencing or detention proceedings, and other necessary procedures. In order for evidence to be relevant, it needs to make any of those final objectives or inferences more, or less, probable.

Thus, evidence can be directly relevant if it makes the defendant's guilt more or less likely. For instance, an eyewitness who claims to have seen the defendant commit the murder is directly relevant. Even a witness who claims to have seen the defendant purchasing a similar gun is relevant, as it shows that the defendant had access to a murder weapon. It can also be directly relevant if it makes any inference necessary in the case to be more or less likely.

Evidence can also be indirectly relevant. If you have the eyewitness to the murder, that would be directly relevant. But if there is another witness who claims that the eyewitness was in another city at the same time, that would also be relevant. It would make that first witness less credible, and thus could affect the probability of the defendant's guilty.

A practitioner should be cautious about relevance. Some evidence may be prejudicial but not relevant. Prejudicial evidence simply means that the evidence makes the defendant look bad. Obviously, evidence that proves a defendant's guilt is prejudicial, but it is also relevant. What kind of evidence might be prejudicial, but not relevant?

Certain kinds of evidence can be prejudicial because it makes the defendant look immoral, but does not actually prove that a defendant committed the criminal offence with which he is charged. For instance, a defendant's alcohol or drug use may lead a judge to condemn those actions, but are they relevant to prove that he defrauded a bank? The evidence may be relevant if the prosecution argues that he needed to defraud the bank to fund his drug usage, thus demonstrating a motive. However, if this isn't a motive, how would this help prove his guilt? Instead, it simply paints him as immoral without establishing that he committed a crime.

Another example might be a defendant's reputation in the community. If his neighbors testified that he wasn't a good neighbor, that he kept late hours, played loud music and yelled a lot, would this help prove that he defrauded a bank? A judge may not want him to be a neighbor, and may find those actions unsuitable, but they don't logically support his guilt or innocence. It isn't relevant.

Evidence can also be prejudicial against someone other than the defendant, but not be relevant. This includes sexual conduct of a rape victim. In most countries, a rape occurs when one person forces another person into sexual intercourse against his or her will. Many countries do not permit the victim's past sexual conduct to be raised at trial, unless it can be shown that there is a pattern of false accusations of rape. Why is this? The evidence of the past sexual conduct can be very prejudicial against the victim, and often a defendant's attorney tries to make the victim appear immoral or promiscuous. However, the question before the court in such cases is not whether the victim consented to sex on other occasions, but whether she consented to sex (or was able to consent) during the event under indictment.

Thus, some evidence of past conduct can be prejudicial and not even indirectly relevant, such as sexual conduct in a rape case. If a defendant has a past history of rape allegations, though, it would also be prejudicial. Would it be relevant? How is it different?

If the defendant had multiple convictions and allegations for rape, it is past sexual behavior. But it is also relevant, because in each instance it was either alleged or proven that he engaged in sexual conduct without the consent of the victim, just as in the case in question. If he had ignored the pleas of victims to stop in the past, it makes it more probable that he might have done so in this case.

Sometimes the past conduct of a defendant or victim is relevant, especially if it directly relates to one of the final objectives in the case. A person's past job as a locksmith may be relevant if he is accused of breaking into a locked store to steal. It may not be relevant, however, if he is accused of tax avoidance. Why? Because his past work as a locksmith does not make any of the elements of tax evasion more or less probable.

Thus, in order to understand whether a quantum of evidence is relevant, one must first understand what needs to be proven. By focusing on relevant evidence, the case is stronger, clearer and does not create unwarranted prejudice against the defendant or other parties. With clearly relevant evidence, the inferences necessary to determine whether a person is guilty or innocent (or adjudicate another final
objective) is much more easily made. However, just because evidence is relevant does not mean that it should be believed to be true or accurate.

b. Credibility

What makes us believe that the evidence is true or accurate? What qualities of a quantum of evidence justify that belief? Evidence can be either tangible or testimonial, and some evidence contains both. Tangible evidence can include documents, physical objects, video, photographs, maps, diagrams or other similar items. Testimonial evidence is the spoken or written assertion by a witness. Obviously, tangible evidence such as a letter or email can also assert testimonial evidence, such as the facts asserted in the email. In such cases, the credibility of the tangible evidence (the email) and the credibility of the testimonial evidence (the facts asserted in the email) should be considered separately.

1. Credibility of Testimonial Evidence

Practitioners are often more familiar with gauging the credibility of a person who is verbally testifying. Often we look at the language used, facial expressions, body position and other non-verbal cues to decide whether we believe a person or not. However, there are additional factors which can affect our belief in the assertions by the witness. First, we have to understand whether a witness has a basis to make the statement. Second, we can look at the actual credibility of what is being said. Further, there are many other factors which can undermine the credibility of testimony.

First, does the witness have a basis to make the testimonial assertion? The most trustworthy basis is for the witness to have personal knowledge of the event. In other words, the witness saw the event himself or herself. This is the typical "eyewitness" to an event.

The next most trustworthy basis is for the witness to have inferred that the event occurred based upon their personal knowledge. As an example, the witness could have seen the airplane with engine trouble fly over the hill. He then heard an explosion and saw smoke. He did not see the event, but from what he did see, he could infer that the crash occurred. Depending on the personal knowledge and the reasonableness of the inference, the judge can assess the credibility of the statement.

The last and least trustworthy basis is for a witness to have no personal knowledge, but to have received that knowledge from another person (the primary source). All we can assess is whether the witness really heard the statement from the primary source, but we cannot assess the credibility of the primary source. We don't know how that person knew that information and whether it was accurate or even true. It may not be credible evidence at trial, but during the fact investigation it may lead to a witness with personal knowledge of the events.

Second, we can examine the actual credibility of the testimonial assertion. This includes determining the witness' veracity, the objectivity of the witness, and witness' ability to observe the events. The veracity of the witness is often a subjective determination whether the witness is lying. This does not mean that the witness is wrong or mistaken, but that they believe one thing but are purposely testifying to something different. Sometimes veracity is determined by the subjective observation of the witness' demeanor, but sometimes it can also be determined by the witness' past convictions or reputation about truthfulness, evidence about witness corruption or intimidation, or possibly other tests, such as polygraph testing.
The objectivity of a witness measures whether a witness is biased. An objective witness has no bias and is reporting everything that they saw accurately. A biased witness believes that they saw an event, but because of what he or she expected or wanted to see or hear. This can include a racial, ethnic or gender bias, which would influence a witness to have perceived or remember events based on their expectations. For instance, a person who is biased against women may not have perceived or remember a woman to have taken heroic action at the crime scene. At best, he might remember that she had a minor role in the event. It is very important to explore the bias of a witness in order to better understand that witness' credibility.

We must also be aware that there are limitations to memory, which was discussed in Chapter 2. A witness may have remembered only that which was important to them. This reflects an internal bias, based on their pattern of recollection. The person may need to review notes, emails, calendars or documents in order to refresh their memory.

Assuming that the witness believes in their testimony and that testimony was objective and accurate, we must also look at the witness' ability to have observed the events. This is sometimes called "observational sensitivity." A person may believe what they saw, and have no bias, but if they had an obscured view of the events or been unable to hear well because of noise. If the witness was drinking or taking prescription medicine when the event occurred, how well could they perceive or remember the events? If they have poor eyesight, poor hearing or other sensory defects, they may not have observed the events accurately. If the witness is a child, they may not have understood all of the events.

If a person has some experience or expertise in the field in which they are now a witness, they may have paid additional attention to the event, but this also means that they tend to have a bias. They will focus only on the events for which they have expertise. A medical doctor who is a witness to a shooting will subsequently focus on the medical condition of the victim, for instance, and may not have seen what happened to the shooter.

Observational sensitivity does not only involve the witness' capability to perceive events, but the conditions during the observation also matter. If the event was sudden and quick, there's much less time for the witness to observe. The witness was also not expecting the event, so they may not have paid much attention. Were they required to hide, take cover, or otherwise prevented from observing the events? Were there many events happening at once so that the witness' attention was diverted?

If a witness has a clear basis to testify, appears to be truthful and unbiased, and was perfectly situated to observe the events, does this mean that the witness should be believed? Recall the example with the honey jar in the box. Your friend had told you that she saw a jar of honey placed in the box before it was sealed. However, other evidence contradicted her assertion. You don't believe that she is lying, she has no bias in favor of honey jars, and she was in the room where the jar was placed into the box. And yet, it doesn't seem like she was right. She may have been mistaken, or may not have seen them remove the jar before the box was sealed. This doesn't necessarily mean that the witness is not credible, but it does lower the value that you give her assertion.

Consistency also helps establish a witness' credibility. What if she made contradictions between a statement this morning and later in the day. In the morning, she said that it was a jar of honey. Now, however, she said that it was a bag of honey. Any contradiction within the statements of the witness can
affect their credibility. It can mean that she lied either in the morning, later in the day, or both times. It can also mean that she is honestly reporting a belief that has changed. In Chapter 2, we discussed how scientific research suggests that every time we remember a memory, especially traumatic or fearful memories, they are revised.

2. Credibility of Tangible Evidence

Testimonial evidence can be credible if the witness had a basis to have observed the event, is truthful, objective, consistent and based on clear conditions to observe and remember the event. These conditions do not apply to tangible evidence. A pistol has observed nothing. It has no capacity to lie or have a bias. It is what it is. Does that mean that all tangible evidence is automatically credible?

Of course not. All tangible evidence can lack credibility. We can examine the credibility of tangible evidence by looking at its authenticity. The credibility of some tangible evidence is also measured by looking at its accuracy or sensitivity, and by looking at its reliability.

The authenticity of the tangible evidence is the most critical measure of its credibility. Is the item really the physical evidence that was involved in the crime? The most obvious example of tangible evidence being inauthentic would be a forged or counterfeit document. Evidence which is intentionally changed or switched is clearly inauthentic and should not be considered by the court. The evidence may also have been subject to error in either collecting the evidence, processing the evidence, storing the evidence, testing the evidence or recording the results. While it may not be intentional, mistakes made to collect, keep or record the evidence will also present evidence which is inaccurate and should not be believed. A witness who testifies about the physical evidence, such as the police officer who collected it, may also be mistaken or lying. The credibility of that witness also affects the credibility of the evidence he collected.

For example, a police officer collects blood samples at the scene of the crime, but does not correctly mark or store them. They are found a day later. When they are sent for analysis, they aren't sure where they came from in the crime scene or where they were during the missing day. They do match the defendant's blood type, but since the evidence has poor authenticity, it lacks much credibility.

Some types of tangible evidence are also subject to other tests of credibility: was the evidence the result of an accurate and sensitive process, and was the evidence the result of a reliable process. Many forms of tangible evidence are the results of a process which observes and records information, such as a surveillance camera. The camera sitting on the corner of the building is one end of a process which results in a videorecording elsewhere in the building. The camera may be accurate and sensitive, taking clear, detailed images of the front of the bank, for instance. The camera, however, may be out of focus, have a dirty lens or be obscured by a tree. In such case, it might not be accurate or sensitive, and may not be able to give a credible image.

On the other end of the building is a device recording the images from that security camera. Is the process reliable? Does it normally record? Is the time-stamp accurate? Is the process going to reliably record the images in such a way that we can trust and believe it? In a similar example, an expert may testify that they tested blood for poison. They are describing a process. Was the blood collected accurately? Was the laboratory machine routinely calibrated to ensure its accuracy? Does the laboratory method give a reliable result?
A different example may further explain this concept. A bank's financial statement for the defendant's account is generally seen to be very credible. But what if the bank tellers make many mistakes when they enter information into the system? That would mean that the bank's process to record transactions is inaccurate and insensitive - it isn't accurately recording the information. If the bank only corrected mistakes when the customer challenged it, it would further mean that the bank did not audit or conduct quality control. This may make a judge question the accuracy and reliability of all of the bank's documentary evidence.

For a process to be reliable, it also needs to be repeatable, dependable and consistent. The bank teller may have entered mistaken information into the bank's computer system, but that computer dependably and consistently recorded it. It was a reliable system, but not accurate. We tend to trust the automated computer systems of today to dependably and consistently record all of the emails, text messages, tweets and bank transactions. The automated nature means that there is no human involvement and, thus, no human error.

Thus, a process is often deemed to be accurate, sensitive and reliable if it is fully automated. A witness can describe that process to the court to increase the court's appreciation of the evidence's credibility. However, as noted with the laboratory test above, an automated process may lose reliability if it isn't properly maintained or has been damaged. Your email may be a reliable process, but if there was a power outage or it was subject to a cyber-attack, it may not be reliable.

Thus, tangible evidence has three main factors which affect its credibility. Physical evidence, such as a murder weapon or mobile phone found at the scene, is primarily credible because it is authentic. If the prosecution proves that the pistol being shown in the court is the same one that was at the crime scene, then he has established that it authentic. However, if the defense attorney can question whether the physical evidence is different from the evidence found at the scene, or was possibly tampered with, the credibility of that physical evidence may diminish.

Other tangible evidence are usually the result of a process, such as documents, emails, bank statements, surveillance video, or lab results. We can question the credibility of the evidence by examining the underlying process which recorded it. First, does the process collect the information in an accurate or sensitive way? This can include the surveillance camera, the bank teller entering information, or the collection of forensic evidence at the crime scene.

Second, is the process one that is repeatable, consistent and dependable? The process can be a standard operating procedure within an organization, such as the requirement to collect, store and maintain a chain-of-custody for the evidence found at a scene. The process could also be a normal process that a bank uses to process deposits. The process could also be a completely automated computer process which records email, bank transfers, or other repeated transactions.

Thus, many documents are deemed credible because they were the result of a normal, unbiased process which recorded the information accurately and then has a consistent process for recording it. Consider the mobile phone record. The person dialing the phone number enters it directly into the phone. It is accurate. The phone company has a reason to keep an accurate record of the phone call, as it wants to charge you money for the call. It thus has installed an automated system to record the process. It is
repeated thousands of time with every phone call made on the system. Thus, we rarely question the accuracy and dependability of that process, so the resulting document is given high credibility.

3. Credibility of Mixed Evidence

Sometimes testimonial evidence is contained in documents or other media, such as a computer. If the underlying document or media is credible, does this add credibility to the statement being asserted? For example, a witness calls the police to report a crime. The dispatcher records every phone call to the emergency phone number. The system is considered accurate, sensitive and reliable. The recording made is authentic. Does this mean that the statement that the witness made to the dispatcher is automatically credible? Of course not, as the practitioner and judge must evaluate the credibility of that statement separately.

Thus, did the witness have a clear basis to testify? Does she sound truthful? Does the witness have any bias? Was she able to clearly observe the events? Is the recorded statement consistent? Is it consistent with a statement she may have made later?

Another example of mixed evidence are on smart phones. These are mobile phones with impressive computing ability, video recording and electronic messages. They can contain important evidence for the case. During a court-ordered search, the police find a mobile phone. A few days later, they look at the photos on the phone and find an incriminating photo of a stack of drugs. The defense attorney asks for the meta-data on the photograph, which is the electronic data which shows when it was created. The metadata on the photo suggest that it was created two hours after the police had completed the search, well after the police had seized the mobile phone. Is the photo now a credible quantum of evidence?

Evidence may thus be relevant to a final objective or intermediate inference. Evidence may also be credible, whether it is testimonial, tangible or mixed. We would thus know that the evidence will effect an important decision by the court and that it is believable. However, does the evidence convince the court? In other words, can we determine its weight or probative force?

c. Probative Force

Probative force is the most difficult characteristic of evidence to conceptualize. Some people believe it is just a form of credibility. Many people refer to it as the weight of the evidence, which ultimately means that it has more or less influence on the final decision of the judge or fact finder. Some might say it is "strong" or "weak" evidence, but that strength or weakness doesn't mean that it isn't credible or relevant. What, then, is this characteristic of evidence?

Ultimately, probative force or weight simply describes whether the evidence is convincing. But why does one quantum of evidence convince someone but another might not? If you recall, evidence supports an inference that the fact finder makes. Evidence doesn't necessarily just lead to one inference. Often, there is a probability attached between one inference and other inferences. If the criminal was seen driving away in a red car, does the defendant having a red car really support the inference that his the criminal? There may be a thousand people with red cars. If all we know is that the criminal has a red car and the defendant has a red car, the probability that the defendant is the criminal is one in a thousand, or 0.1%. Obviously, that isn't very convincing evidence because there is a very low probability that it is correct to infer that the defendant is the criminal.
Often, we make this probability judgment subconsciously. However, there are some qualities which can raise or lower the probability we attach to a quantum of evidence. First, does the evidence fit with our normal experiences and expectations? If it doesn't, is there a good explanation? Second, is it corroborated by other evidence? Lastly, is the evidence internally consistent? While there may be other factors that we subconsciously use to assign probabilities to evidence and inferences, these three factors can be discussed and examined in the courtroom.

1. Fit

One element of probative strength can be described as the "fit" of the evidence. Does it make sense? It may not be impossible, but is it very unusual or difficult to imagine happening? We have identified the logical connections between one piece of evidence and the final objective or intermediate inferences. We have also seen that those inferences can have probabilities attached to them, even if subconsciously. Sometimes we grade those probabilities very simply, such as "strong" or "weak." As we gather other evidence, we may feel like the probability has weakened, or become even stronger.

A quantum of evidence thus has some strength which supports or weakens an inference or conclusion in a case. If a series of inferences are necessary, if each is logical and internally consistent, then this makes it stronger. If the inferences are in keeping with what one encounters in everyday life, then this also makes it stronger. If evidence requires an unusual or less logical inference between it and the final objective, then it appears weaker.

Let's consider an example. A credible witness describes a bank robbery but says that the criminals left in a hot-air balloon. The testimony is clearly relevant and the witness is credible, but the inference made is difficult. It is neither normal nor logical. If the witness had said that the bank robbers had left in a blue Ford, then the probative force would have been stronger because the inference is more in keeping with everyday expectations. Sometimes we might say that the story is more plausible.
However, if other witnesses also described the criminals leaving in a hot-air balloon, the inference is much easier to make. Why? The witness' story has been corroborated by other evidence. This is another element of probative force.

2. Corroboration

Corroboration occurs when one quantum of evidence is supported by other quanta of evidence. This is one of the most important elements of probative strength. Corroboration strengthens the probability that the evidence supports an intermediate inference. Multiple evidence may lead to a conclusion that one inference is more probable than another. While we might say that the evidence corroborates each other and strengthens the conclusion,

Let's take a look at how these two differ. For example, a witness sees a shooting where the murderer drives off in a red Fiat. She says it happened at 3:40. Her mobile phone shows that she called the police at 3:41. The phone call corroborates her story, as it supports the time of the murder being at 3:40. This makes the evidence more credible, obviously, but it also supports the inference that is made. That

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21 There is a fine line between corroborated evidence having stronger credibility (it is stronger and, thus, we believe it more) and having stronger probative strength (there is a stronger probability supporting a particular inference).
A quantum of evidence is thus stronger because of the corroboration. We can say that her statement is corroborated by her phone record. It makes it stronger, more probable evidence.

One way to understand corroboration is to see how things are not corroborated. The opposite of corroborating evidence is conflicting evidence. This makes the probability weaker. For instance, the witness says that she saw the shooting at 3:40, but in this example she phoned the police at 4:30. Why would she wait so long? This evidence conflicts with her story and makes it weaker. There is a lower probability that the murder happened at 3:40, as she claimed.

However, what if the defendant owns a red Fiat? Does that corroborate her story? It doesn't, because it doesn't make her story stronger or support the inference that the murderer drove away in a red Fiat. Thousands of other people in the city also have red Fiats, but that doesn't strengthen the witness' story. If the defendant didn't have a red Fiat, we wouldn't suddenly question whether she really saw the murderer drive away in a red Fiat. We would, however, question whether the Defendant is the right suspect.

Assume that the defendant does own a red Fiat. With greater evidence and further proof, the inference that the defendant was the murderer can be supported because he has a similar car to that used in the murder. We could then say that the inferences corroborate each other and make one final conclusion more probable.

Because this is an important point to understand, we can look at the Case of the Desert Eagle. Recall that the defendant had recently bought a .44 caliber Desert Eagle pistol. There was also evidence which showed that a .44 caliber Desert Eagle pistol had been used as a murder weapon. Thus, we have evidence that the defendant owned the same kind of gun as the murder weapon, but then again, many people might own it.

At this stage, there are two competing inferences that can be made. First, that the murder weapon belonged to the defendant, and second, that it the murder weapon doesn't belong to the defendant. If this is the only evidence we have, we would probably give a low probability to the inference that he owned the weapon. We would give a high probability to the inference that he didn't own the murder weapon.
In the chart, we see that there is one quantum of evidence: the defendant owns the same kind of gun. The inference that the murder weapon is not the defendant's has higher probability, and the other inference has a low probability. It would not be very convincing evidence that the murder weapon belonged to the defendant, and this evidence alone would not convince us of the ultimate guilt of the defendant.

However, as we add another quantum of evidence, the probabilities in our minds change. If we consider two quantum of evidence, it may change the probabilities that support the two inferences. In addition to the evidence that the defendant owns the same kind of pistol, we also know that the defendant told the police that he lost his pistol. With these two facts, we no longer consider the inference that the defendant doesn't own the gun to have a high probability. This has lowered. Likewise, we don't consider that the inference that the defendant owned the murder weapon to be so improbable. In our chart, these two inferences now are about equal.
The inference that the murder weapon might be his has become more probable because several different facts suggest it. Each fact, on its own, might have low probative strength. As the facts corroborate each other, though, they have higher probative strength. We can see that, as we add another quantum of evidence, the probabilities change again. In this next chart, we have added another fact: the murder weapon was found in the same petrol station that the defendant had been proven to use.

Now, each probability has changed. Now, all three support a higher probability to infer that the murder weapon belonged to the defendant. The evidence we have supports a low probability that the weapon isn't is. Each quantum of evidence that gets added to the case makes us re-evaluate the probabilities of all the evidence. Given this evidence, we may be more likely to infer that the murder weapon belongs to the defendant. The strength of that inference, and any corroboration between this inference and others, may lead us to infer the final objective: that he used the weapon to shoot the victim.
Practitioners do not make these charts. This analysis is done in our heads, often without understanding why we are doing so. However, when we actually understand how to make these logical connections, the reasons why we find evidence compelling is clear. That conceptual clarity gives the practitioners and the judge the same vocabulary to be able to argue why evidence is, or isn't, strong. For practitioners and judges to talk about evidence, they need to understand why some of the evidence seems convincing, while other evidence isn't. Many times, when many quanta of evidence all support the same inference, it makes it far more convincing.

We have seen how corroboration works when all of the evidence is relevant and has the same level of credibility. What if one quanta of evidence has more, or less, credibility? Let's consider our example. We have evidence that the defendant owns the same kind of gun and the defendant has said that he lost the gun. We saw before that the combination of these two facts supported a medium probability that the murder weapon belonged to the defendant and also a medium probability that it didn't.

What if there was another witness who said that he had stolen the defendant's gun? That would be very relevant, as it would affect how we evaluated the evidence. However, we don't find the witness very credible. He has a long history of false testimony, owed the defendant money, and hasn't been in the city for almost a year. It's very difficult to believe him. How would that evidence look on this chart?
As you can see, the witness' poor credibility has influenced our view of the evidence. We don't believe that it is very convincing, mostly because we don't believe him. If the evidence was taken on face value, it would have changed the probabilities. Because it isn't credible, though, we only give it a very low probability that supports either inference. It doesn't change anything. As we go through our subconscious assessment of the evidence, we discount or magnify the value of evidence based on its relevance, credibility and the probative strength. Even if one witness or document is very relevant, if we don't believe it, we won't be persuaded by it. If the evidence is credible, but not relevant, it also shouldn't influence the final decision. Further, if evidence is relevant and credible, but isn't very convincing, it may not change the inferences we make when making our ultimate decisions.

3. Internal Consistency

Another element that can affect the probative strength of evidence is whether it is internally consistent. While corroboration compares the consistency of one quantum of evidence with other evidence in the case, internal consistency asks whether the quantum of evidence itself has any contradictions. For example, does the witness' testimony contradict itself? Or does an email, dated on Tuesday, mention a fact that could only have happened on Wednesday? If the evidence is not internally consistent, we tend to believe it less. This effects its credibility. If the evidence is internally consistent, this tends to make it seem stronger. Sometimes we used words such as "the story hangs together" or "the story holds water."

In the following example, there is an internal inconsistency in this witness' statement.

“In the morning, I was on my way to work on the bus. It was very loud, but I heard my phone ring. It was my wife. She had tried to call several times. She said that she heard something outside, and thought someone was trying to break in to our house. She then screamed, and I heard glass break. She dropped the phone. I could then hear her call our neighbor's name, and then something that sounded like he was being beaten."

We are struck that at the beginning of the statement, he said that it was very loud. However, he then clearly describes things that he heard over the phone, especially after the phone dropped to the floor. This is not internally consistent. If it isn't questioned, it may make us question the entire evidence.
However, what if he is asked to explain this? He could say that the bus had stopped, making it quieter. Suddenly, the story seems more complete and consistent. Thus, a witness can be confronted with the internal inconsistency. He or she may correct it and show that it was simply a mistake. This can improve its probative strength. If the explanation doesn't make sense, it can reduce the probative strength.

This suggests that the probability we ascribe to strong evidence comes from its degree of consistency. Is it internally consistent? Is it consistent with our normal expectations about the world? Is it consistent with other evidence and, hence, corroborated? While this degree of consistency helps make evidence stronger, it must also logically improve the probability of the intermediate inferences. The more logical the inference, we will assign that inference a higher probability.

The emotional quality of the evidence may also influence the probability we give to that inference. For example, a photograph which shows blood or injuries will probably be seen as stronger evidence than a photograph which doesn't, even if it proves the same inference.

Summary

Each quantum of evidence that is developed in an investigation and then presented in court has intrinsic qualities that relate to other evidence, the allegations, interim inferences and the final objectives of the case. The evidence can be relevant, credible and have probative strength.

The relevance of evidence depends on what needs to be proven. This includes any intermediate inference or final objective, such as the elements of the criminal offence, mitigating or aggravating factors, or factors needed to justify detention. If the evidence will make any such inference or conclusion in the case more or less probable, it is relevant.

If evidence is relevant, it may still not matter if it isn't believable. The credibility of evidence is a measure of its believability. The credibility of testimony depends on the witness. Does the witness have a basis to know about the facts he is asserting? Did the witness have the ability to perceive the facts clearly? Is the witness remembering the facts correctly? Is the witness lying?

The credibility of tangible evidence, unlike testimony, depends on how the item became evidence. Is it authentic? Was it collected and stored correctly? Can we be sure that it is the same object that was involved in the crime? If not, is it a copy that is accurate, such as a certified copy of a document? What factors help us believe that it is the same document?

While it can be related to credibility, the probative strength of the evidence doesn't focus on whether we believe in the evidence. Instead, it focuses on whether it is convincing. Does it make one inference more probable than another? Evidence can be stronger when it is consistent with our view of the world. The fewer assumptions we have to make in order for the evidence to make sense, the stronger it is.

Evidence can also be stronger it is consistent with, or corroborated by, other evidence. It can also be stronger if it is internal consistent. Conflicting facts can weaken the probability associated with the evidence. Probative strength is also related to the logical steps between the quantum of evidence and the inference. If it isn't logical, it will not be convincing. Further, if the evidence invokes emotions, it may
be seen as stronger. More emotional evidence may not prove anything more than less emotional evidence, but it will be more convincing because it involves the judge instinctively.
Review and Problem Set

Review:

Previous chapters focused on breaking a body of evidence into its various distinct parts. We called each of these parts a “quantum” of evidence. This helps us understand what the evidence is, where it comes from and what issues it might have. After describing the body of evidence by its various parts, though, each of those quanta of evidence can also be described. There is basic language that every attorney should be able to use to describe a quantum of evidence. That language should answer three important questions. Is it relevant? Is it credible? How much probative value does it have?

Relevance measures whether the evidence matters to the case. Credibility measures whether we should believe the evidence or not. Probative value measures whether the evidence is convincing. Evidence that is relevant, credible and has high probative value means that it matters to the case, should be believed and is convincing. Each of these three factors helps explain the importance of the evidence to the case, and should be viewed in relation to other evidence in the case.

The description of a quantum of evidence can depend on its context or source of evidence. Relevance depends on what needs to be proven. Probative value can be stronger or weaker, depending on whether other evidence corroborates or conflicts with it, whether it fits with our normal experience, or whether it is internally consistent. Credibility also depends on the source of evidence, as the credibility of a witness is different than the credibility of a document or physical evidence.

Problem Set:

1. Article 249(1) of the German Criminal Code defines Robbery as:

   **Whoever, by force against a person or threats of imminent danger to life or limb, takes property belonging to another with the intent of appropriating the property for himself or a third person, shall be liable for imprisonment of not less than one year.**

   In your case, the defendant was seen entering a store and holding a knife to the store’s owner, demanding money. The prosecutor also wants to prove that the defendant has a history of drug use. Is this relevant? Why or why not?

2. The defense attorney asks the store’s owner about his recent conviction for false tax receipts. Why would this be relevant?

3. The robbery is shown on the store’s video security system; however, the date and time on the recording are wrong. How does this diminish the quality of the evidence? How might that be remedied?
4. The store owner claims that 15,000 euro was stolen during the robbery. His bank records show that he deposited 18,000 euro later on that day. The store owner says that the bank records are not right. How might he show that the evidence shouldn’t be believed?

5. How probable do you believe that the evidence is true when a witness describes the robbery? Do you feel that it is more probably true when you see the security video? When both the tape and the witness are saying the same thing, does this make this seem even more probable? What if the tape and the witness say something different?
Sample Answers

1. The defendant’s drug use may be relevant if it explains why he was robbing the store. This explains the motive of the crime. However, if the drug use is old and unrelated to the current crime, it is not relevant. In other words, it doesn’t make any of the final objectives more or less probable to be true.

2. A witness or victim’s testimony should be credible. If there is evidence which questions that credibility, it should be heard and is thus relevant. The credibility of a witness includes such elements as his ability to see the crime, his ability to remember it accurately, or his bias. However, his veracity or tendency to tell the truth is also important. If the victim has a history of lying, especially in official matters, this can be relevant so that the court can determine whether or not it believes the victim.

3. Just like witness credibility, a document or videotape should also be credible. A document must be authentic, accurate and reliable. In this case, it isn’t clear that the tape is actually depicting that the crime took place when the it did. It has the wrong date and the wrong time. There is something inaccurate. What if the defendant has an alibi for the time on the security video? While it still shows a crime occurring, its inaccuracy makes it somewhat less credible. However, if the police notice the bad time stamp and can testify that they compared the time stamp with the real time and calculated the difference, it’s accuracy and credibility can be restored.

4. The store owner (or prosecutor) wants to show that there was a real loss from the robbery, which the bank record undercuts. The store owner believes that the deposit was on the day before, but was mistakenly recorded the next day. If he has his bank receipt from the deposit, this may diminish the credibility or probative force of the bank record. He could also ask the bank about whether the system they use has any errors. He could show that he questions mistakes in his bank account every month, which the bank corrects.

A bank record is simply a product of a system where the teller or clerk enters in the information, and then the computer records it. It is later retrieved from the system. If the entry of the information or the recording and retrieval is not accurate, it may not be considered credible.

5. A witness has many issues which affect his or her credibility, such as memory, perception or bias. A video system can only record what it sees, but can be changed or altered. We tend to give more credibility to the evidence that doesn’t have memory, perception, bias or other human faults. Often we believe the videotape more than the witness, especially if it is clear, accurate and reliable.

However, if the witness testifies to the same thing that the videotape shows, the two quanta of evidence corroborate each other. We find it more likely to be true when we consider both together than we would for either the witness or tape alone. If the witness and the video contradict each other, however, the probative value of both goes down. The quantum of evidence which is more credible is likely to be believed and relied upon.
In the preceding chapters, we have reviewed and explored some of the most important dimensions of evidence. It leads to some basic questions to ask as the body of evidence is being developed during the investigation, or as you prepare for trial.

a) What is a body of evidence and what is a quantum of evidence?

When we talk about evidence, we often are being inexact. Evidence can be a witness’ testimony, but that testimony is often a series of assertions. The witness asserts that he was near the murder scene. He asserts that he heard gun shots. He asserts that he saw the flash of the gun. He asserts that he heard five gunshots, and so on. A document can assert many different things. Physical evidence, such as a bullet, pistol, or a dead body, can also "assert" many things, such as ballistics testing, fingerprints or other forensics.

We can thus break down evidence into a body of evidence and quanta of evidence. The body of evidence is the collection of all of the assertions made by the evidence. The quanta of evidence can be equated to each of those assertions. Each of those assertions, or each quantum of evidence, can be tested for such qualities as relevance, credibility and probative strength.

b) What do we need to prove?

Evidence depends on its context to give it meaning and relevance. This means that we have to understand what we need to prove. This means that the elements of the criminal offence, mitigating or aggravating factors, or other procedural needs can be very important to understand whether evidence is critical or even
needed. As a prosecutor qualifies the charges against a defendant, he or she is often considering what evidence is available and what crime might have occurred. Those charges, and the need to show harm to the victim, confiscate assets, detain the defendant, and other steps will inform the prosecutor what needs to be proven. These are the final objectives that need to be proven.

The defence attorney, on the other hand, should be challenge evidence and looking for proof that contradicts or weakens the evidence as it relates to those final objectives. There is no more powerful statement for a defense attorney to utter in court than "the prosecution has not offered any proof to substantiate a charge."

Thus, if the prosecution has to show that the murder was intentional, there should be some evidence that either directly proves that the defendant intended the victim to die, or supports that conclusion with indirect evidence. Whether the evidence offered actually proves the defendant's intent depends on its quality and quantity.

Thus, the practitioner should identify the elements of the crime, the elements needed to prove confiscation of assets, the elements needed to justify detention (if warranted), information needed to justify higher or lower sentencing, and any harm done by the criminal act. During the investigation, the practitioner should ensure that evidence is developed to satisfy those final objectives. This includes any direct evidence or indirect evidence, as well as evidence which make any of the intermediate inferences more or less probable.

c) What are the Final Objectives and Intermediate Inferences?

When you have identified what you need to prove, it can sometimes be proven with evidence that directly establishes that element. For instance, if you have an eyewitness to a murder, he or she can testify that the defendant shot the victim five times. That shows a direct link between the evidence (the testimony) and the elements of the crime ((1) the defendant took an action, (2) that action caused a death, (3) the defendant intended to kill the victim.) The witness saw the defendant take an action (shoot the gun), he saw the action cause a death by those gunshots, and finally, the five gunshots and the defendant's demeanor can establish that it wasn't accidental, but intentional.

However, some evidence doesn't directly establish an element of the crime. What if the witness didn't see the murder, but heard the five gunshots? That doesn't establish any of the three elements. All it does is establish that the witness heard five gunshots. There are several steps between that fact (witness heard gunshots) and the final objective of any of the three elements. We have to make several inferences. This inference is that the gunshots that he heard were those that killed the defendant, who was found with five bullet wounds next door. This inference establishes a time of death, and may help establish that the killing was intentional. The witness' testimony alone isn't enough to connect the defendant with the murder, much less convict him.

When other evidence is added, there can be other inferences. The caliber of the weapon matches a pistol recently purchased by the defendant. A matching weapon was found in a dumpster near a petrol station where the defendant was seen. The defendant states that his new pistol was lost. Do any of these individual pieces of evidence prove any of the elements of the crime? Not directly.
Instead, they collectively support several intermediate inferences. We can infer that the pistol in the dumpster was the murder weapon. We can also infer that the defendant's threw that pistol into the dumpster. These inferences then help us conclude whether the elements of the crime have been proven. If we have confidence in all those inferences, we deduce that the elements of the crime are proven. If we don't have confidence in one, some or all of those inferences, we may not feel that the crime has been proven.

Thus, analyzing evidence doesn't merely involve looking at each quantum of evidence more closely. This is important, of course, but we also look at the body of evidence and what must be proven. For every piece of evidence and every inference that is made, we assign a level of certainty or probability. We assign some evidence and some inferences very high levels of certainty. We would call such evidence and inferences strong. We would feel more confident that they proved something. Other evidence or inferences may have lower levels of certainty. We would consider those to be weaker, and would not feel as confident.

Further, being able to describe evidence is important. However, practitioners should also be able to describe the specific logical inferences that the evidence supports, and then describe why the evidence and inferences can support a final conclusion. Judges, likewise, should be able to understand those arguments and be receptive to them. While we often make these assessments subconsciously, courtroom advocacy requires practitioners and judges to have the common vocabulary to assess the strengths and weakness of the individual evidence and the body of proof. The final written decisions and judgments by the court should reflect the qualities of the evidence and the analysis of the proven case.

d) What are the qualities of evidence?

Each quantum of evidence has different qualities. Those qualities can change, depending on what needs to be proven and the other evidence in the case. These three qualities are generally termed relevance, credibility and probative strength.

1) Relevance

The relevance of the quantum of evidence depends solely on what needs to be proven. It is also called materiality. If the evidence does not increase or decrease the probability of an intermediate inference or the final objective, then it isn't relevant. In other words, the evidence must affect some important inference or decision in the case.

2) Credibility

Once we determine that evidence is relevant, we then consider whether it should be believed. The credibility of the evidence is a measure of whether that evidence is believable. The credibility of witness testimony reflects the ability of the witness to have perceived what they assert, their memory of the event and bias. This measures whether the testimony is accurate or complete. However, credibility also considers whether the evidence is true. Thus, credibility also reflects whether the witness has lied.

While testimonial evidence can be inaccurate, incomplete or simply false, tangible evidence has similar limitations that affect its credibility. We should worry whether the tangible evidence is authentic, or in
other words, is it really true? Is it really the pistol found at the scene? Did that bank statement really come from the bank? Has the evidence been falsified, altered or tampered?

If that evidence is authentic, then does it reflect a process that is accurate and sensitive? For a bank statement, does it really reflect a process where a bank teller accurately records the information? Does it happen regularly? For many business or government documents, we consider whether the process was normal, regular and unbiased. For physical evidence, such as a fingerprint, we consider whether the forensic process was normal, regular, and scientifically correct.

3) Probative Strength or Weight

After we have determined that the quantum of evidence is relevant and that it can be believed, we must consider how convincing it is. Relevance measures whether it affects the likelihood of an inference or final objective. Probative strength measures the degree of that probability. We often say that evidence with a high probability supporting a final objective as strong evidence. Often this means that of all the possible inferences we could make from that evidence, one inference is the most likely and the others are less likely. If that inference supports the guilt of the defendant, for instance, we would say that the evidence is strong.

This probability or strength can be influenced by a number of factors. It can be related to the credibility of the evidence. It can be bolstered by other evidence which corroborates it. It can seem stronger if it is internally consistent. If the evidence is emotional, it may feel like it has more weight. The evidence can also seem weaker if it asserts something unusual or outside of normal expectations. However, if it clearly leads to a logical conclusion in support of the assertion, it appears to be strong. Thus, probative strength is a combination of consistency, logic, emotion and belief. Subconsciously, we assign probabilities based on these factors. If those factors make us more certain about the inferences and conclusions necessary in the criminal case, then we conclude that the evidence has great weight. If those factors are conflicting or make us less certain, we conclude that the evidence is weaker.

e) How would this be used?

We often say that we cannot pursue a case if we don't have any evidence. Evidence feels very real and tangible. However, when we begin to analyze evidence, it begins to feel more theoretical and ephemeral. Unless we see how these factors can be put into practice with real evidence, we may simply rely on our subconscious processes of analysis rather than use it to improve the body of evidence during the investigation or skillfully debate it in court.

Using the facts from the "Case of the Desert Eagle," we can imagine how a court may write a final opinion evaluating the evidence. You may wish to review the chart and then read our hypothetical final opinion.

The medical evidence and eyewitness testimony establishes that the victim was shot at 12:30. We deem the expert's opinion to be reliable because he is an educated and well-experienced medical examiner and he used the latest, well-accepted scientific methods to place the time of death. We deem this testimony to be credible, as the witness had the opportunity to hear the gunshots and could place the timing because of the television show he was watching. The evidence corroborate each other, and we thus consider this evidence to strongly support the conclusion that the victim was shot at 12:30.
The telephone records of the defendant were also credible, as they were produced by the phone company as a result of an accurate and reliable process. They showed that the defendant telephoned the victim from 12:10 to 12:12, a mere 20 minutes before the victim's death. From this we can strongly infer that the defendant and the victim knew each other, and that they had a conversation shortly before the victim's death.

The medical examiner also testified that the victim was shot by four bullets, killing him almost instantly. The ballistic test conducted by the forensic lab confirmed that these bullets were .44 caliber bullets. We deem that evidence to be credible because of the experience and training of the technician and the intact chain of custody of the bullets from the crime scene to the forensic lab. He used well-accepted techniques to measure the caliber of the bullets.

There is a Petrol Station which is 300 meters from the victim's house. The police searched the dumpsters at 16:00, three and a half hours after the time of death. They found a .44 caliber Desert Eagle pistol. There was an intact chain of custody between the crime scene and the forensics laboratory. The ballistics technician then fired bullets from that Desert Eagle pistol and compared them against the bullets taken from the victim's body. He used well-accepted and scientifically credible techniques, and concluded that the bullets matched the Desert Eagle. From that, we can confidently conclude that the Desert Eagle pistol found at the Petrol Station was the murder weapon. We can also conclude that, between 12:30 and 16:00, that weapon was placed into that dumpster. The police report and the ballistic report both confirm that the weapon's serial number had been filed off. While there were some partial prints, the police and the forensic lab both concluded that the weapon had been wiped to remove the fingerprints. There is no usable fingerprint evidence from the weapon.

The registration of firearms have been considered reliable by this court many times, as the documents are filled out by the applicant and kept on file in the central archives as part of a normal and regular practice to retain the records. We deem them credible. Those records show that the Defendant purchased a .44 caliber Desert Eagle pistol three weeks prior to the day that the victim was killed. The serial number of that weapon, as recorded on the registration, was 1232387A.

The Petrol Station has surveillance cameras. They record 24 hours a day and the tapes are kept in a central place. There is a time-stamp on the recording which is accurate. They reuse the tapes every two days. One of the cameras looks down at the pumps. The police retrieved one of the tapes from the day that the victim was killed. We deem the video credible and accurate. At 12:40, the video-recording shows the defendant's BMW arrive at the pumps. The defendant gets out of the car to have a cigarette and pays with his debit card. He appears nervous.

The bank records of the defendant were also credible, as they were produced by his bank as a result of an automated process which was accurate and reliable. The records show that the defendant used his bank card to purchase fuel at the Petrol Station near the victim's house. That purchase occurred at 12:44. This corroborates the activity and the time shown on the Petrol Station's surveillance tape. From this, we can strongly infer that the defendant was at the same Petrol Station where the murder weapon was found during the period of time that the weapon was placed in the dumpster. The surveillance tapes do not show the dumpster, which is on the other side of the building.
We can also conclude that the defendant was within 300 meters of the victim's house a mere ten minutes after the victim was shot. He thus had the opportunity to murder the victim.

When the police first questioned the defendant, they asked him whether he still had the Desert Eagle pistol that he had purchased three weeks before. He responded that he had lost the pistol, and wouldn't explain more. This assertion does not seem credible to us, as it would be a major concern to most normal people if they had lost a pistol. This is even more incredible, as he had just purchased the weapon three weeks before hand.

From the evidence established at trial, this court concludes the following. The defendant knew the victim and called him less than 20 minutes prior to his death. The defendant owned a Desert Eagle that matches the murder weapon. He purchased the weapon weeks before the murder. We conclude from the evidence that the defendant's Desert Eagle is the murder weapon, which he took efforts to hide by filing the serial number, wiping the fingerprints, and hiding the weapon in the Petrol Station dumpster near the victim's house. The evidence conclusively shows that the defendant was at the Petrol Station minutes after the murder, and during the period of time that the weapon was hidden there.

Thus, we conclude that the victim was killed by the actions of the defendant, to wit, shooting him four times by the Desert Eagle pistol. We conclude that the victim died from those actions. The defendant intended those actions to kill the victim, which we infer from the victim being killed by four bullets. This shows that it was not accidental, but intentional.

We also conclude that the defendant prepared ahead of time for the murder. Three weeks before, he bought a pistol. He removed the serial number from the pistol. He called the victim before he arrived, and then shot him four times. After the murder, he wiped the fingerprints from the pistol and threw it in the dumpster at a nearby Petrol Station. When he was asked about the pistol by the police, he lied and said that it had been lost. Due to these aggravating circumstances, we conclude that he deserves a higher sentence.

The judgment above is concise and logical. It only discusses the relevant evidence. It examines each quantum of that evidence and determines its credibility. It then begins discussing the inferences that must be made and how compelling they are. Finally, it concludes that the elements of the criminal offence are met, and that the defendant also deserved a higher sentence because there was proof of aggravating circumstance.
Part II

Challenges and Inferences
In Part I, we discussed the basic vocabulary and concepts needed to understand and analyze evidence. With this knowledge, a practitioner can investigate and develop evidence which is stronger and more accurate. He or she can advocate for their case by describing and analyzing the evidence critically. A court can evaluate the body evidence without relying on emotions or sweeping conclusions.

However, evidence is not always consistent. Typically, some evidence in a case may clearly support guilt, but other evidence may be inconclusive or even exculpatory. Conflicting evidence can weaken the prosecutor's case, but does not necessarily mean that the prosecutor hasn't proven guilt. A defense attorney will certainly try to find evidence which contradicts the prosecutor's allegations and even establishes innocence, such as an alibi. However, such evidence of innocence is rare. Thus, opposing evidence is usually limited to a few categories: Evidence which contradicts the factual assertions of other evidence, evidence which contradicts the inference that can be made from other evidence, and evidence which contradicts the quality of other evidence. Evidence can also be opposed by questioning the quality of the evidence itself. It is only when the contradictory evidence had been presented and the quality of the evidence has been questioned can we say that the proof has been fully tested.

a. Contradictory Evidence

There are three forms of contradictory evidence. The first is the most basic and obvious, and thus can be the strongest if the evidence is available: Evidence which contradicts the factual assertions of other evidence. However, some evidence doesn't directly contradict other evidence, but instead contradicts the inference that can be made from other evidence. This can be equally powerful. Both of these types of
Evidence may not be easy to find, even if it exists. There is a third form, however, which is often more easily found: evidence which contradicts the quality of other evidence.

1. Factual Contradiction.

Evidence which contradicts the factual assertion of other evidence can be the strongest and most obvious. For example, the prosecutor has evidence that the defendant was at the petrol station on Friday at 12:40. If the defendant can establish an alibi, such as demonstrating that he was having lunch with friends in another city, this factually contradicts the prosecutor's evidence. The judge must consider the credibility of two contradicting sources of evidence and then must either believe one, or the other. He cannot believe both to be true.

2. Inference Contradiction.

The second category requires the contradicting evidence to undermine the inference being made from the other evidence. In our "Desert Eagle" example, a strong inference is made that the murder weapon was the same pistol that the defendant had recently purchased and then lost. There is no direct evidence that these two weapons are the same, but the indirect evidence strongly supports inferring that they are the same. If there is a defense witness who says that the defendant had left the pistol at his house after practicing shooting the week before the murder, this would undermine the inference that we have made about the murder weapon. We would then have to either believe the defense witness or the inference that we have made from the other indirect evidence. We would be weighing the credibility of that witness against the combined credibility and probative strength of the indirect evidence. We may decide that we don't believe the witness because of the strength of the other supporting evidence.

However, if that witness then produces the defendant's Desert Eagle, with the appropriate serial number still intact, then this severely undermines the inference that we have made. Would that new evidence conflict with any of the established facts? Not really. The victim was still shot four times with a .44 caliber pistol. Those bullets matched the Desert Eagle found in the Petrol Station. It would have corroborated the defendant's assertion that he had lost the pistol, and would have made any inference that the defendant's pistol was the murder weapon unconvincing.

3. Contradicting the Quality of Other Evidence.

The last major form of contradictory evidence is evidence which addresses the quality of other evidence. For instance, the neighbor in the "Desert Eagle" case claims to have heard the gunshots at 12:30, stating that he had just started watching a television program which let him know the time. If the defendant offered evidence from other neighbors which showed that the witness had very bad hearing, that evidence would not contradict his story. It would, however, raise questions about his ability to have perceived the gunshots. This could allow a defendant to introduce doubt about his testimony and the time of death.

There are many forms of contradicting evidence which is offered to question the relevance, credibility or probative strength of other evidence in a case.  

Contradicting evidence is not limited to the defense offering evidence to contradict the prosecutor's case. The prosecutor can also use evidence to contradict the defense. For instance, it is important for the court to assess the
You can remember from Part I that evidence has three qualities: relevance, credibility and probative strength. Relevant evidence must have the possibility of increasing or decreasing the certainty of one or more inferences or final objectives of the case. If it doesn't do this, it is irrelevant or immaterial. Credibility relates to the believability of the evidence, and it should be considered differently depending on whether the evidence is testimonial or tangible. It can be affected by veracity, bias, limits on perception (such as poor eyesight, distance, or obstructions), memory, authenticity and accuracy. Lastly, the probative strength of evidence measures whether the evidence is convincing. Is it consistent, is it corroborated, and does it make sense in light of normal expectations? Does that quantum of evidence (or body of evidence together) make one conclusion or inference more likely than another?

We can see from the following table some of the evidentiary sources which can typically be used to contradict the qualities of evidence.
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<th>Quality to be challenged</th>
<th>Issue to be Challenged</th>
<th>What could be used to challenge the quality of evidence?</th>
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<td></td>
<td>Relevance</td>
<td>Evidence that suggests that the case is trying to prove the wrong allegation.</td>
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<td><strong>Credibility of Testimonial Evidence</strong></td>
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<td>Evidence that witness is forgetful Evidence that witness takes medicine Evidence that witness uses drugs or alcohol Past medical conditions. Evidence that witness makes mistakes.</td>
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<td>Internal Consistency</td>
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<td>Logic of Inference</td>
<td>Evidence that makes another inference seem logical also.</td>
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<td></td>
<td>Emotional quality of evidence</td>
<td>Evidence which reduces the emotional quality of the main evidence.</td>
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i. Relevance

Since the interim inferences and final objectives of a case, such as the elements of the criminal offence, determine whether evidence is relevant, it isn't easy to challenge the relevance of evidence. At most, a defense attorney might offer evidence that suggests that evidence isn't as relevant as it first appears or that the inferences and final objective are not appropriate. This is rare. As an example, an expert may testify that a particular forensic test is the most suitable to use to identify a narcotic substance. The defense attorney may offer an expert who cites extensive scientific studies to show that forensic test to no longer be consider valid. In doing so, the defense expert is not trying to diminish the value of the forensic expert, but trying to make the test results irrelevant.

ii. Credibility of Testimonial Evidence

An opposing attorney could seek many forms of evidence to challenge the credibility of a witness. It can be as simple as finding other witnesses who say that the eyewitness couldn't have seen the bank robbery from where he was standing. This challenges the eyewitness' ability to have perceived the evidence. If other witnesses or evidence makes it clear that a witness couldn't have seen the actions that she claims to have seen, that evidence reduces her credibility.

The ability of the witness to have perceived the actions can be challenged with other evidence. If the witness has prescription medicine, does that medicine have side-effects which impair the vision or cause hallucinations? Do his neighbors say that the witness has needed new glasses for a long time, or has poor hearing? These other sources of evidence may raise questions about whether the defendant actually perceived the event about which he is testifying.

If the witness has a reputation for having a poor memory, or forgets her keys constantly, does this raise concerns about her ability to remember events clearly? Does she use medicine with a side effect of impairing memory? Will someone testify that she doesn't always remember things well, such as faces, numbers or names? If she has such a problem, has it ever been raised at work?

Do neighbors or co-workers believe that the witness has a bias against a certain group? Is the defendant a member of that group? Do they believe that the witness tends to focus on her interests and fail to notice what else goes on? Do they use phrases to describe the witness such as "she is in her own little world," or "she tends to forget that the rest of us are here?" This could indicate that she will have selective perception, which means that she may not have perceived the events objectively. Instead, she only perceived and remembered the events in which she had an interest. Alternatively, does the witness have an aversion to certain things? If a person is known to hate the sight of blood, this would certainly be a fact to question if that person was a witness to a severe physical attack.

There can be other events which create a bias or affect people's objectivity. If a witness has previously suffered through a similar event, that could make it far more emotional for the witness to observe. Does that witness have post-traumatic stress disorder from the previous attack? This may also taint what they saw and how they remember the events.

Lastly, a witness may have a reputation or history of being untruthful. A witness with a criminal record of perjury will not project great credibility. However, what if the person has a reputation for cheating on
tests or lying at work? What if they don't actively lie, but have a reputation for omitting important facts? If there is evidence that the witness has the traits, it can also influence the credibility of the witness.

### iii. Credibility of Tangible Evidence

Tangible evidence, such as documents, bank records, telephone records or physical evidence, can sometimes be offered into evidence as an infallible truth. However, the opposing attorney may be able to find evidence which can raise questions about the credibility of that tangible proof. An obvious example would be a past finding by a court that the police had collected similar evidence in another case, and either lost it or mishandled it. This would call into question whether the police had handled all of its evidence poorly. The opposing attorney could then ask whether the physical evidence in the current case was authentic.

Any past records of problems with the collection and accuracy of a process that creates evidence can be relevant. Remember that most tangible evidence is the result of a process. Crime-scene evidence is the process of accurately collecting, preserving and testing the actual objects found at the scene. Any failure, or hint of failure, in that process can affect the credibility of the evidence at trial.

The process that creates most documents, such as phone records, bank records, or even wire-intercepts, are supposed to be able to accurately obtain all the relevant information, accurately record it, and then reliably retrieve it. If the bank teller who entered the data has been given multiple warnings about her inaccurate work, would that make a bank record that he created seem less credible? If the computer system at the bank had multiple software problems, would that also affect the credibility of the bank record? Would it seem less accurate? Finally, if the bank has to correct many people's bank statements each month, would that make the whole system appear to be less reliable?

### iv. Probative Strength

Like relevance, it may not be easy to find separate evidence which influences the probative strength of the main evidence. There has to be evidence which simply makes the main evidence less convincing. While this isn't easy, there may be evidence that can be obtained which may raise those questions.

First, the main evidence may seem plausible. It may "fit" with the normal expectations of the judge. However, there may be evidence which makes the main evidence appear less normal. For example, a witness says that he was walking along the street and he saw the robber run out of the bank and drive away in a red Ford. This seems very plausible. However, the witness' friends say that they've never known the witness to walk and that he always drives, no matter how short the distance. Suddenly the testimony doesn't seem so plausible because a question has been raised. Why was he walking along that street? Thus, any new fact which tends to make the witness' testimony appear to be odd or unusual may reduce its probative strength.

Second, the main evidence of the prosecutor may be highly corroborated. There may be little, if any, conflicting information. The story seems very consistent. A defense attorney may want to find evidence, if it is minor, which is inconsistent. In the "Desert Eagle" case, for instance, the facts are consistent and corroborate each other well. How well corroborated would it seem, however, if the defense attorney finds evidence that the witness' television show, which that witness used to remember the time of the shooting, had started five minutes late because of a news report? Would it be important that the "Desert Eagle" was
the most popular pistol in the city, with 25% of guns being that model? Would the main evidence still be convincing?

How strong would the corroboration seem if the defense attorney discovered that the dumpster near the petrol station was usually emptied at 14:00? Remember, the defendant was proven to be at the petrol station at 12:40, and the police found the pistol in the dumpster at 16:00. This new evidence would not mean that the defendant is innocent. He could have thrown the pistol in the dumpster afterwards, or maybe the dumpster wasn't emptied that day. However, that information does make the inference that the murder weapon belongs to the defendant less probable.

Third, additional evidence could be used to challenge the internal consistency of the main evidence. A witness' testimony will seem more compelling if it is consistent and there are few facts that conflict. However, the opposing attorney could find evidence of small inconsistencies. After raising many of those small inconsistencies, the testimony may still seem credible, but we may think it isn't as convincing. We have assigned a lower probability that it is true and accurate, in other words.

For example, a woman testifies that she stood by a car and watched the bank robbery. She describes the weather as sunny, and the robbers as using "rifles." The defence attorney shows her evidence that it was a truck and not a car. He shows her a weather report that shows that it was cloudy. The bank's surveillance camera shows the robbers with shotguns and pistols. While these differences don't affect the main facts being described by the witness, they do make it seem less consistent. If the witness has given a past statement, it may also be used to challenge the internal consistency of the testimony. While that witness may still be credible, however, she may not be as convincing as she had been.

Probative strength can also be affected by the logic of the inference from the body of evidence. An opposing attorney can try to find evidence that helps make other inferences appear logical. For instance, there is a logical inference that the defendant wouldn't have bought a new "Desert Eagle" pistol and then immediately lose it. That inference helps support the conclusion that he didn't lose the pistol, but that he threw it in the dumpster after the murder. What if there was other evidence which made another inference also logical? An extreme example would be that the defendant had a medical report showing that he had received a severe concussion during a basketball game, soon after he bought the pistol. On the medical report, it says that he had trouble remembering where he'd left his cell-phone and keys. In fact, he had to buy a new phone to replace the one he'd lost. Does this information present another logical inference?

On the one hand, it isn't logical that he purchased a new pistol, but lost it within 3 weeks. Therefore, he must have purposely thrown the pistol away. However, with the new evidence, there is an alternative explanation which is logical. The defendant purchased a new pistol, but then suffered a severe concussion. This gave him poor memory, and he lost several important things such as his car keys and his cell phone. He even had to buy a new cell phone. Suddenly, there are two logical explanations: he threw the gun away purposely or he actually did lose the pistol. We may not think that the second explanation or inference has much probability of being true, but we aren't as certain as we once were.

The emotional quality of the evidence may make some evidence seem more convincing than identical evidence that doesn't have the emotional tone. For instance, a photo of a dead child is more compelling than that of a dead adult. Some crime scene photos may have more impact than others. A recording of the victim's voice calling the police, trembling with fear, is also rich with emotion. All of this makes it
more compelling for various reasons. It may be difficult to find other evidence which negates that intangible effect. Even if there is such evidence, it may not be worth raising it.

For example, however, the prosecutor offers a photograph of the defendant standing in front of a symbol with heavy, negative connotations, such as a Germany Nazi Flag. This photograph was found on his cell phone. This evidence would evoke emotions in many people, as they would associate the defendant with the symbolism of the flag. The defendant finds evidence that shows that the flag was in a museum and that many people had their photograph taken there, along with many other parts of the museum. Does this new evidence reduce the emotional reaction to the initial evidence?

v. Summary

During the investigative phase of any criminal procedure, the prosecutor and defense attorney should look for evidence which support their theory of what happened. However, this also should include looking for evidence which weakens the assertion of the opposing party. This can include evidence which directly contradicts the main evidence. However, it can also include evidence which contradicts an inference which the main evidence suggests, or provides a strong alternative inference. Not only should a practitioner look for evidence which contradicts the primary evidence or inferences in a case, but also evidence which can contradict the apparent quality of the primary evidence. The most obvious quality of evidence which can be confronted is its credibility, mostly by finding evidence which question the witness' ability to perceive the evidence, remember the evidence, or accuracy of their memory. It can also question their veracity. Documents and other tangible evidence can also be shown by other evidence to be untrustworthy. While not impossible, it is often more difficult to find evidence to either confront the relevance or probative strength of the main body of evidence.

Finding evidence which confronts evidence directly or questions its qualities is a strong way to contradict the main body of evidence. When that evidence isn't available, the practitioner should critically question the qualities of the evidence presented by the opposing party. When the qualities of evidence are more critically examined, it assists the court to better evaluate the evidence and adjudicate the case.

b. Questioning the Quality of Evidence

The most common way to question the quality of evidence is to cross-examine the witness who is testifying or introducing the evidence. This generally can affect the credibility or probative strength of the evidence. For instance, a witness can be asked questions about her ability to view the crime, her vision, her medicines, or obstacles. This could undermine or improve her credibility. She could be asked to clarify the internal consistency or inconsistency of her story, or ask her to explain other evidence which is corroborative.

This is not a section about cross-examination as a means to create an undue impression that a person is not credible. Such advocacy skills are best described in another book. Evidence, however, does depend upon the impression left upon the judge or fact finder. If a witness is unclear or unsure about their testimony, that uncertainty will justifiably affect their credibility. If an attorney can make that witness express that uncertainty during the cross-examination, that has evidentiary value.
1. Cross examination of witness testimony

Depending on the rules of the legal system, cross examination can be as simple as additional questions by the opposing attorney. In other systems, though, it means asserting a fact to the witness and asking them to confirm or deny the fact. This may not be permitted in some systems.

For example, the neighboring witness in the "Desert Eagle" case had heard shots at about 12:30, which he could time with the beginning of the television show.

Question  How far is your house from the victim's house?
Answer   About 50 meters.

Question  Was your television on?
Answer   Yes

Question  Was it loud?
Answer   Not very loud.

Question  Were you in the same room with the television?
Answer   No, I was in the kitchen. It isn't very far, though.

Question  Was the television loud enough to hear in the other room?
Answer   Yes.

Question  What were you doing in the kitchen?
Answer   I was making lunch.

Question  What were you making for lunch?
Answer   I don't remember.

Question  What do you normally have for lunch?
Answer   Pasta

Question  Were you boiling water for the pasta?
Answer   I don't remember if I was having pasta that day.

Question  Do you remember what you were doing when you heard the loud sound?
Answer   Do you mean the bangs, the gunshots?

Question  Yes, what you've called the bangs.
Answer   I remember I was making lunch.
Question: But you can't remember what the lunch was?
Answer: No.

Question: Do you remember what you were doing in the kitchen when you heard the bangs?
Answer: No. I was in the kitchen.

Question: Did you look out the window?
Answer: No.

Question: Did you stop what you were doing to investigate?
Answer: No.

Question: Were you scared by the bangs?
Answer: No, not really.

Question: Were you concerned by the bangs at all?
Answer: I heard them. I thought they were odd.

Question: Did you stop preparing lunch?
Answer: No.

The questioning of the witness has open-ended questions and moves logically from one topic to another. The attorney is asking questions which probe the credibility of the witness, including whether there was other noise, whether he could remember details, or whether the sounds were really so memorable that he remembered it correctly. Another approach which some systems would allow involves asking the witness to confirm or deny facts which the attorney asserts.

Question: Your house is 50 meters away from the victims, isn't that correct?
Answer: Yes, more or less.

Question: You were in the kitchen when you heard bangs, right?
Answer: Yes.

Question: Your television was on, correct?
Answer: That's true.

Question: Your television is not in the kitchen, correct?
Answer: Correct.

Question: And it was loud enough that you could hear it in the kitchen, correct?
In both of these examples, the attorney is questioning the credibility of the witness' testimony. The attorney could ask a final question, such as "You wouldn't have been able to hear the bangs clearly over the noise of the television, while preparing lunch in a kitchen that was on the other side of the house." The witness may still say that he could hear the bangs clearly, but he may not seem as credible as he did during his direct examination.

2. Cross examination of tangible evidence

We have discussed the difference between testimonial evidence, which a witness asserts, and physical evidence, which must be considered differently. The actual physical object, such as the weapon, fingerprints, blood samples, documents, computers or other similar evidence, has its own properties. The "Desert Eagle" pistol, for instance, has its own properties. It is a .44 caliber Desert Eagle pistol. Its serial number has been filed off. It may not have fingerprints. It may have a certain number of bullets. It can be tested and other information can be obtained from it.

However, there is other information which is important about the Desert Eagle that can't be known by examining it. Where was it found? Who found it? When was it found? There is no way to link the Desert Eagle to the defendant by simply examining it. That additional information is important. Is that information given to the court through a police report, or by testimony at trial? If the police officer who found the pistol in the dumpster testifies, the credibility of the pistol can be tested.

Question Are you the police officer who found the Desert Eagle pistol?
Answer Yes.

Question Where did you find it?
Answer It was in a dumpster behind the Petrol Station.

Question Did you photograph the dumpster?
Answer No.

Question Is it normal procedure to photograph the place where a possible murder weapon is found?
Answer It may be. I'm not sure.

Question Did you leave the pistol in the dumpster for the crime scene specialist to remove it?
Answer No. I took it out wearing gloves.

Question Is it normal procedure to let the crime scene specialist remove the weapon?
Answer It may be. I'm not sure.
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
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<td>Who else saw the pistol in the dumpster?</td>
<td>Nobody. I pulled it out of the dumpster and took it to my shift supervisor.</td>
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<tr>
<td>What did your shift supervisor do with it?</td>
<td>He kept it in his patrol car until we returned to the police station.</td>
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<tr>
<td>Is that normal procedure?</td>
<td>I'm not sure.</td>
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<td>Did you put this in your police report?</td>
<td>No. I didn't write a police report.</td>
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<td>Why?</td>
<td>My supervisor did not think it was necessary.</td>
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<td>Is it normal procedure for the person who finds important clues to write a report?</td>
<td>I think so.</td>
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<td>Is one reason for that procedure so that the police officer will remember details?</td>
<td>I remember finding the pistol in the dumpster.</td>
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<td>The murder happened 18 months ago, is that correct?</td>
<td>Yes, I think so.</td>
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<td>Do you work five days a week?</td>
<td>Yes</td>
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<tr>
<td>How many days have you worked since the murder?</td>
<td>Wow, that's a lot. 18 months times 20 days a month. Maybe 360 days?</td>
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<tr>
<td>So is it fair to say that in the 18 months since the murder, you've arrested about 180 people?</td>
<td>Something like that.</td>
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<tr>
<td>And how many times a month do you respond to citizen complaints?</td>
<td>Maybe 100 times.</td>
</tr>
</tbody>
</table>
Question: Is it fair to say that in the 18 months since the murder, you've responded to about 1,800 complaints?

Answer: Perhaps.

Question: In those 18 months, have you processed evidence?

Answer: Yes.

Question: How many times a month?

Answer: 5-6 times a month.

Question: So would it be fair to say that in the 18 months since the murder, you've processed evidence about 90 times?

Answer: Yes.

Question: You've been busy over the last 18 months, haven't you?

Answer: I work hard, yes.

Question: But without a police report, over all this time and all this activity, you remember this one pistol perfectly?

Answer: Yes. Absolutely.

Question: And you remember this perfectly even though you didn't take a photograph?

Answer: Yes. Maybe not perfectly, but clearly.

We will not dispute that the pistol exists, that it is a .44 caliber Desert Eagle, and that it has no serial number. But after the police officer's testimony, it isn't clear that the correct procedures were followed. He didn't take photographs or write a police report. It isn't clear that he removed it properly or preserved it properly. There may even be doubts that the supervisor stored it properly. How do we know it is the same pistol that he found? At this point, are we trusting the physical evidence (the pistol) or are we really trusting that the police have not made any mistakes?

In this way, we have identified questions about the credibility of the gun. The crime scene techniques may be faulty, and the gun may not be authentic. The entire system of evidence collection seems unreliable. The police officer has not collected it properly. The police officer claims to have a strong memory, but didn't take photographs or write a report. Further, he has conducted many other activities between the murder and the testimony, which makes it seem less likely he could remember this one event with great detail. Not only does this undermine the credibility of the pistol, but it also suggests another possible inference: the police has switched the real pistol found in the dumpster with a Desert Eagle that was also in the police custody. This inference may not have a high probability of being true, but it is an alternative.
Thus, the testimony of a witness or the qualities of tangible evidence can be challenged simply by a skillful, critical cross examination. The following chart suggests some questions that can address the quality of evidence, especially its credibility and probative strength.

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c. Summarizing the quality of evidence

A practitioner should seek evidence that challenges the main body of proof or the proof offered by the opposing party. That challenging evidence can contradict another quantum of evidence, contradict an inference that the main body of evidence would otherwise support, or can call into question the quality of the evidence, such as its credibility. The quality of evidence can also be clarified during cross-examination. However, a judge fact finder may not appreciate all of the challenges that have been made. In some legal systems, the prosecutor and defense attorney are allowed to give final statements, or closing
For instance, in the "Desert Eagle" case, the police officer had not followed proper procedures in retrieving the pistol from the dumpster. Furthermore, he handed it to his supervisor, who took it back to the police station. The supervisor did not testify. The defense attorney could summarize the qualities of that testimony and the pistol in the following way.

The police officer testified about finding the pistol in the dumpster at 16:00. Do we have a photo of the pistol in the dumpster? No. Did the police officer follow normal practices when he found the pistol? He wasn't sure. Did he write a police report so he could remember what he did? No. Why not? He said his supervisor told him not to. Why? We don't know, because the supervisor didn't testify. What did the police officer do with the pistol? He said that he gave it to his supervisor, who took it to the police station. How do we know that the supervisor did this? The police officer didn't see him take it to the police station, and the supervisor hasn't testified. How do we even know that this is the right pistol? We don't.

We also don't know if this is really what happened. The victim died eighteen months ago. The police officer has arrested about 180 people since then. He has responded to about 1800 complaints. He's been to 90 crimes scenes. That is a lot of things to remember. He didn't write a police report or take photographs when he found the pistol. He says that it was at 16:00, but how is he able to remember this one event out of over 2000 other things he did over the past eighteen months? How accurate is that time? How accurate is his recollection that it was even the right place? Did he really find it at the Petrol Station, or maybe he found it somewhere else? The only evidence is the testimony of the police officer who found it. He didn't write it down, didn't take a photograph, and has had over 2000 other events to remember. He may not be remembering it well.

The defendant has been tied to the murder because of this pistol. This is the only real link. The prosecutor asserts that this is the defendant's pistol because it is the same kind of pistol, a Desert Eagle. But we have shown that it is a very popular pistol and there are many people who own this pistol. The prosecutor asserts that the defendant must have put the pistol in the dumpster at the Petrol Station. The police have said that the pistol was found at the dumpster at that station, but how do we know? Is there a police report? Are their photographs? No. We have to rely on the memory of a police officer who is remembering this 18 months later, after many other crime scenes, arrests and other events. Did he really find it at this Petrol Station? Was it really at 16:00?

This Desert Eagle had no fingerprints, but did he really handle it correctly? He just picked it out of the dumpster and handed it to his supervisor. No wonder it didn't have the fingerprints of the real murderer. How many policemen handled it before a forensic technician could examine it? We don't know. Was it really a Desert Eagle that he found in the dumpster? We don't know, since we don't have a photograph. Do we even know what happened to that pistol? No, we don't. The supervisor took it from the police officer. Do we know what the supervisor did with it? No, we don't. The supervisor hasn't testified. The supervisor didn't write a police report. We simply do not know. How is the police officer supposed to know what his supervisor was doing? The supervisor was the boss, and it isn't his job to oversee his boss.
The pistol is a key piece of evidence. But is it the right piece of evidence? Is it even the right pistol? You have to believe the police officer. You have to think that he has an amazing, almost super-human memory. And you have to believe that he knew everything that his supervisor did. That is a lot to believe.

Suddenly, a key piece of evidence doesn't seem quite as credible when all of those questions are asked all at once. But how could the qualities of this evidence be described from the prosecutor's viewpoint? What is the strongest quality of the evidence? It is, in fact, well corroborated and there are other aspects which strengthen its credibility.

The defendant has questioned the credibility of the pistol. He asks if it is authentic. He asks if it was handled correctly. He even asks if it was found at the Petrol Station. He asks us to believe that this pistol was found elsewhere or maybe even switched by the supervisor. But let us take a look at all of the evidence together. The Desert Eagle which the police found matches the bullets that killed the defendant. That pistol was the murder weapon, so it had to have been at the crime scene at 12:30 since it was used to kill the victim.

Was the pistol found at the Petrol Station at 16:00? The police officer may not have written the police report, but the police did write a report at the police station. At that time, the evidence log and forensic police report says it was found at the Petrol Station at 16:00. Who would have said that? The police officer. This evidence log and police report was written at 18:00, just a few hours after the pistol was found. This information was fresh in his mind. Memory is not an issue here.

Thus, the murder weapon was at the victim's house at 12:30. It was in the police station being processed at 18:00. It was found by the police sometime before 18:00. We can believe the police report which says it was found at 16:00, since the police had just found it two hours before. Likewise, we can believe that it was found in the dumpster at the Petrol Station. Why? Because they had just found it two hours before, and wouldn't have forgotten that fact in only two hours.

The defendant also questions whether the pistol was switched by the supervisor. This is not a logical allegation, as it doesn't explain where else the exact murder weapon could have been found. Remember that the Desert Eagle matches the bullets that killed the victim. The police were looking everywhere for the murder weapon, and they didn't have any reason to suspect the defendant at that time. Why would they have planted the murder weapon at a Petrol Station that they didn't know would be connected to the defendant? Only after they found the weapon did they look at the surveillance tapes, finding the defendant buying fuel. Only after they reviewed the cell phone records did they find that he had called the victim only a few minutes before the victim died. That was days after they found the pistol. It simply isn't logical that the police would have planted a pistol at the Petrol Station.

Since the murder weapon is so well corroborated, it remains credible and probative. The defendant had raised the possibility that the weapon was found somewhere else or had been switched, challenging its credibility. But the probative strength of the evidence remains high. It is corroborated by other credible evidence. The credibility of the police officer is strengthened by other, contemporaneous police documents (the evidence log and forensic report). Since his memory would have been fresh when those two documents were created, it helps corroborate the police officer's assertion. The evidence is consistent and logical, and the prosecutor underscores that the defendant's position isn't a logical alternative.
Does it feel like we have arrived back where we started? The evidence that the pistol had been found at the Petrol Station at first seemed to be important and strong evidence. After the defendant's assertion, we aren't as sure that the pistol is as credible as it had been. However, after the prosecutor's response, we are more assured that the pistol is authentic and that it was found at 16:00 at the Petrol Station. After each change, we are recalculating the probability that the pistol belongs to the defendant. Before the defendant's challenge to its credibility, we may have been 80% sure that it was the defendant's pistol. After the defendant questioned the actions of the police officers, we aren't as sure. Perhaps our internal calculation has dropped to 60%. It may rise back to 75% after the prosecutor points out how corroborated the pistol is and how illogical the defendant's allegation that the pistol was switched.

What if the police department had a reputation for improper handling of evidence or even planting evidence? What if the police supervisor had been fired for misconduct, which is why he isn't testifying? Would this effect the credibility of the pistol?
Review and Problem Set

Review:

There are two basic ways to challenge evidence. First, you can present other evidence that either contradicts or weakens that evidence. That second evidence can either contradict the assertion by the first evidence, or it can contradict an inference which the first evidence suggests. The second evidence can also weaken the first evidence by attack its qualities, such as its relevance, credibility or probative value.

The second way to challenge evidence is to raise doubts about its quality. Thus, a practitioner can ask questions about the evidence’s relevance, credibility or probative value, or can use the closing statement in a trial to raise doubts about the three qualities. Cross-examination of a witness, for example, is the perfect opportunity to question that witness’ ability to perceive or remember the crime, thus weakening her credibility. If the quality of the evidence really is weak, the court should be made aware of it. Likewise, a practitioner can use these opportunities to highlight that the evidence really is relevant, that it really is credible and that it has high probative value.

Problem Set:

1. A witness describes watching a man throw a pistol into a garbage can. That pistol is later retrieved from the garbage and positively matches the bullets used in a murder. What can the defense attorney question the witness about in order to lessen his credibility?

2. A police officer describes finding the pistol in the garbage, but then carried it to his supervisor. His supervisor wrote the report. The police officer is now testifying about this at trial, 2 years later. What can the defense attorney ask the police officer in order to raise questions about where the pistol was found?

3. An elderly women testifies that she watched the bank robbery from her bedroom window which is across the street from the bank. She testified that the robbers sped away in a large truck. Is there anything that the defense attorney can question her about to raise doubts about the qualities of her testimony?

4. Sometimes the evidence suggests an important inference. For instance, a telephone call from the defendant to a victim supports the inference that the defendant knew the victim. What evidence would you offer, or qualities would you question, which suggest another inference?

5. During the closing statement, you want to question the probative strength of a witness. What kinds of issues could you raise?
Sample Answers

1. The credibility of a witness can be challenged by asking about the basis for the testimony, whether he could perceive the events he described, whether he has any biases, the accuracy of his memory or the likelihood that he is lying. In this case, the defense attorney could ask the witness about any obstructions to his view of the man or the garbage. If he was a great distance away, how could he see that it was a pistol? Could he see the man? Did he take any medicine or was there a reason his memory could be cloudy? Why is he remembering this so clearly now?

2. Since the police officer didn’t write the report, and he is testifying about an event that happened two years later, his memory may not be accurate. The attorney could ask about the number of crime scenes that the police officer has handled over the last two years. The attorney could raise questions about why the police officer didn’t write the report, since he found the pistol. The attorney could ask whether it was standard procedure to remove the pistol and carry it so far from where he found it. The attorney could ask whether the police officer looked for other evidence in the garbage? The credibility of the pistol depends on the credibility of the police officer, his supervisor, and the system that finds and maintains that evidence from the crime scene to the courtroom.

3. The elderly woman may have poor eyesight or obstructions between her bedroom window and the bank. It may be a long distance. The attorney could ask about these limits on her ability to perceive that the bank robbery was occurring. The witness may take medicines which are known to affect memory. The women may have difficulty with her memory anyway. These are all bases for the attorney to question her about the credibility of what she is saying. Further, a bank robbery where the criminals leave in a large truck is unusual. Maybe it was a delivery truck and she has mistaken it? This alternative inference weakens the probative strength because the story doesn’t fit with our normal expectations of a bank robbery. An alternative inference may seem more probable, in fact. Maybe she simply saw a delivery truck that parked near the bank, and she mistook that truck and those people as the criminals.

4. Obviously another witness who says that the defendant and the victim do not know each other can be offered, but it may not be believed. Perhaps the victim’s phone number is similar to another which the defendant could have been calling. Maybe the phone call to the victim is very short, which suggests that the defendant had called the wrong number. All of these would raise doubt about the inference that the defendant knew the victim.

5. The probative strength of a witness, or any evidence, can depend on its fit with normal expectations, its internal consistency, any corroborating evidence, or whether the inference is even logical.
Chapter 7
Inferential Evidence: Judicial Notice, Judicial Admissions, and Presumptions

Courts often rely on evidence which is neither testimonial nor tangible. Instead, this evidence is a product of the judicial process itself. Sometimes the court creates the evidence itself, sometimes it is proposed to the court. It can be evidence which is minor, or it can be decisive. The court relies on it, however, as seriously as it does an eyewitness allegation or a confession.

This evidence is the first set of what this book will call "inferential evidence." This is evidence which is neither direct evidence nor indirect evidence. Instead, this evidence is inferred by the court to help it make its decision. In this chapter, we will be considering three types of this inferential evidence. The first is called in some systems "judicial notice," but it may also be called "judicial presumption of facts." Second, we will examine judicial admissions, which are also called stipulations, where the parties agree that a fact is not in dispute. The last is actual presumption, which Thayer described as "aids to reasoning and argumentation, which assume the truth of certain matters for the purpose of some given inquiry." Often, they are mandated by legislative or human rights rules.

a) Judicial Notice

Which direction is "up?" Where is the courthouse? Is there a river in your city? What does a red-light mean for traffic? These are all commonly understood facts. The maxim has long been true in common law: *manifesta non indigent probation.* This means that what is known does not need to be proven. There has also been a tension between this and another maxim: *non refert quid notum sit judice si notum*

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non sit in forma judici. This asserts that it does not matter what a judge knows, if he doesn't know it through the court. Thayer describes this tension well.

These two maxims seem to intimate the whole doctrine of judicial notice. It has two aspects, one regarding the liberty which the judicial functionary has in taking things for granted, and the other the restraints that limit him. 24

In other words, a judge should be able to rely on common knowledge without need of having proof be offered. However, there is a limit past which a court is able to recognize the truth of something without proof, especially in legal systems that did not develop under the common law. It should be clear, however, that this is not a judicially-directed investigation. Rather, this is a judge using his or her own personal knowledge to evaluate the case.

In common law systems, the judge accepting a well-known fact as evidence is called “judicial notice,” while in civil law systems, this evidence is called “notorious” evidence. Judicial notice has also been employed in international tribunals. There are similarities in all three kinds of courts to the approach and purpose of judicial notice or notoriety of evidence. In these systems, judges can take judicial notice of the law and facts. Judicial notice of the law simply recognizes that judges have deep knowledge and experience in the law. Judicial notice of facts, however, is a source of evidence.

In the United States in the 1950s, two well-regarded legal scholars debated the evidentiary purpose of judicial notice. 25 John Wigmore, the Dean of Northwestern University School of Law, argued that the purpose for judicial notice was to reduce the amount of evidence subject to proof as a matter of judicial efficiency. For Wigmore, facts over which “dispute was unlikely to arise” could be judicially noticed. They created a presumption that the facts were proven, unless one of the parties disputed it. 26 Edmund Morgan, professor at Harvard Law School, argued that judicial notice was needed to keep the cases before the courts focused on the real issues. Judicial notice was meant to keep parties from arguing over matters that were irrelevant or from presenting evidence which was clearly false. Under Morgan’s view, judicial notice did not create a rebuttable presumption; instead, once the court took notice of a fact, that fact was decided. 27

Thus, the common law practice of judicial notice of facts depends on a rationale of judicial economy and the judicial prevention of error. Very often in common law, one of the parties asks the court to take judicial notice of a fact. Sometimes, a court relies on judicial notice on its own accord. In addition to taking notice of legal statutes or legal precedent, a court may take notice of facts which are “common knowledge” or “notorious.” This can included facts for which evidence is simply unnecessary, such as whether it is dark at midnight or that rain makes things wet.

A court may also take notice of other facts if it is satisfied that the source of the fact is indisputably accurate. Under some circumstances, this takes the form of a court relying on evidence that had been

26 Id.
considered in another case. More often, this can include the proof of customs, usage or practice. For instance, a court can take judicial notice that the local police practice is to arrest subjects and process them in the central police station. Since the court has undoubtedly heard this procedure many times, it doesn’t need yet another set of proof.

Similar concepts are found in continental systems, where the principle notoria non agent probatione permits the court to take notice, without proof, of notorious facts. For instance, in the civil procedure code of Germany, § 291 ZPO (Zivilprozessordnung) permits manifest and notorious facts to be accepted by the court as true. These must be facts which are generally obvious or well-known to the court through its official activity. In German Criminal Procedure, however, there is no explicit legal provision to permit judicial notice. However, the presiding judge in a criminal proceeding may order, ex officio, the production of further items to serve as evidence, § 221 StPO (Strafprozessordnung), or the judge may refuse to take evidence if the “matter is common knowledge” or “if an important allegation which is intended to offer proof in exoneration of the defendant may be treated as if the alleged fact were true.” §221 StPO.

Likewise, the Civil Procedure Code in such atypical continental systems as Italy or Columbia includes provisions that allow “notorious facts” to be considered without evidence. In those criminal codes, however, both countries have undertaken more adversarial systems with less explicit provisions for notorious evidence. In the Netherlands, though, Article 339 of the Code of Criminal Procedures allows evidence to be admitted through the judge’s own perception, statements by the accused, statements by witnesses, statements from experts and written documents.

Thus, many common law and civil law systems allow the judge to take notice of evidence that is common knowledge, notorious or even proven elsewhere. The International Tribunals for Rwanda and the Former Yugoslavia have taken a middle path, somewhat reflective of the debate between Wigmore and Morgan over fifty years ago. The typical rule for judicial notice of evidence is in Article 94 of the Rules of Procedure and Evidence for the ICTY:

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30 Kenneth Davis first postulated that there were two kinds of facts that may result in judicial notice or judicial admission: legislative facts and adjudicative facts. Legislative facts are those that are general and only effect the parties in their role as a member of that society. Adjudicative facts are specific and only concern the parties in the case. K. Davis, "An Approach to Problems of Evidence in the Administrative Process," 55 Harv.L.Rev. 364, 404–407 (1942).


33 Articula 177 de Codigo Procedimiento Civil di Colombia, “Los hechos notorios y las afirmaciones o negociaciones indefinidas no requieren prueba.” (“The notorious facts and indefinite affirmations or denials do not require evidence.”)
Rule 94 - Judicial Notice

(A) A Trial Chamber shall not require proof of facts of common knowledge but shall take judicial notice thereof.

(B) At the request of a party or proprio motu, a Trial Chamber, after hearing the parties, may decide to take judicial notice of adjudicated facts or documentary evidence from other proceedings of the Tribunal relating to matters at issue in the current proceedings.

In this rule, the Court may take one of two paths towards judicial notice of a fact. Under Paragraph A, the court is mandated to take judicial notice of facts of common knowledge. This reflects the narrowing of evidence to those facts in dispute, which suits Morgan’s thesis. Once the judicial notice is taken, there is no rebuttable presumption. The fact is, thus, established. Under Paragraph B, the court may on its own motion or at the request of a party, use its discretion to consider the facts proven in other cases before the tribunal. Since there is discretion, this can be disputed before the court. In fact, Paragraph B requires the court to hear from the parties before taking judicial notice of a fact under this procedure. By comparison, a Court may not necessarily need to consult with the parties before taking judicial notice of a fact under Paragraph A.

In the body of law which the ICTR and ICTY have compiled over the years, the prospect of taking facts through judicial notice has been both attractive and controversial. As a result, there have been some decisions which provide guidance on the boundary between notorious or “common” knowledge and facts which should be adjudicated normally. From these court decisions, we can derive some basic principles that define that boundary.

1) Judicially noticed facts should not prove the acts, conduct or mental state of accused.

In general, judicially noticed facts should be proof of the personal responsibility or mens rea of the accused. 34 To do otherwise would permit judicial notice to circumvent the presumption of a defendant's innocence and his fair trial right to challenge evidence against him or her. This does create a tension between evidence being relevant to demonstrating a defendant's guilt, and judicial notice excluding all evidence which shows personal responsibility. One might consider that this tension would exclude any evidence from being judicially noticed, as only evidence proving a defendant's responsibility for the crime is relevant.

This tension was addressed by the Appeals Chamber in the ICTR in Karemera, 35 which recognized that judicially noticed evidence should not be proof of the personal responsibility of the accused. It noted that it "would plainly be improper for facts judicially noticed to be the “basis for proving the Appellant’s criminal responsibility” and that the court should "take careful consideration of the presumption of innocence and the procedural rights of the accused." 36 However, the appeal chamber


36 Karemera, at Para. 47.
disagreed that judicial notice "cannot extend to facts that “go directly or indirectly” to the
criminal responsibility of the accused (or that “bear” or “touch” thereupon)." 37 The appeal chamber
alluded that direct evidence of personal responsibility could not be subject to judicial notice, while
indirect evidence might. More specifically, though, the appeals chamber stated that the trial court
"should instead assess the particular facts of which the Prosecution seeks judicial notice to determine
(a) whether they are related to the acts, conduct, or mental state of the Accused; and (b) if not,
whether under the circumstances of the case admitting them will advance [judicial] expediency
without compromising the rights of the Accused." 38

2) Notorious facts should not be subject to reasonable dispute.

The ICTR held that judicially noticed evidence should not be legal conclusions, but only facts in common
knowledge, which can not "be characterised either as controversial" and which are not "subject to
reasonable dispute." 39 The Nyiramsukuko decision by the ICTR explained previous decisions, such as
Semanza, which considered that common knowledge could include "common or universally known facts,
such as general facts of history, generally known geographical facts and the law of nature" or "those facts
that are generally known within a tribunal's territorial jurisdiction." Such facts did not need to be
"universally accepted," but must be "reasonably indisputable." 40

This requirement does not mean that the opposing party must agree with the judicial notice. This is a
subjective standard where the court must decide that a fact is so commonly known or notorious that most
reasonable people would not dispute it.

3) Facts from past cases can only be judicially noticed if fully adjudicated.

Further, the ICTR held in Semanza that past facts which had been adjudicated could be judicially noticed,
but not if the facts were from a plea agreement or from voluntarily admitted facts by that past defendant. 41
Such admissions, it concluded, did not contain any guarantees as to its general knowledge or currency,
and it did not have an indisputable character. In truth, if a court were to accept facts from another court
case that had not been properly tested or challenged, it would be denying the defendant the right to
challenge that evidence. Further, the ICTR in Semanza and the ICTY in Simic 42 considered judicial
notice to be limited only to facts, and not legal conclusions, such as guilt, personal responsibility or mens
rea. The defense should have the opportunity to challenge such legal conclusions through the adjudicative
process.

37 Karemera, at Para. 48.
38 Karemera, at Para. 53.
39 Prosecutor v. Nyiramsukuko, et al., ICTR-98-42-T, Decision on Prosecutor's Motion for Judicial Notice and Admission of
40 Ibid. (citing Prosecutor v. Semanza, ICTR-97-20-T, Decision on Prosecutor's Motion for Judicial Notice and Presumption of
41 Semanza at Para. 34-35.
42 Prosecutor v. Simic, IT-95-9-PT, Decision on the Pre-Trial Motion by the Prosecutor Requesting the Trial Chamber to take
4) Facts should be clear and not be subject to mischaracterization.

Another risk of the court taking judicial notice of notorious or previously adjudicated facts is that they may be misunderstood. A fact may be taken "Out of context" or mischaracterized, or simply not be clear. In the *Kamera* appeal decision, the trial court refused to take judicial notice of previously adjudicated facts which were taken out of context and then recombined by the prosecutor to assert a new inference.43 The prosecution appealed, claiming that it had no duty to put the evidence into context. The appeals chamber agreed with the trial court that judicial notice should only be for facts which are clear and not misleading, and should be consistently construed with the facts of the previous judgment.

**Conclusion**

There can be some common principles that are derived from these Tribunal decisions. A court might take notice of facts which assist judicial efficiency or help focus the trial to only the facts which are in dispute. However, taking judicial notice of facts should not deprive the defendant of the presumption of innocence or the right to a fair trial. Facts which are related to the acts, conduct, or mental state of the accused should not be taken by judicial notice, unless it greatly improves judicial expediency without compromising the rights of the accused.

Facts which are judicially noticed should be clear and sufficiently self-contained so that they are not subject to mischaracterization.

A court can take judicial notice of notorious, or commonly known, facts. This includes general facts of history, generally known geographical facts, laws of nature or facts within local knowledge. Such facts should not be subject to reasonable disputes, but this does not mean that it needs to be subject to universal agreement. This should not include stereotypes about groups of people, however.

Finally, some jurisdictions will allow previously adjudicated facts to be admitted by judicial notice. In those jurisdictions, the court should be avoid facts that were not fully tested in that previous court proceeding.

b) Judicial Admissions or Stipulations.

The principle of free consideration of proof is also overruled in situations where there is proof from judicial admission or when there is legal presumption. In the first case, the parties have agreed that a fact is not being disputed and are asking the court to take that fact as true. In the second case, the law has determined that the court should consider facts in a certain way. A court can reject a judicial admission or stipulation if it does not believe the evidence to be true or accurate; however, it cannot reject a presumption.

One could view judicial notice to be related to judicial admissions, sometimes called stipulations. While a court takes judicial notice when a fact is well known and not subject to reasonable dispute, a court takes judicial admission of a fact when it is not subject to any dispute at all. In an adversarial system, such an agreement between the parties would lead to the court admitting the stipulated evidence or testimony as if

it were fact. This also promotes judicial economy. However, if a legal system has elements of judicial control of evidence, the court may not have the legal right or desire to accept a fact which the parties do not dispute. The court, in such a case, would want the evidence to be presented normally so that it can judge the qualities of the evidence.

Judicial admissions are most often found in adversarial systems, or systems which embrace a form of negotiated plea agreements. Such pleas are based upon an agreement between the defendant and the prosecution of facts and their legal consequences. When they ask the court to accept the plea agreement, they are also asking the court to consider the stipulated facts to be true and accurate, at least in that one criminal proceeding. Of course, the stipulation is only evidence for the party who stipulates its truth. If a stipulation from one plea agreement were to be used in another defendant's criminal trial, it would violate that defendant's right to challenge evidence.

In a trial, stipulations can allow the court to focus on the evidence which is being disputed. As noted above, it is related to judicial notice. If the legal system allows the court to consider notorious evidence without formal proof, especially facts which are not subject to reasonable dispute, there is no policy reason to prevent it from accepting stipulations. If the court is asked to take judicial notice of a fact, it should accept that fact if it is within common or universal knowledge, and is not subject to reasonable dispute. A stipulation is more likely to occur when the facts are not within common or universal knowledge, but are facts specific to the case. In such stipulations, the parties do not dispute the fact.

As an example, a court could take judicial notice of the fact that the airport is located near the capital city of the country. This is a well-known fact that is not subject to reasonable dispute. However, the prosecutor and defendant could stipulate that the defendant's residence is in the capital city. This is not universally known, but neither side would dispute that fact. As long as the court does not dispute or mistrust the fact, is there really a reason to have a witness testify to this one fact?

c) Presumptions.

This chapter has considered evidence which the court accepts without any formal proof, either because the evidence was notoriously known or settled in a previous case, or because the parties both agreed that the fact was true and accurate. However, there is a third manner in which a court can consider a fact to be settled without any formal proof. This is through legal presumptions.

Legal presumptions have permeated ancient law, such as in Talmudic law or Medieval Roman law, and continued into cannon law in Europe. These presumptions have had influence on both continental and common law. In general, there are two forms of presumptions: rebuttable presumption and conclusive presumption. Further, there can be presumptions with evidence or presumptions without evidence.

A presumption with evidence can be demonstrated with a common example. In many U.S. jurisdictions, if a person is shown to have been missing for a period of time (such as five years), they are presumed to be dead. In Ohio, for instance, the law states that if a person has been continually absent from their home without being heard from for five years, they are presumed to be dead.44 The court can make this

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44 Ohio Revised Code 2121.01(A)(2) also provides for the presumption of death: "[w]hen the person has disappeared and been continuously absent from the person's place of last domicile without being heard from and
presumption after receiving evidence that the person was continually absent for five years and had not been heard from.

This is also a rebuttable presumption. In Cleveland, Ohio, three women were abducted and were missing for over ten years. They were presumed dead, but when they were found alive in Ariel Castro's home in May 2013, this presumption was clearly rebutted.

Some presumption do not need evidence, such as the presumption of innocence. When there is factual ambiguity, this presumption requires a court to accept the conclusion that supports the defendant's innocence.

There can be a blurred line between a court taking judicial notice of a fact, and the court making a legal presumption. In some jurisdictions, for example, there is a rebuttable presumption that mail which is placed into the postal system is delivered to the address on the envelope. However, this is also something that most people feel is obvious, at least most of the time. On the other hand, in no known jurisdiction is there a legal presumption that email which is sent has been delivered. However, most people would think that email delivery is more reliable than a postal service. It wouldn't be difficult for a court to take judicial notice of the reliability of email delivery.

Other presumptions can directly impact criminal liability. For instance, conspiracy law in the United States presumes that once a person joins a conspiracy, they know what the other conspirators do in furtherance of the conspiracy. They are thus responsible for every act of that conspiracy. Likewise, in some jurisdictions corporations are presumed to be responsible for the actions of their officers and employees acting within the scope of their employment.

When Thayer considered presumptions, he called it "an error" to consider it part of the law on evidence; rather, he believed it should be part of legal reasoning. Presumptions assume the existence of a fact, which aid the judge to make a logical, fair and reasoned decision. Thus, a defendant is presumed innocent until proven guilty. A person is presumed dead if they have been missing for a long time.

These presumptions shift the burden of proof from one party to another. Thus, a prosecutor can overcome the presumption of innocence by presenting strong evidence of guilt. The presumption of death can be overcome by showing that the person is alive, or has been seen or heard from.

However, these presumptions have strong evidentiary effects in a case. A defendant does not have to provide evidence of innocence, but can rely on the presumption of innocence. A prosecutor does not necessarily have to provide evidence of a dead body, if there are suspicious circumstances and a person missing for a certain period of time. Thus, the court is required to assume the truth of a fact, such as a person's death, without any actual evidence that the person is dead. Thayer is correct that presumptions are related to legal reasoning, but presumptions also have a significant presence in the body of evidence.

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was at the beginning of the person's absence exposed to a specific peril of death, even though the absence has continued for less than a five-year period."

d) Conclusion

Courts expect to receive evidence at trial and adjudicate guilt based upon that evidence. However, facts may be presented to the court -- and accepted as true by the court -- without any actual proof. Some of those facts are commonly known or notorious, and have no reasonable dispute about their truth. Some are previously adjudicated. Courts are often permitted to consider these facts within the body of evidence. These facts may, at times, be quite important in determining the guilt or sentence of a defendant. Courts accept these facts by judicial notice, or by considering them notorious.

Other facts are not only beyond dispute, they are presented to the court by agreement. These facts are considered "judicial admissions" or "stipulated facts," and are often associated with adversarial systems. They are also integral to the process of plea agreements. Stipulated evidence, however, should only be applied to the parties who do not dispute it.

Thus a court can accept notorious evidence where there is no reasonable dispute, and can even accept evidence when neither party disputes its truth. Often, this aligns with Kenneth Davis' two types of facts: legislative and adjudicative facts. Notorious, commonly known facts which few reasonable people dispute usually involves legislative facts, or facts which are general and apply to most people. Stipulations are facts to which the parties both agree. These tend to be adjudicative facts, or facts which are specific to the case and mainly concern the parties in the case. Adjudicative facts, by their nature, are not well known.

The last category in this chapter also requires no proof or evidence, but can have large influence on the body of evidence and the final determination of a case: presumptions. While common knowledge or the agreement of the parties can both allow judicial notice and stipulations to be accepted by the court, the law requires the court to assume the existence of a fact. This can often be confused with judicial notice. Some presumptions are also difficult to dispute and are common knowledge, such as the presumption of death. After a person has been missing for a number of years, few people would dispute that they are probably dead. However, while judicial notice is not normally mandatory, a presumption is legally required.

Thayer considered presumptions an integral part of legal reasoning, and not a pure evidentiary rule. However, by this chapter readers should consider the line between legal reasoning and evidence to be indistinct. Evidence only has value because of its effect on legal reasoning. The qualities of evidence, such as its relevance or probative strength, depend on the legal goals and the inferences that must be made. Judicial notice, stipulations and presumptions are merely forms of legal reasoning which we trust enough to substitute for actual evidence. Why are we willing to trust this?

We are willing to trust the facts which the court judicially notices because they are generally well-accepted facts that people do not dispute, or they are facts which are the result of a full adjudicative process in another case. The opposing party is also able to dispute the court's acceptance of that fact. We are also willing to trust the facts which are stipulated by the parties. If the parties are unwilling to dispute those facts, why shouldn't they be trusted? Presumptions, on the other hand, are a smaller set of facts which the law says should be assumed. Since it isn't the judge or parties, but the law which requires the presumption to be made, this is also trustworthy.
Judicial notice, stipulations and presumptions are forms of inferential evidence. They are not based on direct evidence, but require an assumption or inference to be made. They are forms of legal reasoning and evidence melded together. The remaining chapters will examine other forms of inferential evidence, such as statistical evidence or scientific evidence. It will also look at summary evidence, which often is used to represent a large quantity of evidence to show a pattern. Statistical evidence, scientific evidence and summary evidence all represent other forms of inferential evidence. However, instead of requiring an assumption to be made, it is revealing a pattern in other evidence.
Review and Problem Set

Review:

A court should rely on what is proven in court to adjudicate a case. However, there is a small category of things that a court can rely upon that does not need to be proven in court, which this book calls “inferential evidence.” This includes the logical deductions and inferences that a court makes from the evidence proven in court. For example, if one witness saw the defendant leave their home at 2:10 and another saw him arrive somewhere else at 2:15, the court can infer that he drove somewhere in between. Nobody has testified to this, but the court can rely on this inference.

Another category is “judicial notice” which some legal systems allow a judge to take notice, without proof, of “notorious facts” or facts proven in another case. A judge may do this ex officio or may do so at the request of the parties, depending on what the domestic law permits. Regardless of the legal system, evidence taken by “judicial notice” should not interfere with defendants’ fair trial rights or right to confront witnesses against them. For example, a court might find that the city where a crime took place has a river to be a “notorious fact” which anyone would know. There are four lessons from international tribunals and their use of judicial notice: (1) judicially noticed facts should not prove the acts, conduct or mental state of an accused, (2) notorious facts should not be subject to reasonable dispute, (3) facts from past cases can only be judicially noticed if fully adjudicated, and (4) facts should be clear and not be subject to mischaracterization. These lessons should be considered in keeping with local law and human rights concerns. For instance, previous statements of witnesses from other cases should not be used if the current defendant has not been permitted the opportunity to question that witness, particularly if that will be the sole or decisive evidence in the current criminal case.

Another category is “judicial admissions” or “stipulations.” This is more common in adversarial systems, but also where negotiated pleas of guilty are allowed. If the defendant and the prosecution agree to the same set of facts, in those systems the court is allowed to accept those facts as true.

The last category is “presumptions,” where the law itself instructs the court what it should find to be true. Usually, a presumption can be rebutted with evidence. Sometimes this is called a “shifting burden” or “reversing burden” of proof. The most common is the presumption of innocence, which the prosecution must overcome with proof. However, there can be a presumption that, if a person is missing, after a certain amount of time has elapsed they are considered legally deceased. This is a legal presumption that can be rebutted by showing evidence that the person is alive.
Problem Set:

1. A witness describes the defendant as having left the house angrily talking to the victim on the phone. The phone records show that a long phone call was made between the defendant and the victim. Can a court infer that the defendant knew the victim? Can it rely on that inference? Is that inference “proof?”

2. Some facts are “notorious,” meaning that they are very well known and few people would dispute their truth. Think about the city in which you live. What “facts” about that city would you consider to be notorious?

3. A person has been missing for eight years. None of her friends or family have heard from her since a Tuesday night when she went on a date with the defendant. She wasn’t at work the next day. She was supposed to go to her sister’s birthday party the night after the date, but never arrived. Her mobile phone went unanswered. The defendant claims to have taken her home early from the date because she said she had a headache.

The law in your country says that “when a person has disappeared and has continually been absent for five years without contact with friends or family, he or she may be presumed to be dead.” Could the victim be considered dead by a court for the purpose of trying the defendant for murder?

What if the law says that a person may be presumed dead only if “the person has been continually absent for three years and at the time of the disappearance was exposed to a specific peril of death”? 
1. The court might be able to infer that the defendant knew the victim, and might be able to rely on that inference as though it was a proven fact.

2. The answer to this question, of course, depends on the city in which you live. It may be notorious that a street is always crowded with traffic, or that bridges cross the river only on certain streets, or which buildings are tall.

3. These are examples of legal presumptions, in this case, the presumption of death. In the first example, the person has been missing for a specific period. While there may not be sufficient evidence to show that the defendant was the murderer, there is enough to satisfy the presumption that she is dead. In the second instance, the law requires the person to have been missing following exposure to a “specific peril of death.” The date with the defendant does not qualify as a specific peril of death.
How do you answer a question about a large number of people, events or objects? Normally, this is answered with a statistic, such as the average. We can know, for instance, that a court hears 9,000 cases in a year. If there are 20 judges, each judge has responsibility for an average of 450 cases. Some judges may have more, some may have less, but the average is found simply by dividing the number of cases (9,000) by the number of judges (20).

The above example involves descriptive statistics. Descriptive statistics requires the entire population of people, events or objects to be known, such as the number of cases heard in the court. We are simply describing the characteristics of that group. Another form of statistics is called predictive, or inferential, statistics. This is where the researcher does not know about the entire population, but instead takes a sample of the population. We see this is surveys of a population. The United States, for instance, has over 300 million people. If we wanted to find out how many people were older than 65 years, we could ask everyone their age. This would be a massive, expensive undertaking. In fact, this is only done every 10 years in the United States as part of the Census. However, we can make a prediction of that same number by taking a representative sample of the population.

Thus, there are two forms of statistics which a practitioner should understand: descriptive and predictive. But why should a prosecutor, attorney or judge know about statistics? Isn’t that what experts are for?

a) Many Kinds of Evidence are Statistical.

We rely on statistics for evidence quite often; however, it is silent and in the background. In civil cases, statistics can sometimes be used as direct proof. In criminal cases, it is most prevalent in scientific or
expert evidence. How can statistics be used as direct proof? As a first example, we should look at a civil case where a minority is trying to prove that they face discriminatory hiring practices. The minority would first show that they are 20% of the population, but only 5% of the workforce at this one company. Does this suggest discrimination?

What if the minority then shows that the company hires engineers, and that this minority comprises 35% of engineers – 15% more than the percentage of the whole population. And yet, they are only 5% of the engineers working at this company. Does this statistic suggest that there may be a problem of discrimination, whether or not the hiring managers are conscious of this discrimination?

What if there was a university study which showed that, when names and other information which can identify ethnicity is removed, hiring managers would be more likely to hire people in percentages very similar to that of the population. Thus, this survey would suggest that minorities should make up 20% of the company’s engineers. Is this helpful evidence?

1. Statistics as Evidence in a Criminal Case

Moving from a civil case to a criminal case, we have already seen an example of how a statistic can be used as direct proof. In the “Desert Eagle” case, the defendant was an owner of a Desert Eagle. The murder weapon was also a Desert Eagle. If the company which made the weapon said that there had only been one Desert Eagle sold in the country, this would be very strong evidence that the defendant owned the murder weapon. If everyone in the country, however, owned a Desert Eagle, the defense could say that the weapon was so populous that there is no reason to link it to the defendant.

However, if the country has a population of a million people and only 30 Desert Eagles had ever been sold, would this be useful information? We would know that one in approximately 33,333 people would own such a weapon. This means that if you went to a random person in the country and asked if they owned a Desert Eagle, you would have only a 0.003% chance that the person would say “yes.” Conversely, you would have a 99.997% chance that someone would say “no.” You would understand that very few people owned this weapon.

But maybe using the whole population isn’t asking the right question. How many pistols are in the country? Let’s assume that this number is known, and that there are 10,000 pistols of any type in the country. If this is the case, then one out of every 333 pistols is a Desert Eagle. Now we know that 0.3% of pistols are Desert Eagles. This means that they are rare.

Thus, we can already say that few people own this weapon and that among all pistols in the country, it is rare. But what if we are still asking the wrong question? This means there are only thirty pistol owners, which the police should be able to question. If 28 of the gun owners still have their Desert Eagles, and two can no longer account for their pistol, how does this affect the statistics? We are now asking about only two “lost Desert Eagles.” Either of those could, conceivably, be the murder weapon. It is unlikely, however, that the owner of the other Desert Eagle has as many connections to the murder victim as the defendant.

Thus, we know that few people own this weapon and that it is rare in the country. Of those who do own a Desert Eagle pistol, all but two can account for the weapon. This information helps the court determine whether it is likely that the defendant’s Desert Eagle is the murder weapon. Thus, statistics helps the
court understand the evidence better, and can also be evidence itself. The fact that the Desert Eagle is rare is useful information, as it means that the Defendant’s gun has a very high probability of being the murder weapon. Likewise, the very low number of “lost Desert Eagles” means that there is a low probability that another pistol was the murder weapon.

We would not convict someone solely on statistical evidence. However, it can be very important supporting evidence. It is often used to determine the likelihood of a match between the defendant and some evidence associated at the crime scene. For instance, we used the rarity of the Desert Eagle to demonstrate how it was unlikely that the murder weapon belonged to anyone else but the defendant. This is similarly done with other matches, such as blood type, DNA, fingerprints or medical tests.

2. Statistical Evidence that Excludes Suspects: Blood Type and DNA

Let’s consider blood type. Blood can have three antigens: A antigens, B antigens and Rh antigens. There are four groups of blood types based on first two forms of antigens: A, B, AB and O. Blood in each group can either have the Rh antigen or not. When they are present, it is positive (+) but when it isn’t, it is negative (-). Thus, a person’s blood can be characterized in six ways: A+, A-, B+, B-, AB+, AB- and O-.

In the United States, the American Red Cross collects blood and has broken down these groups by the ethnicity of the donors. The most common blood type is O+, while AB- blood is the rarest.

<table>
<thead>
<tr>
<th>Blood type</th>
<th>Caucasian</th>
<th>African-American</th>
<th>Hispanic</th>
<th>Asian</th>
</tr>
</thead>
<tbody>
<tr>
<td>0+</td>
<td>37%</td>
<td>47%</td>
<td>53%</td>
<td>39%</td>
</tr>
<tr>
<td>O-</td>
<td>8%</td>
<td>4%</td>
<td>4%</td>
<td>1%</td>
</tr>
<tr>
<td>A+</td>
<td>33%</td>
<td>24%</td>
<td>29%</td>
<td>27%</td>
</tr>
<tr>
<td>A-</td>
<td>7%</td>
<td>2%</td>
<td>2%</td>
<td>0.5%</td>
</tr>
<tr>
<td>B+</td>
<td>9%</td>
<td>18%</td>
<td>9%</td>
<td>25%</td>
</tr>
<tr>
<td>B-</td>
<td>2%</td>
<td>1%</td>
<td>1%</td>
<td>0.4%</td>
</tr>
<tr>
<td>AB+</td>
<td>3%</td>
<td>4%</td>
<td>2%</td>
<td>7%</td>
</tr>
<tr>
<td>AB-</td>
<td>1%</td>
<td>0.3%</td>
<td>0.2%</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

Let’s assume someone describes a Caucasian male leaving a fight, and there are traces of his blood at the scene. If the blood is found to be O+, it is not very limiting. It simply suggests that 37% of the population of Caucasian males might have been the suspect. However, what if the witness describes an Asian Male leaving the scene, having left traces of his AB- blood? Instead, this limits the population of suspects to only 0.1% of the Asian males.

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46 In statistics, this is actually called the “Prosecutor’s fallacy,” as using the probability of a match as a substitute for proof of guilt actually does not interpret the mathematics correctly. The statistics being used actually test for innocence, or a non-match. It can only prove that someone is innocent, in other words. It cannot prove guilt, but it can substantially narrow the population of those who might be guilty. Thus, this information can be used in combination with other, corroborating evidence to strengthen the conclusion of guilt.
In the first example, a Caucasian male suspect with other corroborating evidence is identified. In the second example, an Asian male with other corroborating evidence is identified. If the Caucasian male doesn’t have O+ blood, he is probably eliminated as a suspect. Likewise, if the Asian male doesn’t have AB- blood, he is also probably not going to remain a suspect. The blood type has ruled out suspects, but what if a suspect with corroborating evidence and matching blood type is found? How does this help?

The matching blood type of the Caucasian male means simply that he is one of 37% of Caucasian males with O+ blood. More than one out of three Caucasian males has this blood type. The blood type does not really demonstrate that there is a unique match between the blood at the scene and the suspect.

However, the matching blood type of the Asian male does help limit the pool of suspects. An Asian male with AB- blood is uncommon. Only 0.1% of the Asian population would have it. If there are one thousand Asian males living in the city, on average this would mean that only one Asian male would have this blood type. We cannot say with certainty that the suspect matches the blood at the scene, but the statistics do suggest that it is highly likely. If there is other evidence which supports his guilt, then this additional statistical evidence would also contribute to that conclusion.

This principle becomes even more pronounced with more advanced methods, such as DNA testing. DNA testing is considered so accurate because the number of people with matching DNA is very, very small, even in an enormous population. This would usually only occur with identical twins. However, forensic DNA testing does not match the entire strand of DNA, since there are about 3 billion pairs in the human genome.

Instead, forensic DNA testing looks at repeated patterns. Each long strand of DNA is wrapped into a bundle called a chromosome. Each human has 23 pairs of chromosomes. In each of those 23 pairs of chromosome is one chromosome that corresponds to the mother’s genes and the other corresponds to the father’s genes. DNA is comprised of four basic chemicals (guanine, adenine, thymine and cytosine), which are often simply abbreviated “G,” “A,” “T,” and “C.”

Instead of matching the entire DNA, the repeated pattern of G, A, T, C at certain locations on the gene are compared. For instance, at position D7S280 on the seventh chromosome, the pattern “GATA” can be repeated between 6 and 15 times. Such repeated patterns are called “Short tandem repeats,” or STRs. DNA profiling compares STRs at different locations on the gene. In the United States, the FBI’s Combined DNA Index System (CODIS) compares STRs at 13 locations on the gene, while in the UK its national database compares STRs at 10 locations. At each location, the repeated sequences are counted on each strand, one on the “mother’s” side and one on the “father’s” side. For instance, at location “D7S820” mentioned above, the laboratory may count 10 repeats on one strand and 12 repeats on another strand. That would mean that “Genotype” at that location is 10/12. (If both strands have the same number, such as 12, then the Genotype would only be listed as “12” and not 12/12.)

What does this mean? For the FBI in the United States, the genetic matching would be on two strands at 13 locations along each strand. Each location would have a number of possible combinations. This means that there are many different combinations which are possible. In fact, there are estimates that the chance of two different people having an exact match of all the combinations in the CODIS database is
about 1 in 575 trillion. For comparison, the population of the planet is estimated to be just over 7 billion.

Figure 2: Image from US National Institute of Standards and Technology

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Thus, a match of both STRs at all 13 locations has a low probability of occurring. Using an example of a DNA Profile, we can see why it is important to know about the statistical principles involved. In our example, there are two possible suspects for a rape. DNA was collected from the victim, who only described the person as a Caucasian male in his mid-20s with blonde hair. The two suspects both match that description and were in the area. Both have previous convictions for sexual assault. The court orders them to give DNA samples, which are then compared to the sample from the crime scene. The laboratory prepares the following chart:

<table>
<thead>
<tr>
<th>STR Location</th>
<th>Sample from DNA left on Rape Victim</th>
<th>DNA Sample from Suspect 1</th>
<th>DNA Sample from Suspect 2</th>
<th>Genotype Frequency of Suspect 1’s STR</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPOX</td>
<td>7, 8</td>
<td>7, 8</td>
<td>8, 8</td>
<td>0.30</td>
</tr>
<tr>
<td>D3S1358</td>
<td>15, 17</td>
<td>15, 17</td>
<td>17, 17</td>
<td>0.13</td>
</tr>
<tr>
<td>FGA</td>
<td>23, 27</td>
<td>23, 27</td>
<td>21, 23</td>
<td>0.31</td>
</tr>
<tr>
<td>D5S818</td>
<td>13, 13</td>
<td>13, 13</td>
<td>9, 12</td>
<td>0.29</td>
</tr>
<tr>
<td>CSF1PO</td>
<td>8, 11</td>
<td>8, 11</td>
<td>11, 12</td>
<td>0.18</td>
</tr>
<tr>
<td>D7S820</td>
<td>10, 11</td>
<td>10, 11</td>
<td>9, 10</td>
<td>0.26</td>
</tr>
<tr>
<td>D8S1179</td>
<td>12, 13</td>
<td>12, 13</td>
<td>14, 15</td>
<td>0.34</td>
</tr>
<tr>
<td>THO1</td>
<td>9.3, 9.3</td>
<td>9.3, 9.3</td>
<td>6, 9.3</td>
<td>0.38</td>
</tr>
<tr>
<td>vWA</td>
<td>15, 16</td>
<td>15, 16</td>
<td>18, 19</td>
<td>0.22</td>
</tr>
<tr>
<td>D13S317</td>
<td>12, 12</td>
<td>12, 12</td>
<td>12, 12</td>
<td>0.21</td>
</tr>
<tr>
<td>D16S539</td>
<td>9, 13</td>
<td>9, 13</td>
<td>11, 12</td>
<td>0.10</td>
</tr>
<tr>
<td>D18S51</td>
<td>12, 18</td>
<td>12, 18</td>
<td>14, 18</td>
<td>0.11</td>
</tr>
<tr>
<td>D21S11</td>
<td>28, 30</td>
<td>28, 30</td>
<td>27, 30.2</td>
<td>0.06</td>
</tr>
<tr>
<td>Overall Genotype frequency of Suspect 1</td>
<td></td>
<td></td>
<td>8.81 x 10^{-10}</td>
<td></td>
</tr>
</tbody>
</table>

What does this mean? How do we even begin to understand what the DNA expert will say in court? As a defense attorney, how would I cross examine him about this chart?

The first column simply lists the location on the chromosome where the laboratory tested, which in this case was done in compliance with the FBI standards. It lists the 13 STR locations. The next column is the sample from the DNA left by the perpetrator. It lists two numbers. For instance, for the STR location TPOX, there was 7 STR repetitions on one strand of DNA and 8 STR repetitions on the other strand.

The next two columns are the results of the DNA profile done from both suspects. As you can see, not all of the genotypes for Suspect 2 match the sample left with the rape victim. That person has been excluded as a suspect by this test. However, every one of the genotypes for Suspect 1 matches the sample from the victim. We shall consider this suspect further.

The last column has the percentage that each of Suspect 1’s genotype occurs in the population. Thus, for the location vWA, the genotype of 15,16 occurs in 22% of the suspect's ethnic group. This is the genotype frequency for that one genotype. If you multiply these frequencies together, we see that there is an overall frequency for suspect 1: 8.81 x 10^{-10}. This is a very small number, in fact it is 0.000000000881%. What does this number mean? This means that the chance that a random person in the suspect's ethnic group would have this particular combination of genotypes is 0.000000000881%, or about 1 in 1.1 billion.
Does this mean that the DNA test is conclusive proof that Suspect 1 is the rapist? If there is no other evidence linking Suspect 1 to the crime, the answer is no. For instance, if the two suspects were in the FBI's database, the DNA profile for Suspect 1 would be retrieved. There is no other evidence to link Suspect 1 to the rape. This very small number, 0.00000000081%, would simply be the probability of seeing this DNA profile if a random person was selected.

It is important to understand that this number is not the probability that Suspect 1 committed the crime. Regarding this as the probability of guilt is called the "prosecutor's fallacy." We will discuss this later in the chapter. However, it should be clear that modern evidence can involve a reliance on statistics, and the complexity of the evidence can easily be confusing or misleading.

b) Basic Concepts of Descriptive Statistics

When a statistician describes the group that he or she is studying, he calls it the population. The population usually must be defined. For example, the statistician is studying the population of all males in a country. He or she isn’t studying all people, but all males within the one country. Let's assume that there are 2 million males in the country. If the statistician has data about every male in that country, he should have information on all 2 million males. This might happen with a census or other official records, such as birth certificates.

If the study includes the entire population, we would say that the statistics are descriptive. Any error in the statistics would come from the collection or recording of the data, but there wouldn’t be any mathematical error. If we trust that the information is collected and recorded correctly, such as with recording birth certificates, we can trust that the statistics of that population are accurate.

Instead of the entire population of 2 million males in a country, let’s think smaller. In our example, we have a farmer with 10 cows. He doesn’t care about anyone else’s cows, so our entire population is 10 cows. He wants to know more about their feeding, so he measures how much hay they eat for a week. After a week, he has this chart:

<table>
<thead>
<tr>
<th></th>
<th>Cow 1</th>
<th>Cow 2</th>
<th>Cow 3</th>
<th>Cow 4</th>
<th>Cow 5</th>
<th>Cow 6</th>
<th>Cow 7</th>
<th>Cow 8</th>
<th>Cow 9</th>
<th>Cow 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunday</td>
<td>2 kg</td>
<td>1.5 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>2 kg</td>
<td>2 kg</td>
<td>2 kg</td>
<td>1.5 kg</td>
<td>2.5 kg</td>
<td>2 kg</td>
</tr>
<tr>
<td>Monday</td>
<td>2 kg</td>
<td>2 kg</td>
<td>2.5 kg</td>
<td>2.5 kg</td>
<td>2.5 kg</td>
<td>1.5 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>1.5 kg</td>
</tr>
<tr>
<td>Tuesday</td>
<td>3 kg</td>
<td>2 kg</td>
<td>2 kg</td>
<td>2 kg</td>
<td>2 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>1.5 kg</td>
<td>2 kg</td>
<td>2.5 kg</td>
</tr>
<tr>
<td>Wednesday</td>
<td>1.5 kg</td>
<td>3 kg</td>
<td>2.5 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>2 kg</td>
</tr>
<tr>
<td>Thursday</td>
<td>3 kg</td>
<td>1.5 kg</td>
<td>2 kg</td>
<td>1.5 kg</td>
<td>2 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>1.5 kg</td>
<td>3 kg</td>
<td>1.5 kg</td>
</tr>
<tr>
<td>Friday</td>
<td>2 kg</td>
<td>3 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>2 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>2 kg</td>
<td>3 kg</td>
</tr>
<tr>
<td>Saturday</td>
<td>2 kg</td>
<td>2 kg</td>
<td>2 kg</td>
<td>1.5 kg</td>
<td>2 kg</td>
<td>3 kg</td>
<td>2 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>3 kg</td>
</tr>
</tbody>
</table>

1. Sum.

What sort of statistical numbers can we obtain from this chart? First, we can find the sum, or total, of each category. This simply means adding them together. For instance, for Cow 1, the sum of hay for the entire week is 2kg + 2 kg + 3 kg + 1.5 kg + 3 kg + 2kg + 2kg = 15.5kg. We know that Cow 1 ate 15.5kg of hay during the week. This is the sum.
This allows us to add a new row and column to the chart, as below:

<table>
<thead>
<tr>
<th></th>
<th>Cow 1</th>
<th>Cow 2</th>
<th>Cow 3</th>
<th>Cow 4</th>
<th>Cow 5</th>
<th>Cow 6</th>
<th>Cow 7</th>
<th>Cow 8</th>
<th>Cow 9</th>
<th>Cow 10</th>
<th>Sum (kg)</th>
<th>Mean (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunday</td>
<td>2 kg</td>
<td>1.5 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>2 kg</td>
<td>2 kg</td>
<td>1.5 kg</td>
<td>2.5 kg</td>
<td>2 kg</td>
<td>2 kg</td>
<td>21 kg</td>
<td>2.14 kg</td>
</tr>
<tr>
<td>Monday</td>
<td>2 kg</td>
<td>2 kg</td>
<td>2.5 kg</td>
<td>2.5 kg</td>
<td>2 kg</td>
<td>1.5 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>23 kg</td>
<td>2.35 kg</td>
</tr>
<tr>
<td>Tuesday</td>
<td>3 kg</td>
<td>2 kg</td>
<td>2 kg</td>
<td>2 kg</td>
<td>2 kg</td>
<td>3 kg</td>
<td>1.5 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>1.5 kg</td>
<td>26 kg</td>
<td>2.35 kg</td>
</tr>
<tr>
<td>Wednesday</td>
<td>1.5 kg</td>
<td>3 kg</td>
<td>2.5 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>1.5 kg</td>
<td>21.5 kg</td>
</tr>
<tr>
<td>Thursday</td>
<td>3 kg</td>
<td>1.5 kg</td>
<td>2 kg</td>
<td>1.5 kg</td>
<td>2 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>1.5 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>23.5 kg</td>
</tr>
<tr>
<td>Friday</td>
<td>2 kg</td>
<td>3 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>2 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>2 kg</td>
<td>26 kg</td>
<td>2.65 kg</td>
</tr>
<tr>
<td>Saturday</td>
<td>2 kg</td>
<td>2 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>2 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>23.5 kg</td>
<td>2.65 kg</td>
</tr>
<tr>
<td>Sum</td>
<td>15.5kg</td>
<td>15kg</td>
<td>16kg</td>
<td>16kg</td>
<td>16.5kg</td>
<td>17kg</td>
<td>18.5kg</td>
<td>16kg</td>
<td>18.5kg</td>
<td>15.5kg</td>
<td>164.5 kg</td>
<td>2.35 kg</td>
</tr>
</tbody>
</table>

Thus, with a little simple addition we can now understand how much hay each cow eats in a week and how much hay is eaten each day by all of the cows. We also can see that in one week, 164.5kg of hay is consumed in total.

2. Measures of Central Tendency (Average)

In statistics, there are three forms of average: Mean, Mode and Median. Each one measures something a little different. The **Mode** is simply the most frequently occurring value. Thus, for Cow 1, the mode would be 2kg, as this value was more frequent (four times) and any other value.

Another form is **Median**. This simply means the center value between the highest and lowest value. For Cow 1, the highest value is 3kg and the lowest is 1.5kg. The median between those two values is 2.25kg.

The last, and most informative, form of average is the **Mean**. This is often what we think about when we consider the average. The mean is simply the sum divided by the number of data points. For Cow 1, the sum is 15.5kg for the week. We also know that there are seven data points, one for each day of the week that the cow ate. The mean, in this case, would be 15.5kg/7, or 2.21kg.

Thus, we can describe Cow 1 as eating an average of 2kg a day (the mode), an average of 2.25kg/day (the median), or an average of 2.21kg/day (the mean). However, most people would expect the word ‘average’ to indicate that the cow had eaten 2.21kg/day, or the mean. This is also the most useful statistic. Let’s include these onto our chart.

<table>
<thead>
<tr>
<th></th>
<th>Cow 1</th>
<th>Cow 2</th>
<th>Cow 3</th>
<th>Cow 4</th>
<th>Cow 5</th>
<th>Cow 6</th>
<th>Cow 7</th>
<th>Cow 8</th>
<th>Cow 9</th>
<th>Cow 10</th>
<th>Sum (kg)</th>
<th>Mean (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunday</td>
<td>2 kg</td>
<td>1.5 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>2 kg</td>
<td>2 kg</td>
<td>1.5 kg</td>
<td>2.5 kg</td>
<td>2 kg</td>
<td>2 kg</td>
<td>21 kg</td>
<td>2.14 kg</td>
</tr>
<tr>
<td>Monday</td>
<td>2 kg</td>
<td>2 kg</td>
<td>2.5 kg</td>
<td>2.5 kg</td>
<td>2 kg</td>
<td>1.5 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>23 kg</td>
<td>2.35 kg</td>
</tr>
<tr>
<td>Tuesday</td>
<td>3 kg</td>
<td>2 kg</td>
<td>2 kg</td>
<td>2 kg</td>
<td>3 kg</td>
<td>1.5 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>1.5 kg</td>
<td>2 kg</td>
<td>26 kg</td>
<td>2.35 kg</td>
</tr>
<tr>
<td>Wednesday</td>
<td>1.5 kg</td>
<td>3 kg</td>
<td>2.5 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>1.5 kg</td>
<td>3 kg</td>
<td>1.5 kg</td>
<td>26 kg</td>
<td>2.65 kg</td>
</tr>
<tr>
<td>Thursday</td>
<td>3 kg</td>
<td>1.5 kg</td>
<td>2 kg</td>
<td>1.5 kg</td>
<td>2 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>1.5 kg</td>
<td>3 kg</td>
<td>1.5 kg</td>
<td>26.5 kg</td>
<td>2.65 kg</td>
</tr>
<tr>
<td>Friday</td>
<td>2 kg</td>
<td>3 kg</td>
<td>2.5 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>2 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>23.5 kg</td>
<td>2.65 kg</td>
</tr>
<tr>
<td>Saturday</td>
<td>2 kg</td>
<td>2 kg</td>
<td>1.5 kg</td>
<td>2 kg</td>
<td>2 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>3 kg</td>
<td>23.5 kg</td>
<td>2.65 kg</td>
</tr>
<tr>
<td>Sum</td>
<td>15.5kg</td>
<td>15kg</td>
<td>16kg</td>
<td>16kg</td>
<td>16.5kg</td>
<td>17kg</td>
<td>18.5kg</td>
<td>16kg</td>
<td>18.5kg</td>
<td>15.5kg</td>
<td>164.5 kg</td>
<td>2.35 kg</td>
</tr>
<tr>
<td>Mean (kg/day)</td>
<td>2.21</td>
<td>2.14</td>
<td>2.28</td>
<td>2.28</td>
<td>2.35</td>
<td>2.42</td>
<td>2.64</td>
<td>2.28</td>
<td>2.64</td>
<td>2.21</td>
<td>2.35</td>
<td></td>
</tr>
</tbody>
</table>
From our new row on the chart, we can see that each cow can eat a different average amount, ranging from 2.14 kg/day to 2.64 kg/day. We also see that on each day, there can be an average amount which is eaten per cow, ranging from 2.1 kg/day to 2.65 kg/day. Thus, the statistician can ask “what is the average (mean) amount of hay that a cow eats on Monday (2.35 kg) versus the average amount (mean) that a cow eats on Friday (2.65 kg)?” This compares the average amount eaten each day. There isn’t any individual information about the cow, just the day. If the farmer was interested in how much hay to feed all of his cows on any given day, he may look at this column more closely.

On the other hand, the statistician can also ask “what is the mean amount of hay that Cow 1 eats per week (2.21 kg) versus the mean amount of hay that Cow 7 eats per week (2.64 kg)?” At this point, the question is different than the last, as it doesn’t focus on the day. Instead, it is focusing on the individual information about each cow. For instance, if the farmer is more interested in how each cow is eating, and whether it is healthy, he might look more closely at this row. Let’s continue our example and simply focus on the amount each cow is eating. Thus, we will simply look at the last row.

<table>
<thead>
<tr>
<th>Cow 1</th>
<th>Cow 2</th>
<th>Cow 3</th>
<th>Cow 4</th>
<th>Cow 5</th>
<th>Cow 6</th>
<th>Cow 7</th>
<th>Cow 8</th>
<th>Cow 9</th>
<th>Cow 10</th>
<th>Mean (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (kg/day)</td>
<td>2.21</td>
<td>2.14</td>
<td>2.28</td>
<td>2.28</td>
<td>2.35</td>
<td>2.42</td>
<td>2.64</td>
<td>2.28</td>
<td>2.64</td>
<td>2.21</td>
</tr>
</tbody>
</table>

We actually have a lot of information about each cow. We know that the average cow eats 2.35 kg/day. Some cows are higher than that mean, some are lower. How many are higher? Three. How many are lower? Six. Cow 5 actually eats the exact average amount of 2.35 kg/day. But does this seem right? After all, 2.35 kg/day is the average. Doesn’t this mean that there should be 5 cows lower and 5 cows higher?

In fact, there are three higher and six lower. Some cows (Cow 1, Cow 2, and Cow 10) are about 0.1 kg/day less than the average. Many cows are near the average of 2.35 kg/day. However, Cow 7 and Cow 9 are almost 0.30 kg/day higher than the average—a lot more. These are hungry cows. These hungry cows are skewing the average higher. We can take a look at this on a chart.

![Figure 3: Average Hay Consumption for Farmer 1’s cows](image-url)
The chart has two peaks (cow 7 and cow 9) which are higher than the rest. This affects the mean by moving it higher. If there were some cows which were eating very little, it would move the mean down.

3) Measures of Dispersion (Range, Variance and Standard Deviation)

The mean is an important statistic, as it indicates the middle of the population, taking into account the hungry cows or the cows which eat very little. However, it doesn’t tell you much more about the population. How much variance is there between each cow? As an example, we have the average hay eaten by each cow in our farmer’s herd.

<table>
<thead>
<tr>
<th>Farmer 1</th>
<th>Cow 1</th>
<th>Cow 2</th>
<th>Cow 3</th>
<th>Cow 4</th>
<th>Cow 5</th>
<th>Cow 6</th>
<th>Cow 7</th>
<th>Cow 8</th>
<th>Cow 9</th>
<th>Cow 10</th>
<th>Mean (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>2.21</td>
<td>2.14</td>
<td>2.28</td>
<td>2.28</td>
<td>2.35</td>
<td>2.42</td>
<td>2.64</td>
<td>2.28</td>
<td>2.64</td>
<td>2.21</td>
<td>2.35</td>
</tr>
</tbody>
</table>

His neighbor also has ten cows. If he also recorded how much his cows ate, it might look like this:

<table>
<thead>
<tr>
<th>Farmer 2</th>
<th>Cow 1</th>
<th>Cow 2</th>
<th>Cow 3</th>
<th>Cow 4</th>
<th>Cow 5</th>
<th>Cow 6</th>
<th>Cow 7</th>
<th>Cow 8</th>
<th>Cow 9</th>
<th>Cow 10</th>
<th>Mean (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.82</td>
<td>2.1</td>
<td>1.8</td>
<td>3.28</td>
<td>1.5</td>
<td>1.2</td>
<td>3.64</td>
<td>2.28</td>
<td>3.69</td>
<td>2.21</td>
<td>2.35</td>
</tr>
</tbody>
</table>

The mean is the same: 2.35 kg/day. But if you look at the numbers, they are very different. There are higher numbers and lower numbers. The chart for Farmer 2 looks like this:

![Chart: Average hay consumption for Farmer 2's cows](image)

The chart looks very different for Farmer 2 than for Farmer 1, with more high and low dots. This means that there is more variability in the data. How do we measure this, and why do we care?

The Range of the data is one way to measure how much variation there is. This simply means that you identify the highest number and the lowest number in the data. The range is the difference between the two. Thus, for Farmer 1, the highest number is 2.64 and the lowest is 2.14. Thus, the range for Farmer 1 is 0.50 kg/day. However, Farmer 2’s cows have a much higher range. The highest number is 3.69 and the lowest is only 1.2. Thus, the range for Farmer 2’s cows is 2.49 kg/day. This means that some cows eat a lot and some eat a little. However, if there is just one cow which eats a lot and one cow that eats a
little, we won’t know that. We also need a measure which lets us know whether all of the cows are eating
differently or not.

The Variance can be measured using the averages that we have already collected into the two tables.
Calculation of the variance (and standard deviation) is more complicated than simply looking at the range,
but it is important to understand these concepts, as these two numbers say a great deal about statistical
evidence.

<table>
<thead>
<tr>
<th>Farmer 1</th>
<th>Cow 1</th>
<th>Cow 2</th>
<th>Cow 3</th>
<th>Cow 4</th>
<th>Cow 5</th>
<th>Cow 6</th>
<th>Cow 7</th>
<th>Cow 8</th>
<th>Cow 9</th>
<th>Cow 10</th>
<th>Mean (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (kg/day)</td>
<td>2.21</td>
<td>2.14</td>
<td>2.28</td>
<td>2.28</td>
<td>2.35</td>
<td>2.42</td>
<td>2.64</td>
<td>2.28</td>
<td>2.64</td>
<td>2.21</td>
<td>2.35</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Farmer 2</th>
<th>Cow 1</th>
<th>Cow 2</th>
<th>Cow 3</th>
<th>Cow 4</th>
<th>Cow 5</th>
<th>Cow 6</th>
<th>Cow 7</th>
<th>Cow 8</th>
<th>Cow 9</th>
<th>Cow 10</th>
<th>Mean (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (kg/day)</td>
<td>1.82</td>
<td>2.1</td>
<td>1.8</td>
<td>3.28</td>
<td>1.5</td>
<td>1.2</td>
<td>3.64</td>
<td>2.28</td>
<td>3.69</td>
<td>2.21</td>
<td>2.35</td>
</tr>
</tbody>
</table>

The variance is calculated by four steps. First, find the difference between the data and the mean. This is
also called the deviation from the mean. For instance, Farmer 1/Cow 1 eats an average of 2.21 kg/day.
The mean is 2.35 kg/day. The difference is a negative number: -0.14 kg/day. Farmer 1/Cow 6 eats an
average of 2.42 kg/day. The difference this time is a positive number: 0.07 kg/day. We can complete this
chart using the differences between the data and the mean for both Farmer 1 and Farmer 2.

<table>
<thead>
<tr>
<th>Farmer 1</th>
<th>Cow 1</th>
<th>Cow 2</th>
<th>Cow 3</th>
<th>Cow 4</th>
<th>Cow 5</th>
<th>Cow 6</th>
<th>Cow 7</th>
<th>Cow 8</th>
<th>Cow 9</th>
<th>Cow 10</th>
<th>Mean (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (kg/day)</td>
<td>-0.14</td>
<td>-0.21</td>
<td>-0.07</td>
<td>-0.07</td>
<td>0</td>
<td>0.07</td>
<td>0.29</td>
<td>-0.07</td>
<td>0.29</td>
<td>-0.14</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Farmer 2</th>
<th>Cow 1</th>
<th>Cow 2</th>
<th>Cow 3</th>
<th>Cow 4</th>
<th>Cow 5</th>
<th>Cow 6</th>
<th>Cow 7</th>
<th>Cow 8</th>
<th>Cow 9</th>
<th>Cow 10</th>
<th>Mean (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (kg/day)</td>
<td>-0.53</td>
<td>-0.25</td>
<td>-0.55</td>
<td>0.93</td>
<td>-0.85</td>
<td>-1.15</td>
<td>1.29</td>
<td>-0.07</td>
<td>1.34</td>
<td>-0.14</td>
<td></td>
</tr>
</tbody>
</table>

The second step is to square the deviations. This means multiplying the deviation by itself. One effect of
this is to remove the negative signs from some of the numbers. Another effect is to amplify the
differences. For instance, Farmer 1/Cow 1 has a deviation of -0.14 kg/day. If this is squared, it would be
(-0.14 kg/day)² = 0.0196. We can repeat this for the entire chart.

<table>
<thead>
<tr>
<th>Farmer 1</th>
<th>Cow 1</th>
<th>Cow 2</th>
<th>Cow 3</th>
<th>Cow 4</th>
<th>Cow 5</th>
<th>Cow 6</th>
<th>Cow 7</th>
<th>Cow 8</th>
<th>Cow 9</th>
<th>Cow 10</th>
<th>Mean (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (kg/day)</td>
<td>0.0196</td>
<td>0.0441</td>
<td>0.0049</td>
<td>0.0049</td>
<td>0</td>
<td>0.0049</td>
<td>0.0841</td>
<td>0.0049</td>
<td>0.0841</td>
<td>0.0196</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Farmer 2</th>
<th>Cow 1</th>
<th>Cow 2</th>
<th>Cow 3</th>
<th>Cow 4</th>
<th>Cow 5</th>
<th>Cow 6</th>
<th>Cow 7</th>
<th>Cow 8</th>
<th>Cow 9</th>
<th>Cow 10</th>
<th>Mean (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (kg/day)</td>
<td>0.2809</td>
<td>0.0625</td>
<td>0.3025</td>
<td>0.8649</td>
<td>0.7225</td>
<td>1.3225</td>
<td>1.6641</td>
<td>0.0049</td>
<td>1.7956</td>
<td>0.0196</td>
<td></td>
</tr>
</tbody>
</table>
Thus, we now have the deviation of each cow’s average hay consumption from the average. We have
squared it. Now for step three, we add all of those numbers together for each farm.

<table>
<thead>
<tr>
<th>Farmer 1</th>
<th>Cow 1</th>
<th>Cow 2</th>
<th>Cow 3</th>
<th>Cow 4</th>
<th>Cow 5</th>
<th>Cow 6</th>
<th>Cow 7</th>
<th>Cow 8</th>
<th>Cow 9</th>
<th>Cow 10</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (kg/day)</td>
<td>0.0196</td>
<td>0.0441</td>
<td>0.0049</td>
<td>0.0049</td>
<td>0</td>
<td>0.0049</td>
<td>0.0841</td>
<td>0.0049</td>
<td>0.0841</td>
<td>0.0196</td>
<td>0.271</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Farmer 2</th>
<th>Cow 1</th>
<th>Cow 2</th>
<th>Cow 3</th>
<th>Cow 4</th>
<th>Cow 5</th>
<th>Cow 6</th>
<th>Cow 7</th>
<th>Cow 8</th>
<th>Cow 9</th>
<th>Cow 10</th>
<th>Sum</th>
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</thead>
<tbody>
<tr>
<td>Mean (kg/day)</td>
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<td>0.0625</td>
<td>0.3025</td>
<td>0.8649</td>
<td>0.7225</td>
<td>1.3225</td>
<td>1.6641</td>
<td>0.0049</td>
<td>1.7956</td>
<td>0.0196</td>
<td>7.040</td>
</tr>
</tbody>
</table>

Now that we have two numbers that represent the “sum of the squares” for each farm. The sum of the
squares, or the sum of the squared deviations for each data point, is very telling already. The “sum of the
squares” for the cows in Farmer 1’s farm is 0.271 – a small number. But look how big it is for Farm 2!
However, these numbers are affected by the size of the population – the larger the population, the larger
these numbers would be. You could only compare these numbers with populations that are the same size.
The only way to make them comparable with any other population is to “average” the sum of the squares.
This is the last step.

For Farm 1, the sum of the squares was 0.271. We would average this by dividing it by the number of
cows, which is 10. Thus, the variance for Farmer 1’s cows is 0.271/10, or 0.0271. Likewise, the variance
for Farmer 2’s cows is 7.040/10, or 0.704.48

Variance is important because we can tell how “spread out” the data is. We know that Farmer 1 has cows
that eat a fairly consistent amount of hay because the variance is only 0.0271. However, Farmer 2 has
cows that eat different amounts of hay. We know this because the variance is much higher: 0.704. There
is another number that we can deduce from the variance, and this number is seen in many statistical
studies.

If you already have the variation of a population, the Standard Deviation is easy to calculate. You
simply take the square root of the variance. The variance of hay eaten by each cow at Farm 1 and Farm 2
is found as follows:

\[ \text{The Standard Deviation at Farm 1} = \sqrt{0.0271} = 0.165 \]

\[ \text{The Standard Deviation at Farm 2} = \sqrt{0.704} = 0.839 \]

So, what does this mean? The standard deviation lets you know how spread out the numbers are in the
distribution. In other words, how much difference is there between one cow’s eating habits and another.
Since the mean for both is 2.35 kg/day for each cow, we know that Farm 2 has more variation around that
number. When larger populations are used, the distribution tends to become more and more regular. In

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48 In the next section, you will see that variance is calculated in a slightly different way when you are sampling a
population. Instead of dividing by the population, the variance is divided by the size of the sample -1. Thus, if you
have sampled 100 cows, but you are trying to understand what is happening with thousands of cows, you would
divide by 99.
those larger populations, we can then predict how many cows will eat within one standard deviation of the mean, how many will eat between two standard deviations, and how many will be able to eat within three.

The standard deviation of Farm 1 is 0.165. Thus, within 0.165 kg/day of the mean, we should have about 68% of the entire population within that first standard deviation. Within the second standard deviation, we should observe another 27% of the population. Thus, about 95% of the population should be accounted for within the first two standard deviations. Finally, most of the remaining population should be within the third standard deviation.

We can look at this graphically.

In the chart above, we can see that 68% of Farmer 1’s cows should eat between 2.185 and 2.515 kg/day. (In fact, because it is such a small sample (10 cows) nearly all of them are within that constraint; however, with larger populations this should become closer to 68%). Let’s look at the second farm. Like Farmer 1, its cows have an average consumption of 2.35 kg/day. However, it has a much larger standard deviation of +/- 0.839. As you can see from the chart below, 68% of the cows will be eating a much wider range of amounts. This is the purpose of standard deviation, which gives an indication of how tightly grouped or wide-ranging the data is.
As we look at the main descriptive statistics, such as the mean and standard deviation, we can begin to understand how a statistician looks at data. She can see where it is grouped (the mean) and how wide or narrow that group is (the standard deviation). Suppose an expert is called in court to testify that he measured the cows and found that the average cow ate 2.35 kg/day of hay. He doesn’t say what the standard deviation of the group is. Does it look more like Farmer 1’s herd of cows, which all eat about the same amount? Does it look more like Farmer 2’s herd of cows, which has a much wider range. Both have the same average, but neither herd is actually similar. A very hungry cow in Farmer 1’s herd would be an average, unremarkable cow to Farmer 2.

When we are dealing with scientific evidence, the range of the data can be important. As one example, a body is found 11 meters next to a 10 story building. The deceased lived on the 10th floor, with his balcony facing the yard where the body was found. The expert testifies that he conducted tests with an object that weighed the same as the body. After fifty attempts, he states that on average, the body would have only fallen 9.28 meters from the building. He thus concludes that the person was thrown from the building.

He has never said what the range, variance, or standard deviation of his test was. If every single time the fake body fell 9.28 meters away from the building, then this is fairly convincing evidence that a person falling from the building would be found no further than 9.28 meters. However, maybe there was wind some of the time. There may be variation in the results. Perhaps the test results looked like this:

<table>
<thead>
<tr>
<th>Distance from building (m)</th>
<th>7m</th>
<th>8m</th>
<th>9m</th>
<th>10m</th>
<th>11m</th>
<th>12m</th>
<th>13m</th>
<th>14m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of times body landed at this distance from building.</td>
<td>4</td>
<td>13</td>
<td>18</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>
In this example, the range is actually between 7 m and 14 m. The standard deviation is actually 1.6 m, which means that we should consider about 68% of the time, the body would land between 7.68 and 10.88 meters from the building. However, about 95% of the time, the body would land within 2 standard deviations from the mean. What does this mean? Most of the time, the body would be found between 6.08 m and 12.48 m of the building. If we know how dispersed the data really is, the expert’s opinion that the body had to have been thrown from the building does not seem to be supported by his own experiments.

While the expert may have other reasons for his conclusion that the victim was pushed from his balcony, he should provide the court with a full understanding of the experimental results, which should include at least the range and the standard deviation. In this case, the person fell 11m from the building, which was near the first standard deviation. Statistically speaking, it wasn’t impossible that he fell.

Statistical data can do more than merely describe data. In fact, it can be a very powerful tool to predict or infer information about a larger population using a smaller sample. In fact, in the example above with the victim falling from the building, the expert is using a sample of 50 experimental drops of a simulated body to predict how often a body would fall certain distances from that tall building. Most of the forensic and medical data is based upon predictive or inferential statistics. There are factors, however, which can affect the reliability, credibility and weight of predictive statistical evidence.
c) Basic Concepts of Predictive (or Inferential) Statistics.

In the previous section, we discussed the statistics which describe a complete and known population. In other words, if we have a basket of red and green apples, we can count how many are red and how many are green. We can weigh them and say what the average apple in that basket weighed. We can even say how much variation there is in the weight of the apples.

But we say whether that basket of apples describes all apples found in the world? If the basket has 20 red apples and 10 green apples, does that mean that in the orchard there are twice as many red apples as green apples? Does it say anything about the color of all the apples in the world? Most of us would not think that one single basket of thirty apples could represent the thousands of apples in the orchard or the billions of apples in the world.

However, what if someone worked in the orchard for many years and had seen many, many baskets of apples? If every basket out of the orchard looked very similar, with 20 red apples and 10 green apples, we might begin to think that it might represent the orchard. And if the sample were much, much larger and widely collected, we might think it represented the world’s division of red apples and green apples.

A smaller sample can represent a larger population under certain conditions. This is how survey research and medical research is conducted, for example. Not everyone is given a survey; instead, a smaller group of people are asked questions. Medical research is not conducted on every person; instead, a smaller “statistically representative” sample receives the treatment. This is similar to the orchard and the baskets of apples – if you look at enough baskets, you begin to see a pattern and believe that pattern to be representative.

1) Representative Samples – the power of numbers.

If an expert or a witness discusses research that involves a sample of people, this should raise questions. The foremost question should be: was the sample representative of the greater population? For instance, a medical examiner cites a study that says that a substance is poison to 30% of people. However, if the study was very small or biased, it may not be able to represent the greater population. Thus, a practitioner should be aware that a study should have a large enough sample size and should minimize any bias.

A sample should be sufficiently big enough to represent the larger population. How big a sample is needed? This depends on the population you want to represent. If you want to study a population that is smaller, such as 100 people, you might need a sample that is a high percentage of that population. However, if you want to study a million people, you may need a sample that is a smaller percentage of that population. Why is this?

Statistics is a science which better predicts trends in larger populations. Over larger populations, individual decisions and tastes no longer have much influence. In smaller populations, it is possible that you have, by chance, a strange group of people. Thus, if you want to infer statistics over a small number of people, you have to examine more of them to ensure that you haven’t encountered a group of unusual people.
a) Sample size matters

If a travel bus can hold 50 people and will go a long distance, at some point people will be hungry. Some will want soup, some will want a sandwich with meat, and some will want a sandwich without meat. The population is small: 50 people on the bus. Let’s say you ask 10 people what they want for lunch. This is your sample size of 10 people. They all say soup. Would you feel very comfortable that this represents what the whole bus wants? You would feel that there might be a lot of error with that sample.

If you asked 40 people, however, would you feel like there was less error? You might feel more comfortable that you could predict what the final 10 people might want. As you can see, there is a relationship between how much error there would be in a prediction (or how much confidence you have that the prediction is right) and the percentage of people being asked. Asking 40 people, or 80%, gives you much more confidence than asking 10 people, or 20%.

However, instead of one bus with 50 people, you now want to look at 20 buses. There are a thousand people on those 20 buses. If you asked 50 people on one bus, you would still feel there wasn’t a lot of confidence if you wanted to predict the lunches of all the people. If you picked 20% of a thousand, however, you would be asking 200 people what they wanted for lunch. You would begin to have more confidence that you could predict more accurately for all 1000 people.

Sometimes we accept that there may be error. We may not predict every single lunch preference in that 1000 person population, but we may predict it within 5%. If we are happy with that level of accuracy, we would call that our “margin of error.” The larger the margin of error, the less people we need to sample. The smaller the margin of error, the more people we need to sample.

In addition to the margin of error, we also may want to know how confident we are in the prediction. We can rarely, if ever, be 100% confident, but we can be 99% confident. We may even be happy with 90% confidence. If we want to be more confident and have very little error, we need a higher percentage of the population being sampled. We need to look at more apples in the orchard, in other words. However, if we don’t mind being a little wrong and a little less confident, we can look at less apples.

Rather than going through the mathematics of calculating the size of a sample, there are tools available on the internet. However, to give you an idea of how a sample size may vary, and why it matters, look at the following chart.
## Effects of Confidence and Error on Sample Size

<table>
<thead>
<tr>
<th>Population Size</th>
<th>95% Confidence</th>
<th>99% Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Margin of Error</td>
<td>Margin of Error</td>
</tr>
<tr>
<td></td>
<td>5%</td>
<td>1%</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>20</td>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td>30</td>
<td>28</td>
<td>30</td>
</tr>
<tr>
<td>50</td>
<td>44</td>
<td>50</td>
</tr>
<tr>
<td>75</td>
<td>63</td>
<td>74</td>
</tr>
<tr>
<td>100</td>
<td>80</td>
<td>99</td>
</tr>
<tr>
<td>150</td>
<td>108</td>
<td>148</td>
</tr>
<tr>
<td>200</td>
<td>132</td>
<td>196</td>
</tr>
<tr>
<td>250</td>
<td>152</td>
<td>244</td>
</tr>
<tr>
<td>300</td>
<td>169</td>
<td>291</td>
</tr>
<tr>
<td>400</td>
<td>196</td>
<td>384</td>
</tr>
<tr>
<td>500</td>
<td>217</td>
<td>475</td>
</tr>
<tr>
<td>1000</td>
<td>278</td>
<td>906</td>
</tr>
<tr>
<td>1500</td>
<td>306</td>
<td>1297</td>
</tr>
<tr>
<td>2000</td>
<td>322</td>
<td>1655</td>
</tr>
<tr>
<td>5000</td>
<td>357</td>
<td>3288</td>
</tr>
<tr>
<td>10,000</td>
<td>370</td>
<td>4899</td>
</tr>
<tr>
<td>25,000</td>
<td>378</td>
<td>6939</td>
</tr>
<tr>
<td>50,000</td>
<td>381</td>
<td>8056</td>
</tr>
<tr>
<td>100,000</td>
<td>383</td>
<td>8762</td>
</tr>
<tr>
<td>500,000</td>
<td>384</td>
<td>9423</td>
</tr>
<tr>
<td>1,000,000</td>
<td>384</td>
<td>9512</td>
</tr>
<tr>
<td>10,000,000</td>
<td>384</td>
<td>9594</td>
</tr>
<tr>
<td>100,000,000</td>
<td>384</td>
<td>9603</td>
</tr>
</tbody>
</table>
As you can see, there is a relationship between a large population and the sample size. If you want to understand a larger population, you need to sample more people. However, you need a smaller percentage of that larger population. Further, if you want more confidence in the answer and a smaller margin of error, you need to sample a greater number.

Look at the chart. Assume we have a population of 1,000 people in our buses. If we are satisfied with a 95% confidence in our answer with a 5% margin of error, we only need to ask 278 people what they want for lunch. We may get some of the lunches wrong, but we will be close. However, if we want to be very accurate and have 99% confidence and only a 1% margin of error, look how many people need to be surveyed: 943. At that rate, you may as well ask all 1,000.

However, as the numbers get even larger, we begin to see that there is a limit. If we want to estimate what 500,000 people want for lunch, we could ask only 384 people. We would need to be satisfied with a 95% confidence in our answer and a 5% margin of error, but it isn’t much more than what was needed for 1,000.

However, if we want to estimate the lunch demands of 500,000 with high confidence (99%) and high accuracy (1% margin of error), look how many people need to be surveyed: 16,055. That is a large number, but it’s only 3.2% of the total population. With just a few more people in the sample, you could estimate the lunch desires of 10 million people or a 100 million people.

Let’s consider how the survey size could be an issue in a criminal case. A medical expert testifies that very few people would be killed with a certain chemical, and the chemical spilled by the defendant didn’t contribute to anyone’s death. When asked more, the medical expert says that one medical study was conducted by the chemical’s manufacturer. It had a sample size of 50 laboratory animals, and only one showed any reaction to the chemical. The medical expert then says that because of this, he is very certain that this chemical could not kill anyone. If the population of people affected by this chemical is in the millions, is this sample size sufficient?

Assuming that the laboratory animals are a reasonable substitute for humans, we would have concerns about a sample of only 50 subjects. Even at 95% confidence and a 5% margin of error, we could only estimate a very small population. Many professional researchers would not be satisfied with a sample size less than 500, unless they are trying to estimate a small population.

b) Minimize the bias

If the sample size is large enough, it may still not be representative if there is bias. For instance, if you selected all the thin people on the bus and asked them what they wanted for lunch, they may just ask for soup. You might then only carry soup on the bus. Would that really be representative of all the people on the bus who weren’t thin and, perhaps, wanted a sandwich? The sample should be picked randomly.

Let’s consider an example that could be in a courtroom. The expert is testifying about the victim’s losses. He explains that after he was shot, he couldn’t work as a driver and has lost income. The expert then says that he looked at the pay of 100 drivers, finding that they made an average of $1000 a month. However, when the driver was asked if the sample was random, he said that he simply asked the drivers of rich
company owners. This raised the income considerably. Another sample could have been made of only government drivers, which might have lowered that average. Neither would have been a random sample, and neither would have been very representative of the real world.

2) Caution about methodology.

There is a difference between statistics and the methodology of a study. A survey or scientific study may have a randomly-selected population that is large enough; however, if the study’s methodology itself is flawed it will create poor answers. In a previous chapter we discussed the credibility, relevance and probative strength of evidence. Credibility of documents depended on the system which created it. For instance, a bank document is created by a system. If it collects information accurately, stores that information, and reports it reliably, then we believe that document to be credible. The same is true of a scientific study or survey.

A survey may ask people a question that has no bias, such as “Which of the following is your favorite color: (1) Blue, (2) Red, (3) Yellow, (4) Green, (5) Purple, or (6) Orange?” The question does not provide information that creates a bias, nor does it present the information in a way that directs the person being surveyed to answer in any particular way.

Some other questions can suggest answers, such as: “Blue is a color that indicates strength and intelligence. What is your favorite color?” Other questions can dissuade a person from answering in a certain way. “Adolph Hitler’s favorite color was blue. What is your favorite color?” These kind of questions are called “push questions” or “Push polls,” as they “push” the survey respondent to answer in a certain way.

Likewise, there can be errors in the handling of the study. In a medical study, or laboratory tests for forensics, a sample can be tainted or mislabeled. Even if the study is statistically sound, the practitioner should question whether there are mistakes or errors in the underlying studies.

f) Understanding Probability.

A pair of dice can be considered an excellent symbol for statistics, and one that we can use to better understand probability. A single die has six sides, each with dots representing 1, 2, 3, 4, 5 and 6. Thus, the chance of getting any one number is 1/6, or 0.167. For instance, the chance of getting 3 is 0.167. The chance of not getting 3 on any throw is 1.00 - 0.167 = 0.833. (We can represent this as 100% - 16.7% = 83.3% chance, but often in statistics we represent 100% simply as 1.00.)

Thus, if I throw the die, I have a 0.167 chance of rolling a three. Every single time I roll that die, I have the exact same chance of rolling a three: 0.167. It never changes, as each throw of the die is independent. For the same reason, a lottery is independent. It has the same chance of having the same numbers every day. Thus, if an event is independent, it will always have the same probability. Thus, if I throw the die five times and each time it rolls a five, what are the chances that it will roll a five on the next throw? The probability has not changed – it will still be 0.167.

However, if two events are linked, then the probabilities do affect each other. One example is called the “Monty Hall Dilemma,” named after a 1970s game show in the United States. There are three boxes, one with a good prize, such as cash, and two with bad prizes, such as used socks. You do want the good prize
and you don’t want the bad prizes. You can’t see into the boxes and you aren’t allowed to examine the boxes. You must pick the box based on pure chance.

If you think about the probability of picking the correct box, there is a one in three chance of being correct. This is 1/3, or 33%. It doesn’t matter which box you pick, you have a 33% chance of being right (winning the cash) and a 67% chance of being wrong (winning one of the two old socks). Let’s say that you pick Box #3. This is the first part of a two-part game. You now have a 33% chance of winning cash.

In the second part, the person running the game then says that he will take away one of the bad prizes, and asks if you would like to change your selection. He then removes Box #1, which we now know to contain an old sock. The question is: should you change from Box #3 to Box #2? The real question is which choice has the higher probability of winning cash? Most people would think that you now have a 50/50 chance of winning the cash. After all, there are two boxes left and you can only pick one. However, that would be wrong.

Let’s think about your first choice: keeping Box #3. You have picked Box #3 and still have a 33% chance of winning cash and a 66% chance of winning an old sock. Your probability has not changed, even by revealing that Box #1 has an old sock. You only have a 33% chance of winning.

In fact, you should switch your selection from Box #3 to Box #2. Why? You already know that you have a 33% chance of winning cash with Box #3, but a 66% chance of having won an old sock. But now you have more information from the second part of the game. You know that 66% of the time you picked the wrong box. Now you only have one other box to pick. If there is a 66% chance that Box #3 is the wrong box, what must you do? Pick the right box, which is Box #2.

Another way to look at this is that there are three scenarios.

1. In the first scenario, you picked Box #3 which has an old sock. He can remove Box #1, which also has an old sock. The remaining box has the cash.
2. In the second scenario, you picked Box #3 which has an old sock. He can remove Box #2, which has the old sock, and leave Box #1. The remaining box has the cash.

3. In the third scenario, you picked Box #3, which has the cash. He knows that Box #2 or Box #1 both have old socks, and so he can remove either one.

There is only a 33% chance that the last scenario is correct. In either of the first two scenarios, the remaining box has the cash. By changing boxes, you actually double the probability of winning. This is counterintuitive to most people, who think that they have a 50/50 chance of winning, since there are two remaining boxes. In fact, the probabilities are linked. When this game is played, it consistently demonstrates that switching boxes gives the player twice the probability to win the cash. However, casinos always make money based on similar cases of probability. If the probability is counterintuitive, people will be tricked.

This should illustrate that statistics and probabilities can be counterintuitive. Evidence which relies on statistics should be carefully considered by the judge and critically examined by practitioners. Statistics can be powerful and convincing, but they may have more credibility or probative value than they are due. If they are well understood, however, they can provide strong supporting evidence in a criminal case.

e) The Prosecutor’s Fallacy and Bayesian Statistics.

Should any conviction or decisive action be taken in a criminal case based solely on statistical evidence? Keeping in mind the Monty Hall Dilemma, we might think that statistical evidence is proving something it isn’t. Many kinds of statistical tests are tests that exclude other possibilities. In fact, we only understand the Monty Hall Dilemma when we consider what has been excluded, instead of thinking of what has been proven.

We have dealt with this before when we considered DNA testing. Let’s review that topic.

<table>
<thead>
<tr>
<th>STR Location</th>
<th>Sample from DNA left on Rape Victim</th>
<th>DNA Sample from Suspect 1</th>
<th>DNA Sample from Suspect 2</th>
<th>Genotype Frequency of Suspect 1’s STR</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPOX</td>
<td>7, 8</td>
<td>7, 8</td>
<td>8, 8</td>
<td>0.30</td>
</tr>
<tr>
<td>D3S1358</td>
<td>15, 17</td>
<td>15, 17</td>
<td>17, 17</td>
<td>0.13</td>
</tr>
<tr>
<td>FGA</td>
<td>23, 27</td>
<td>23, 27</td>
<td>21, 23</td>
<td>0.31</td>
</tr>
<tr>
<td>D5S818</td>
<td>13, 13</td>
<td>13, 13</td>
<td>9, 12</td>
<td>0.29</td>
</tr>
<tr>
<td>CSF1PO</td>
<td>8, 11</td>
<td>8, 11</td>
<td>11, 12</td>
<td>0.18</td>
</tr>
<tr>
<td>D7S820</td>
<td>10, 11</td>
<td>10, 11</td>
<td>9, 10</td>
<td>0.26</td>
</tr>
<tr>
<td>D8S1179</td>
<td>12, 13</td>
<td>12, 13</td>
<td>14, 15</td>
<td>0.34</td>
</tr>
<tr>
<td>THO1</td>
<td>9.3, 9.3</td>
<td>9.3, 9.3</td>
<td>6.9, 3</td>
<td>0.38</td>
</tr>
<tr>
<td>vWA</td>
<td>15, 16</td>
<td>15, 16</td>
<td>18, 19</td>
<td>0.22</td>
</tr>
<tr>
<td>D13S317</td>
<td>12, 12</td>
<td>12, 12</td>
<td>12, 12</td>
<td>0.21</td>
</tr>
<tr>
<td>D16S539</td>
<td>9, 13</td>
<td>9, 13</td>
<td>11, 12</td>
<td>0.10</td>
</tr>
<tr>
<td>D18S51</td>
<td>12, 18</td>
<td>12, 18</td>
<td>14, 18</td>
<td>0.11</td>
</tr>
<tr>
<td>D21S11</td>
<td>28, 30</td>
<td>28, 30</td>
<td>27, 30.2</td>
<td>0.06</td>
</tr>
<tr>
<td>Overall Genotype frequency of Suspect 1</td>
<td></td>
<td></td>
<td></td>
<td>8.81 x 10^{-10}</td>
</tr>
</tbody>
</table>

In this example, there are 13 locations in the DNA that the FBI laboratory tests, and the DNA from Suspect 1 matches perfectly. For each match, there is number in the last column which indicates the
frequency that such a genotype has in the suspect’s ethnic group. For the location vWA, for instance, the genotype of 15,16 occurs in 22% of the suspect's ethnic group.

When all of these frequencies are multiplied together, we see that there is an overall frequency of 0.000000000881%. This means that the chance that a random person in the suspect's ethnic group would have this particular combination of genotypes is 0.000000000881%, or about 1 in 1.1 billion. However, this is not proof that Suspect 1 is the rapist, especially if this is the only evidence offered.

There can be two situations where this DNA test will be used. First, it can be used to confirm a suspect which was already identified due to other, independent evidence. Second, the suspect’s DNA could be in a database, such as at the FBI. When the DNA from the crime scene is tested and the profile entered into the database, a match occurs and the database gives the suspect’s name. In that scenario, there is nothing else that incriminates the suspect.

In the first scenario, other evidence incriminates Suspect 1 and eliminated Suspect 2. Such a match has a frequency of 0.00000000881%, which means that it is rare. The rarity of the DNA match can be used to support and corroborate the other evidence.

In the second scenario, though, Suspect 1 has his DNA profile in the FBI's database. When the DNA profile from the crime scene is entered, the database shows Suspect 1 as a match. There is no other evidence to link Suspect 1 to the rape. This very small number, 0.00000000881%, is not the probability that Suspect 1 is the rapist. Instead, it simply is the probability of seeing this DNA profile if a random person was selected. It simply means that it is rare. Regarding this as the probability of guilt is called by statisticians the "prosecutor's fallacy."

In 1996, the Court of Appeals of England and Wales decided Regina v. Adams. In that case, a woman had been raped by man she described as being in his 20s. DNA was recovered from the rape victim, which matched the DNA profile of Denis Adams. She could not pick Adams out of a lineup and described Adams as being in his 40s. At the time, Adams was 37 years old and had an alibi. The only evidence against him was the matching DNA. Despite the lack of any other evidence, the prosecution successfully argued that the match probability was 1 in 200 million people. The defense argued that the match probability was closer to 1 in 2 million people. The jury found him guilty.

The match probability in such a case is the only evidence against the defendant. Statisticians would never assert that this evidence proves that Adams was the rapist. This would be the Prosecutor's Fallacy. Such a claim would be that the proof was deductive, or that you could draw a logical connection between the proof and the guilt of the defendant. However, it does present inductive proof, which doesn't prove the defendant's guilt, but essentially means that the alternatives to his guilt are very unlikely.

Most people would think that a high match probability means that it is very unlikely that anyone else could be the rapist. After all, only 1 in 200 million people have that DNA profile. However, remember the Monty Hall Problem. In that problem, the common sense approach was the wrong approach. Probabilities are a tricky subject. The number "1 in 200 million people" sounds very convincing, but it is a theoretical number.

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arguments to conceptualize the evidence. However, there is a very strong mathematical reason why we should express DNA match results (and other statistical proof) as simply a measure of how rare the match is within the population.

One powerful tool in a statistician's arsenal is called "Bayes' Theorem," named after an English minister and statistician who lived in the 1700s. He tried to use statistics and math to better express the unknowable and unproven aspects of religious faith. In doing so, he created one of the most powerful statistical tools to understand human behavior.

It is a very simple equation with a very simple premise: the more and more we know, the closer and closer we can predict the truth. Thus, our evidence and belief about a subject is critical to predicting an outcome. We are also constantly re-calculating that probability as well. This concept requires a clear example.

If a female comes home and finds another woman's bra in the house, what would be her conclusion? There are a few possibilities. First, the bra belongs to her husband, who secretly wears it. Second, the bra is a gift from the husband that he hasn't given to her yet. Third, he is cheating on her with another woman. While she is concerned about the first possibility, she is very worried about the third. She would like to know what the probability that her husband is cheating on her.

In order to estimate the probability, you need to know or estimate three things. First, you need to estimate the probability that the evidence would be there because your hypothesis is true; in this case, what is the estimate that the bra is there because he is cheating on her? It may seems easy to imagine how the bra is there if he is cheating, but you would also think he was more careful about the evidence of cheating. Perhaps the probability is 50 percent that the bra would be there as a result of cheating.

Second, you should estimate what the probability that the evidence is there as a result of your hypothesis being false. In this case, what is the probability that the bra would be there for some other reason. As noted above, he could like to wear bras. It may belong to his sister. It may be a gift. These don't seem as likely, though. They may have a probability of only 5%.

Third, you need to estimate what statisticians call the "prior probability." What probability of him cheating did she consider before she found the bra? While it is difficult for her to make this assignment while she is holding the suspicious bra in her hands, she might have had suspicions. Or we could rely on the general probability from surveys. Some surveys have said that there is a 4% rate of married partners cheating. For now, we will consider the prior probability to be 4%.

In this example, there is a 4% prior probability that he is cheating on her. She finds the bra, and estimates that there is a 50% chance that the bra would appear as a condition of him cheating. She also estimates that there is only a 5% chance that the bra would appear for other reasons.

After the calculation of the Baysean probability, statisticians would call this the "posterior probability," which is her revised estimate of how likely it is the he is cheating after she found the bra.

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51 This example is drawn from N. Silver, _The Signal and the Noise, Why So Many Predictions Fail but Some Don’t_, Chapter 8 (Penguin Press 2012).
x = Prior Probability  
\[ x = 4\% \]

y = Probability that Bra Found as a Condition of Husband Cheating  
\[ y = 50\% \]

z = Probability that Bra Found if Husband is Not Cheating  
\[ z = 5\% \]

PP = Posterior Probability
\[
\frac{xy}{xy + x(1-x)}
\]
\[
\frac{0.04 \times 0.50}{0.04 \times 0.50 + 0.05 \times (1-0.04)}
\]
\[
\frac{0.02}{0.02 + 0.05 \times (0.96)}
\]
\[
\frac{0.02}{0.02 + 0.048}
\]
\[
\frac{0.02}{0.068}
\]

PP = 29%

Just like the Monty Hall Problem, this result seems counterintuitive: she found a bra in the house and thinks that there is a 50/50 chance that it can only come from him cheating. But she didn't have any suspicion that he cheated before. This prior probability has an incredible effect on the probability, even after finding the bra, that he cheated.

What if she believed that he might have been cheating, even before finding the bra? How would this change the probability that he was cheating now that the bra was found? Let's say she would have assigned a 33% probability that he was cheating, maybe from past evidence such as suspicious phone calls.
x = Prior Probability
   x = 33%

y = Probability that Bra Found as a Condition of Husband Cheating
   y = 50%

z = Probability that Bra Found if Husband is Not Cheating
   z = 5%

PP = Posterior Probability

\[
\frac{xy}{xy + z(1-x)}
\]

\[
\frac{0.33 	imes 0.50}{0.33 	imes 0.50 + 0.05(1-0.33)}
\]

\[
\frac{0.165}{0.165 + 0.05(0.67)}
\]

\[
\frac{0.165}{0.165 + 0.0335}
\]

\[
\frac{0.165}{0.1985}
\]

PP = 83%

What does this mean? The probability in the first scenario is only 29%, but the probability in the second scenario is 83%. Why is it so different? In the first scenario she had no reason to suspect that he was cheating. In the second scenario, the new evidence adds more weight to the suspicions she already has. Bayesian statistics supports countless accurate predictions, from political elections, sports team records and social trends. The reason that it has accuracy is because it takes into account new information and old information.

How does this apply to other forms of evidence? Some tests have false positives which can lead to misleading statistics and unwarranted confidence. Others, such as DNA evidence, are really tests of rareness and should only be used to indicate guilt with additional evidence. One concern is that we commit the prosecutor's fallacy and confuse a test which states how rare a match is with one that actually shows guilt.

i) False Positives

A false positive is a result of a scientific test, such as a cancer test, which indicates that cancer is present when, in fact, it isn't. Most scientific tests have a rate of false positives. One such famous example is the mammogram, which tests for breast cancer in women.

Only 1% of women at age forty who have routine mammogram screening have breast cancer. Of those with breast cancer, 80% will have a positive test. Of those without breast cancer, 9.6% will also get
positive results (these are false positives). If a 40 year old woman has a positive mammogram in a routine screening, what is the probability that she really has cancer?

When physicians in the United States were asked to guess the answer to this question, only 15% answered correctly. This result has been replicated in many studies, so this isn't simply found in the United States. Most would think that if you have a positive cancer test such as this, you have a very high possibility of having cancer. The physicians normally guessed between 70% and 80% probability. However, you and those physicians would be wrong. In fact, the woman still has a low probability of cancer.

How can that be? If 80% of those who have a positive test result have cancer, how can she have a lower chance of actually having cancer? Let's think about this from a Bayesian viewpoint. The prior probability is 1%, as only 1% of women at age 40 have breast cancer. This means 99% of women do not have cancer. If there are 1000 women who are age 40, we can divide them into two groups. One group has 10 women with cancer (1%) while there are 990 in the other group (99%).

Focusing first on the first group of 10 women with cancer, we know that the mammogram will find that cancer in 80% of those cases. Thus, 8 of those women will have a positive result.

Looking at the second group, which is much larger, we know that 9.6% of them will have a false positive. Since this group has 990 women, this means that about 95 women will have a false positive. (990 women * 0.096 = 95.04)

All we know is that we have a positive test result. If I have cancer, I am a member of a very small group. Eighty percent of that small group would have a positive result. In our example, 8 women are in this group. If I don't have cancer, however, I am a member of a much larger group. In that larger group, 9.6% will have a positive. In our example, 95 women are in this group.

Out of 1000 women in our example, 103 women would test positive. Only 8 women out of that 103 would have cancer. Now, what do you think your chance is? That's right, 8/103 or about 7.8%. Under this scenario, you would only have a 7.8% chance of really having breast cancer, despite the positive test.

Just like the Monty Hall Problem, the apparently obvious probability is not the correct one. Why? Because we focus on the population of women who have had the test, and not on the entire population of women who might have cancer. Bayesian statistics emphasizes that more information is needed to have accurate predictions. We needed to know how many women had cancer in the normal population of those

\[ \text{PP} = \frac{xy}{xy + z(1-x)} = \frac{0.01 \times 0.80}{0.01 \times 0.80 + 0.096(1-0.01)} = \frac{0.008}{0.008 + 0.096(0.99)} = \frac{0.008}{0.008 + 0.995} = \frac{0.008}{1.003} = 0.008 \]

\[ \text{PP} = 7.8\% \]

\[ W. \text{ Casscells, A. Schoenberger and T. Grayboys, "Interpretation by Physicians of Clinical Laboratory Results," 299 New England J. Med. 999-1001 (1978).} \]

\[ 53 \] If we were to calculate this in the more classical Bayesian formula, it would look like this:

\[ x = \text{Prior Probability} = 1\% \]

\[ y = \text{Probability that test positive as a condition of having cancer} = 80\% \]

\[ z = \text{Probability that test positive as a condition of not having cancer} = 9.6\% \]

\[ PP = \frac{xy}{xy + z(1-x)} = \frac{0.01 \times 0.80}{0.01 \times 0.80 + 0.096(1-0.01)} = \frac{0.008}{0.008 + 0.096(0.99)} = \frac{0.008}{0.008 + 0.995} = \frac{0.008}{1.003} = 0.008 \]

\[ PP = 7.8\% \]
tested, thus creating these two groups: women with cancer and women without cancer. Then we needed to know how many of each of those groups had positive test results. Only then did we know what the positive test result really meant.

ii) Tests of Rarity

As mentioned several times before, many of forensic tests have only two uses. They can exclude people as suspects or, if they aren't excluded, they can determine how rare the match is. For instance, if a suspect has a blood type of AB-, but the blood found at the crime scene was O+, then this excludes him from being a suspect. If both are O+, though, then we simply know how rare this match is. (In the United States, it is 37% of Caucasians.)

We would never convict someone only because his blood type matched that of blood left by a criminal at the crime scene. There is simply too much error. We don't think that such a match is rare enough. After all, 37% of Caucasian people could also match. We can even look at this using Bayesian statistics in order to realize that statistically, the chance of having the right person is even smaller than 37%.

In our scenario, a white male wearing a mask robs a bank. He cuts his finger as the money is being handed to him, leaving a small drop that can be tested. Weeks have passed, so the cut finger would have healed. The only evidence is the blood, which is O+. The only reason the suspect is arrested is because he has O+ blood. In the city, there are 1,000 white males. Thus, there is a 1 in 1,000 chance that you have the right person. This is your "Prior Probability."

We know that 37% of that 1,000 white males should be O+, or 370. There is a 100% probability of a match being positive as a result of the person being guilty. (Any person who is guilty will be a match 100% of the time.) The chance of the match being positive as a result of not being guilty is 369 out of 999 will have a "false positive" of having an O+ blood. This means 36.9%.

When we calculate this, it results in probability of having the right suspect that is very low: 0.27%. Why is this so much lower than 37%? Again, we have to consider the probability that we initially picked a person, essentially at random, from the population. If the population was bigger, this would be even smaller.

Instead of the Caucasian with the most popular blood type, let's assume that the blood is AB- and the criminal was Asian. Instead of 37% of the population of Caucasians, only 0.1% of Asians have the blood type of AB-. If there are 10,000 Asian males in the population, we can calculate the probability that the criminal was selected.

\[ PP = \frac{xy}{xy + z(1-x)} \]

\[ = \frac{0.001 * 1.00}{0.001 * 1.00 + 0.369(1-0.001)} = \frac{0.001}{0.369(0.999)} = \frac{0.001}{0.37} \]

\[ PP = .0007\% \]

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54 In the cancer example, the test only was positive 80% of the time when there really was cancer. Unlike detecting cancer, the blood type will match the suspect 100% of the time.
55 \[ x = \text{Prior Probability} = 0.1\%
\]
\[ y = \text{Probability that test positive as a condition of being guilty} = 100\%
\]
\[ z = \text{Probability that test positive as a condition of not being guilty} = 36.9\%
\]

\[ PP = \frac{xy}{xy + z(1-x)} = \frac{0.001 * 1.00}{0.001 * 1.00 + 0.369(1-0.001)} = \frac{0.001}{0.001 + 0.369(0.999)} = \frac{0.001}{0.001 + 0.369} = \frac{0.001}{0.37} \]

\[ PP = .0007\% \]
Our "Prior Probability" is 1 in 10,000, as we have only one criminal out of the population of 10,000 Asian males. We know that 0.1% of that 10,000 white males should be AB-, or 10. Thus, the chance that a match is positive as a result of being guilty is 100%. The chance of the match being positive as a result of not being guilty is 9 out of 9999 will have a "false positive" of having an AB- blood. This means 0.09%. Does this seems to be much more likely to have the right person?

When we calculate this, it results in probability of having the right suspect that is still very low: 1.1%. After all, we have still essentially selected this person at random from the entire population of Asian males. This "Prior Probability" has strong effects on the final probability. However, if the person hasn't been randomly selected, but there is other evidence against him, it should cause a very large change.

Instead of the randomly apprehended Asian male, let's assume that he matches the description, has a past history of bank robberies, and lacks any alibi. We think that there is a 50% chance that he is the criminal, based on the other evidence. All of the other information is the same.

Our "Prior Probability" is now 50%. When we calculate this probability, it results in probability of having the right suspect that is quite high: 99.1%. This is the power of corroboration.

The matching of blood types is sufficient to exclude a suspect, but is a very rough test to match a suspect with the crime scene. As discussed earlier, DNA testing results in even more precision. However, does that greater precision translate into greater a greater probability of matching the criminal?

In our first scenario, the DNA match comes from a database and there is no other evidence. The DNA is left by a Caucasian male rapist. We know that in this city there are 1,000,000 Caucasian males. The only evidence is the DNA. Thus, there is a 1 in 1 million chance that you have the right person. This is your "Prior Probability." There is also a legally mandated prior probability, which we call a "presumption of innocence."

We are told that there is a 0.00001% chance that a random person would have this DNA profile. The DNA matches the suspect's DNA in an FBI database, so he is arrested. The chance of a match being positive as a result of being guilty is 100%. The chance that the match happened as a result of the person being innocent is not a clear number. If there are a million males in the city and the DNA match can occur in 1 out of a million, this doesn't mean that there is a 0% chance of a false positive. It does mean that it is a very small number. Let's call it 0.00001%.

\[ PP = \frac{xy}{xy + z(1-x)} = \frac{0.0001 \times 1.00}{0.0001 \times 1.00 + 0.0009(1-0.001)} = 0.0001 \times 0.0001 \times \frac{0.0001}{0.0009} \]
\[ PP = 1.1\% \]

\[ PP = 1.1\% \]

\[ PP = 99.1\% \]

\[ PP = 99.1\% \]

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\[ x = \text{Prior Probability} = 0.01\% \]
\[ y = \text{Probability that test positive as a condition of being guilty} = 100\% \]
\[ z = \text{Probability that test positive as a condition of not being guilty} = 0.9\% \]

\[ PP = \frac{xy}{xy + z(1-x)} = \frac{0.0001 \times 1.00}{0.0001 \times 1.00 + 0.0009(1-0.001)} = 0.0001 \times 0.0001 \times \frac{0.0001}{0.0009} \]

\[ PP = 1.1\% \]

\[ PP = 1.1\% \]

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\[ PP = 99.1\% \]
When we calculate this, it results in probability of having the right suspect that is not very high: 50.000025%. After reading the first part of this chapter, you probably expect that it wouldn't be very high. You can appreciate the prosecutor's fallacy that asserting that this very rare event (a DNA match) must mean that the suspect is guilty does not match the actual probability.

However, what if there is evidence that this person was in the area, had a history of this crime, and could not account for himself at the time of the crime. Let's assume that we think that there is a 33% chance of guilt prior to the DNA test. Would this substantially raise the probability of guilt? By recalculating the probabilities, we can see that the probability of guilt is now 99.9998%.

Statistical evidence can appear very compelling, but the actual probabilities are sometimes counterintuitive. Sometimes people want to rely on the compelling aspect of statistical evidence, but don't want to understand what is really being presented. An expert can simply present "a number" that is never challenged or fully understood in court. That number can be very convincing. Simply asking the expert about the rate of a false positive can give a clearer picture of the statistic's meaning. Often, an expert on one topic (such as medicine) may present a statistic that he or she calculated, even if they have no expertise in statistics.

Statistics that exclude a suspect or make an event or match seem very rare are particularly powerful and misleading. This includes such statistical tests as DNA testing. When the only evidence is statistical, such as in a DNA match, particular attention must be spent to really understand what is being proven. Often, they simply prove that such a match is rare, but do not prove that the defendant was guilty.

Probability is simply using the information that you have to determine the likelihood of an event, such as guilt. If you have seven days in a week, there is a 1/7 chance that today is Wednesday. But if you know that yesterday was Tuesday, you are very certain that today is Wednesday. It is no longer a 1/7 chance. The power of additional information should be clear from this chapter. It can have an enormous effect to improve the probability of guilt. Simply having DNA evidence that shows that a match is rare may, in fact, only result in a modest probability of guilt. Having additional evidence raised that probability to over 99% in our example. Such high probability of knowing the truth is always a goal of courts.

\[ PP = 50.00025\% \]

\[ PP = 99.9998\% \]

\[ x = \text{Prior Probability} = 0.000001 \]
\[ y = \text{Probability that test positive as a condition of being guilty} = 100\% \]
\[ z = \text{Probability that test positive as a condition of not being guilty} = 0.000001 \]

\[ x = \text{Prior Probability} = 0.33 \]
\[ y = \text{Probability that test positive as a condition of being guilty} = 100\% \]
\[ z = \text{Probability that test positive as a condition of not being guilty} = 0.000001 \]
f) Conclusion

There is no expectation that courts begin calculating the statistical probability of a person's guilt. This chapter, however, is meant to make the reader aware that people are not good at estimating uncertainty. In fact, this is what judges or juries do all the time when they adjudicate a case. Statistical evidence, however, can be misleading. We have seen with several examples that our intuition can mislead us. In the Monty Hall Problem, most people would believe that there was a 50/50 chance that they chose the right box. Instead, the probability is demonstrably double if you switch boxes. The difference between the intuition that we trust and the true probability is what allows casinos, lotteries and con men to profit.

When physicians were asked to identify the real risk of actually having cancer after a positive cancer test, only 15% correctly guessed the real probability. It was deceptively low because the population of people who actually get cancer is so low. The risk of a false positive is low, but the population of people who don't have cancer is so large.

Some statistical evidence is used as indirect, circumstantial evidence. It is relevant because it clarifies some issue for the court. However, some evidence can be exceptionally relevant, such as DNA evidence. In fact, it appears to be very compelling because the match is so rare. Some people commit the "prosecutor's fallacy" by saying that if it is so rare, it must prove that he is guilty. Some courts have even convicted people solely on such apparently compelling statistical evidence. However, when the statistics are calculated they reveal that there is more doubt than first thought.

Remember that there are three basic qualities of evidence: relevance, credibility and probative strength. The relevance of the DNA evidence is clear. The expert from the DNA laboratory shows that the laboratory procedures were done correctly and clearly has no bias. However, the probative strength of the evidence is being misrepresented. It may be evidence that the match is rare. Such rarity is helpful evidence, but it isn't conclusive. If combined with other evidence that shows the defendant's guilt, DNA testing becomes nearly conclusive.

This chapter is meant to give the practitioner an appreciation for the risks of statistical evidence. It should prompt you to ask further questions of an expert who asserts a probability. These questions should consider how the estimate of probability was calculated, whether the expert has the education and experience to make those calculations, and whether there is a probability of error or false positives. This chapter should make you aware that corroboration of evidence can statistically improve the probability of a person's guilt. This is especially true in statistical tests which examine the rarity of a match between the suspect and evidence at the crime scene.

If you do not feel comfortable with this, please re-read the chapter. In the following chapter we will discuss expert evidence. Like statistical evidence, expert evidence is given credibility and probative force that it may not fully deserve. In this chapter, we examined some of the more common reasons for statistical evidence to be misleading or for our intuition to be wrong. If we understand the limitations of the statistical evidence, we can better adjudicate the case as a whole.

Usually, the statistical evidence is conveyed by an expert. We will look at how to understand the limitations of expert evidence and how to better adjudicate based on that evidence as well.
Review and Problem Set

**Review:**

Evidence that depicts a trend or probability derived from a large number of examples involves statistics. It can be descriptive statistics, such as an average or a comparison of percentages. This simply describes the data that is known. It can be predictive, which uses known data to predict something that isn’t known. Statistics are most often used in scientific evidence, such as DNA evidence. This evidence can exclude someone as a suspect by clearly showing that the suspect’s DNA does not match DNA found at the crime scene. It is more nuanced when there is a match. The “Prosecutor’s Fallacy” in statistics essentially means that you cannot conclusively say that a DNA or other match means that someone is guilty. It does mean, however, that the chances of a match are very, very rare.

While a lawyer is not normally asked to calculate statistics, it is good that practitioners understand what statistics generally mean. This allows a lawyer or judge to know what questions to ask. An expert might explain that a laboratory test is very accurate. The lawyer may ask the expert about the rate of error or the standard deviation of the laboratory tests. These considerations help understand how accurate or reliable the tests are. Questions about the methods and tests help to understand whether the testimony is credible.

If statistical evidence is predictive, there are important factors to determine the reliability of the results. The sample size is very important. If an expert makes a prediction based on a very small sample, it should not be believed. Further, if there is a sample which has a bias, it may also not be credible.

People make predictions about their daily life based on probabilities. They believe they are good at understanding probabilities. This is why casinos and lotteries make money, as they understand the probabilities of the games better than most of the people. Some very simple questions can actually have misleading probabilities, as demonstrated by the Monty Hall Dilemma. This is why relying solely on statistics in a criminal case is problematic, even though some courts have done so. However, Bayesian theory is an area of statistics which demonstrates that statistical evidence which is supported by other evidence is much more likely to be correct. This is why corroboration of evidence is so powerful and so important.

**Problem Set:**

1. A baby food factory has allowed tainted food to be sold, and a child died after eating it. An expert testifies that the factory’s safety and quality controls are 99% accurate. If the factory sells 10,000 jars of baby food a week, does this expert’s testimony reassure you that the food is safe? What if he said it was 99.9% accurate? What if he said it was 99.99% accurate?
2. DNA is considered to be very accurate. If a match probability is 1 in 200 million people, does this mean that a person who has DNA matching the DNA found from the crime scene must be guilty? If not, what does it mean?

3. What is a false positive? Let’s say that only 1% of the population are allergic to nuts. A laboratory promotes a device which tests for nut allergies. Of those who actually have an allergy to nuts, 90% will have a positive result. However, those without allergies will still have a positive result 5% of the time. What is the probability that a person with a positive result on this test is allergic to nuts?

4. During a murder there was a pattern of blood splattered on the wall. An expert notes that in tests, the average pattern from a right-handed person would have similar blood splatters 70% of the time. The average pattern from a left-handed person would have similar patterns only 40% of the time. Is any information missing which would make this test seem more convincing, or less convincing?
1. Ninety-nine percent sounds like a very high number. However, if the factory sells 10,000 jars of baby food, 99% accurate quality control means that 9,900 of the jars are known to be good. 100 jars may not be good. Thus, one hundred jars of baby food being eaten by children from this company are questionable. Does this really make the baby food seem safe? If the accuracy is higher, such as 99.99%, this still means that 9,999 jars are known to be good. One jar might be bad. This is better, but if every week the factory makes one possibly bad jar of food, this is still a safety issue.

2. A match probability of 1 in 200 million people simply means that if people were picked at random, one out of 200 million would match that sample. This information by itself only means that this match is very rare, and that it is unlikely that another person would also match. However, if the match probability is 1 in 200 million and there is other evidence which suggests that this defendant is guilty, then we know from Bayes Theory that there is a much higher chance that the defendant is guilty.

3. A false positive is when a laboratory test or other process indicates a positive result, but in fact it is wrong. If 1% of the population is allergic, our prior probability is 1%, or 0.01.

\[
x = \text{Prior Probability} = 1% \\
y = \text{Probability that test positive as a condition of having allergy} = 90% \\
z = \text{Probability that test positive as a condition of not having allergy} = 5% \\
PP = \frac{xy}{xy + z(1-x)} = \frac{0.01 \times 0.90}{0.01 \times 0.90 + 0.05(1-0.01)} = \frac{0.009}{0.009 + 0.0045} = \frac{0.009}{0.0135} = 0.67 \\
\]

Thus, a person who has a positive medical test for allergies to nuts has only a 15.65% chance of actually being allergic. Why? Because the group of people who actually have allergies is so small, and the group of false positives is much larger than it appears.

4. An expert conducted tests and testified that the average pattern from a right-handed person would have similar blood splatters 70% of the time. The average pattern from a left-handed person would have similar patterns only 40% of the time. However, we do not know the variation or standard deviation of these tests. If the average pattern from the right hand matches 70% of the time, and the left hand matches 40% of the time, this sounds like the pattern must have come from the right hand. However, if all of the patterns are closely matched, then there really may not be that much difference between the two patterns. These distinctions are statistically not meaningful if the standard deviation of both right and left hand tests are close. They probably look a lot like each other. However, if the standard of deviation is high, then that means that 40% of the time the left-handed patterns may look like the crime scene, but 60% of the time they probably look very different.
In the previous chapters, we have examined the qualities of evidence: relevance, credibility and probative strength. We have seen that the evidence should be relevant to the interim and ultimate issues in the case. For witnesses, the credibility depends on the ability of the witness to have observed and remembered the events, as well as their veracity. The credibility of documents depends not only on their authenticity, but on the process that created them. The process should ensure that the documents are reliable. Finally, the probative strength simply considers how much the evidence improves the probability that an interim or ultimate fact or inference is true.

In previous chapters we have also looked at inferential evidence, such as statistics. This evidence helps the court to infer the truth, rather than directly know the truth. Since the evidence is inferential, this means that there is uncertainty. This relates directly to the probative strength of such evidence, as our intuition about uncertainty is often easily misled by statistics. We may believe statistical evidence has much greater persuasiveness than it deserves.

Expert evidence is related to statistical evidence in many ways. Some experts rely on statistics in order to analyze evidence and give an opinion. Expertise is also a quality which may often be credited with more credibility and probative strength than it should. This point may seem strange; after all, the court and prosecution are not highly knowledgeable about forensic science, accounting, genetics or other highly technical fields. They should be able to trust in an expert in this field to analyze data and give an opinion.

It can be easy for a court or prosecutor to simply entrust to the expert all of decision-making, treating the expert's words as unassailable fact. However, the prosecutor, attorney and judge still have a duty to examine the evidence critically. If a medical expert gave an opinion about physics or engineering, would
we treat it as anything other than an ordinary opinion? Of course not, since the medical expert does not have education or experience in those fields. If that medical expert gave an opinion based on statistics, would we defer to that opinion, or wonder whether the statistics were correct? After all, medical school doesn't teach in-depth statistical analysis. If the medical expert gave an opinion about cardiology, even though she was a pediatrician, should we give that expert opinion any special weight?

In many legal systems, expert testimony is given special treatment compared to other witnesses. For this reason, the opinion evidence from an expert has much more weight than the opinions given by other witnesses. In fact, the opinion evidence from an expert can have as much, if not more, weight than a direct, eye-witness. When an expert opinion has such sway in determining the adjudication by the court, the practitioners and the court should understand the credibility and reliability of the expert, the analysis that the expert used, and whether the expert is giving an opinion with which other experts in this field would probably agree.

1) What is Expert Evidence or Expertise?

A normal witness explains what he or she perceived. That witness may have seen or heard an event, or had processed an important document, or has some other information that is directly relevant to the case. An expert, on the other, is simply giving an opinion. They didn’t see the crime, nor did they see any event associated with the crime. Instead, they have either examined the evidence or have access to specialized information, and due to that the court allows them to give an opinion.60

That opinion, however, should be based on something. Do they have specialized knowledge? Do they have specialized education or experience? Have they done research on this topic? What gives this expert the authority and weight to simply give an opinion which counts as evidence? In English law, or South African Law, for instance, it has been held that expert evidence can only address matters outside of “ordinary human experience.”61 As Judge Learned Hand explained over a century ago, experts provide “general truths derived from... specialized experience.”62 This specialized experience gives an expert a specific set of knowledge outside of that ordinary human experience. But how do experts provide this information or analysis reliably?

There are two general types of experts. The first type bases their expert opinion on scientific testing. The expert should have scientific training and experience in the field, as well as appropriate equipment and methods. This usually required access to the physical evidence and possibly laboratory, medical or technical analysis. This can include forensic testing, medical testing or computer forensics.

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60 In some jurisdictions, such as England, an expert is deemed an expert witness. In the Dutch system, as in many other continental systems, an expert is deemed a separate institution under Article 343 and 344 of the Wetboek van Strafvoering, or Dutch Criminal Procedure Code. An expert can only provide an opinion under the Dutch law and cannot testify to facts which they observed (such as testing). Courts have solved this issue by asking experts to take both the oath for experts and for witnesses, deeming them expert witnesses. See L. Meintjes-Van Der Walt, Expert Evidence in the Criminal Justice Process, A Comparative Perspective, 67 (Rozenberg Pub. 2001). Under Article 85 of the German Strafprozessordnung (Criminal Procedure Code), there is a similar provision for experts relating facts. Dutch law also includes another category of “specialized witness” (deskundige getuige) which can include medical officers or police officers, which can also be used as evidence similar to expert opinion testimony. Id.
61 Meintjes-Van Der Walt at 64 (citing R. v. Turner [1975] 1 QB 834).
The second type bases their expert opinion on specialized knowledge. This does not necessarily require access to the physical evidence. It can include an expert estimating the value of an object, forensic accounting, or simply an expert providing the court with necessary factual background on a technical topic.

An expert is providing an opinion. This means that the opinion can be fallible, and may be wrong, even if they are highly qualified. The expert may have made a mistake, may be biased, or may be using a technique for which there is not universal agreement. Thus, the expert should give their opinion on interim matters, but should never give an opinion on the ultimate issue: guilt or innocence. Their opinions should be helpful to the court’s adjudication. It should not replace the court’s judgment on these final issues.

2) Qualities of Expert Evidence

The qualities of expert evidence differ from the qualities of a normal witness. First, the relevance of the expert is almost a given, as the question being posed to the expert by the prosecutor, defense or court is presumably important to the case. Often, the probative strength given to the expert's testimony and report is often quite high, especially if the expert declares his opinion to have very high statistical certainty.

An expert is giving an opinion and is not describing facts that he or she saw about the crime. The expert witness did not perceive the crime, nor is he or she trying to remember facts and details about the crime. The value that the expert gives to the court's decision-making is drawn from the analysis that the expert conducts. The expert's ability to conduct the analysis, and the quality of the analysis itself, directly influences the reliability and credibility of the expert opinion being given.

Unfortunately, if an expert's credentials and analysis are not fully examined, the reliability and credibility of the evidence is assumed to be high. However, if the credentials are inadequate or inappropriate to the expertise being given, what makes that expert's opinion more valid than that of a non-expert? Thus, the reliability and credibility of an expert and the expert analysis are the most pertinent questions to consider about expert evidence. However, the expert evidence is only as good as the information he or she is asked to analyze.

3) Opinion based on other Evidence

An expert must not only have access to the evidence needed, but should actually review the evidence and seek more available evidence if it is needed. We could call this evidence the "subject evidence," since that evidence will be subjected to analysis. Since the expert is basing his or her opinion on an analysis of the subject evidence, it is critical that the expert actually reviewed the evidence.

The first question to ask is how the evidence has been transmitted to the expert. Did he or she look at copies or originals? Is there any concern that the evidence that the expert reviewed had been changed or tampered with? If the subject evidence that the expert analyzed is not credible, then the expert's opinion has no reliable basis.

The second question to ask is whether the expert had been able to examine all of evidence that the analysis required? Is there any subject evidence missing from the analysis? If so, has the expert taken that gap into account when giving his or her opinion?
The third question is whether the expert analyzed the evidence at all. If an expert has given a standard analysis without any reference to the subject evidence, or has made mistakes about the subject evidence, a practitioner or judge should question the expert about whether they examined the subject evidence. If the expert has not properly examined the subject evidence, the expert's analysis may not even be relevant to the criminal case.63

4) Methods to Appoint Experts

Legal systems appoint experts in three general ways. In some systems, the experts may only be appointed by the court. In other systems, the experts are appointed by parties. A recent trend in some countries, such as Australia and the U.K. is for concurrent expert testimony so that experts can debate with each other over any differing opinions. Each format carries with it some strengths, while also carrying with it weaknesses. These strengths and weaknesses also affect the qualities of the evidence being given by the expert.

In many continental systems, the court appoints the expert. The primary benefit of this type of system is that the expert appears to be neutral and is not associated with any party. Instead, the expert is associated with the judicial process. This strength can also be its weakness, as an expert who is appointed by a court can also appear to be unassailable. A practitioner who disagrees with the expert may not challenge his evidence before the very judge who appointed that expert, or the colleague of the judge who appointed the expert. Thus, in such systems the expert testimony tends to be more difficult to challenge and can be exceptionally decisive.

In many common law countries, the experts are appointed by the parties, but only rarely by the court. The party has to demonstrate to the court that the expert is qualified and has the basis to testify. This generally means that the testimony must be helpful to the court, that the expert is educated, experienced and knowledgeable in the field, and that the expert used a method of analysis that is scientifically or technically sound.

However, the opposing party can also propose an expert to also testify. That expert would also have education, experience and knowledge, and may have used different, but well-accepted analysis. Both experts may have different opinions, based on methodology or knowledge that are both arguably correct. A judge without any scientific or technical training or background may be asked to believe one expert over the other. In these systems, the experts are seen as biased towards the party which hired them, and it can place a court in the difficult position of choosing which expert to believe.

A third method has gained traction in recent years. Concurrent expert testimony has two or more experts before the court either at the same time, or consecutively. The court or the parties ask the experts questions, but one expert can also question the other expert. In Australia this has been called “hot tubbing” the experts, as it puts both experts into the same tub and doesn’t let them out until the both have

63 If an expert has been asked to give a general opinion, however, it may not be necessary that he or she examines the subject evidence. An expert may be asked for a opinion for general information which may be relevant to the case, but isn’t related to the subject evidence. For instance, if an expert is asked to give a value for a stolen car, he or she may simply refer to recent sales of similar cars. An expert could also be asked for the number of a particular firearm in a country, the general dangerousness of a chemical, or some other technical or scientific fact which is relevant to the case.
reached a similar conclusion. While this has the advantage of having several experts testify until they arrive at a single conclusion, it doesn’t always work. Some experts simply won’t agree with each other. It can also be more time consuming and expensive.

Thus, there are three basic forms of appointing an expert. A *court appointed expert* is more efficient and provides a single, seemingly unbiased opinion. However, if the expert is mistaken, biased or using controversial or old methods, it is difficult to challenge that expert before the court. *Party appointed experts* provide a broader and arguably more accurate set of opinions. However, the experts can be biased towards each party, and this leaves the court to decide which technical or scientific opinion should be believed. Lastly, *concurrent expert testimony* attempts to use the positive aspects of both. However, it doesn’t always work and it can be more resource-intensive.

5) Reliability Due to Qualifications of Experts

Because courts give expert evidence more credence than many other forms of evidence, practitioners and judges should all be highly concerned that the evidence is reliable. In criminal cases especially, there can be dire and irreversible consequences to a court decision which is based on unreliable expert evidence. There can be two critical areas where the reliability of evidence given by an expert can suffer. First, an expert can give an opinion on a topic in which he or she has no qualifications or expertise to discuss. Second, the expert may use inappropriate or faulty analysis before arriving at his or her conclusion. Either of these problems can make expert evidence unreliable and, thus, not credible.

A qualified expert should only be allowed to give an opinion within the area of his or her expertise. Often, however, an expert’s opinion is given credibility even though he or she has no training or experience in that area. For instance, a medical examiner who has been trained as a doctor with extensive forensic medical classes and experience can clearly give an opinion about the reasons for a person’s death. However, does that expert have the qualifications to discuss firearms ballistics? Does that expert have the qualifications to conduct a statistical analysis? Does that expert have the education or experience to explain how far a person can fall or jump from a building? If the answer is no, then why should the court believe that medical examiner’s opinion about matching bullets? Why should the court find reliable an opinion on the statistical chances of cancer? Unless the medical examiner is also a physicist, why should we believe his opinion about how far a falling body would travel?

Unless the expert actually has the background that qualifies him or her to give expert testimony, any other information the expert provides is simply an opinion. This begs the question: What is a qualified expert?

There are no international standards for an expert’s qualifications. In the United States Federal Courts, for instance, an expert is qualified under Rule 702 of the Federal Rules of Evidence, which states:

*Rule 702 (Testimony by Experts)*

If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise, if (1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case.
Under this standard, the expert must possess “scientific, technical, or other specialized knowledge” which they have acquired through “knowledge, skill, experience, training or education.”

In Germany, on the other hand, the court selects the expert witness under Section 73 of the Strafprozessordnung (StPO). Under Section 75 StPO, the “person appointed as an expert must comply with the appointment if he has been publicly appointed to render opinions of the required kind, or if he publicly and commercially practices the science, art or trade, the knowledge of which is a prerequisite for rendering an opinion, or if he has been publicly appointed or authorized to practice such profession.”

Thus, under the German standard, an expert should either be appointed for the purpose of giving such opinions (such as a forensic laboratory scientist or a medical examiner) or should be “publicly and commercially practicing the science, art or trade, the knowledge of which is a prerequisite for rendering an opinion...”

The issue of expert scientific evidence was discussed at length in Daubert v. Merrill Dow Pharmaceuticals, Inc.64 in which the United States Supreme Court considered both the qualifications of an expert and his methodology. In both, the trial court “must ensure that any and all scientific testimony or evidence admitted is not only relevant, but reliable”65 and that “evidentiary reliability will be based upon scientific validity.”66 This scientific validity includes sufficient training and experience in that scientific discipline for that expert to analyze evidence and provide an opinion.

However, when an expert is not testifying about scientific results, that “evidentiary reliability” may rely on personal knowledge, skill, work experience, or training.67 For instance, the Supreme Court held that, whether a scientific expert or another kind of expert, the knowledge of that expert is important towards establishing evidentiary reliability.68 After all, an expert witness of any type differs from a normal witness because of the “assumption that the expert’s opinion will have a reliable basis in the knowledge and experience of his discipline.”69

It thus stands to reason that an expert should not be a novice or unschooled in the discipline about which he is testifying. There are no standards for how much education is sufficient or whether two years’ experience is enough. There is a growing reliance on certifications of experts which allow a court to qualify an expert more easily. If the body which grants the certification has legitimate standards and testing, this can help a court identify experts more easily.

An expert should have sufficient experience, skills or education, or as the German code phrases it, he or she must publicly and commercially practice the science, art or trade. However it is phrased, an expert should have knowledge or experiences about the topic which are different than those of a normal witness. That knowledge should give his opinion greater value. However, this is only half of the reason for an

65 Id. at 589.
66 Id. at 590-91.
68 Kumho Tire Co. at 147.
69 Id. at 148.
expert’s opinion to have greater weight in the courtroom. The expert must also conduct some sort of analysis or have some sort of methodology which would not be alien to others in his or her field.

6) Reliability of Methods of Analysis

Every expert witness should have some sort of methodology by which he or she arrives at their opinion. If the expertise is scientific, then it should have scientific validity. If the expertise is based on the knowledge and experience of his or her discipline, then it should have acceptance within that field. The U.S. Supreme Court in Daubert noted that courts should focus on the “principles and methodologies” that an expert uses, and not their conclusions.\(^\text{70}\) Likewise, the Court said that an engineering expert is an “applied science” which also relies on “scientific reasoning and methodologies.”\(^\text{71}\) It warned that courts should pay particular attention to the testimony’s “factual basis, data, principles, methods, or their application” to determine whether the expert testimony has a “reliable basis in the knowledge and experience” in that field.

In fact, Rule 702 has three requirements to allow expert testimony: if (1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case.

How can a judge, who is not an expert, determine whether there is sufficient facts or data? How can the court determine whether the methods and principles are reliable? Further, how can this non-expert judge evaluate whether those principles and methods were applied reliably to the facts in the case? It seems to require an expert to evaluate the expert. However, there are some indicia which can help a court determine if scientific, technical or specialized methods are reliable.

a) Generally Accepted Practices

The primary indicia that a scientific, technical or specialized method is reliable is that it is well accepted in the field.\(^\text{72}\) If a method is the primary or most accepted mode of analysis in its field, this generally indicates that many other experts in that field consider it to be reliable. This acceptance can be demonstrated in science by its use in peer-reviewed journals or being considered a standard practice in textbooks. The acceptance can also be shown if it is a recommended or mandatory practice by an association or regulatory body. For instance, there are eight blood types: A+, A-, B+, B-, AB+, AB-, O+ and O-. In Canada, the national health service and Canada Standards Association both have standard procedures for the collection of the blood sample, handling of the sample, and the testing procedure to determine the blood type. Further, if a particular laboratory equipment is being used, the manufacturer of that equipment will normally have recommended practices to ensure the reliability of the laboratory results from that equipment. In a field which is applied science, such as engineering, there are also many generally accepted principles and methods. For instance, there is an organization called the American Society for Testing and Materials, now called ASTM International, which develops consensus engineering standards.

\(^{70}\) Daubert at 595.

\(^{71}\) Kumho Tire Co. at 148.

\(^{72}\) This was the standard set by Frye v. United States, 293 F. 1013 (D.C.Cir. 1923) which found that a lie detector test was unreliable in a criminal case because it had not gained "general acceptance." This "general acceptance" standard held in the United States for seventy years until the Daubert decision.
Not all expert analysis is scientific or based on scientific principles. For expertise based on art or trade, or technical, or other specialized knowledge, an expert may not have conducted analysis through a formal methodology. However, there are often standard practices in many fields. For instance, an expert who is asked to value land or an automobile will refer to other, comparable sales. In the United States or the United Kingdom, there are industry books that list the value of cars. The expert could simply refer to that book, or refer to previous sales of similar cars in the area. Land valuation is done similarly, referring to similar real estate sales in the area. In the U.S. State of California, for instance, real estate appraisers are licensed. The methods that those California-licensed appraisers use are governed by the standards of the Uniform Standards of Professional Appraisal Practice (USPAP), which are promulgated by the Appraisal Foundation.\footnote{California Bureau of Real Estate, Reference Book, Ch. 15 (2011).}

Very often an expert will be asked a common question in his or her field, or will have conducted a well-accepted laboratory test. However, not all methods are so well settled that a government, association or regulator has reduced them to writing. Some experts may dispute the "generally accepted" practices as incorrect, or inappropriate in some circumstances. In other cases, the expert is asked to give an opinion on a topic where there is no generally accepted practice. What can a court rely on to determine whether that methodology is reliable?

\textbf{b) Use of a Methodology which is Otherwise Reliable}

If an expert uses a method whose general acceptance has not been shown by its adoption by a regulator or an association, how else can its reliability be shown? In the \textit{Daubert} decision, the Supreme Court listed some suggestions which included (1) whether the theory or technique can be, and has been, tested, or (2) whether it has been subjected to peer review and publication. There may be techniques or controls which reduce any error in the procedure. Further, if the expert can demonstrate whether there is a known, or potential, rate of error for the technique this assists the court in determining its reliability.\footnote{\textit{Daubert} at 595.} For instance, an expert who has used a technique for which there is no consensus standard might testify in the following way:

\begin{tabular}{ll}
\textbf{Question:} & Is this method required by any regulator or professional association? \\
\textbf{Answer:} & No, it is not. \\
\textbf{Question:} & Is there another method which a regulator or professional association does recommend or require in this situation? \\
\textbf{Answer:} & No, there is not. This is not a common situation. \\
\textbf{Question:} & Is this method based upon a theory or principle which is generally accepted? \\
\textbf{Answer:} & Yes, it is based on a well-accepted scientific theory. This technique has been used in several articles published in well-respected, peer-reviewed scientific journals, including
\end{tabular}

Question: Are there other methods which could have been used?
Answer: There are competing methods based on different theories, but they have not been as well accepted.

Question: Is there a reason that those methods are not as well accepted?
Answer: Those methods are based on theories which have very little evidence to support them. Further, the methods tend to have much higher error rates than the method which I used.

Question: You've mentioned error rates. What is the error rate of your method?
Answer: Several studies have shown that the error rate of this method is 0.01%. In other words, there is an error in 1 out of 10,000 times it is conducted. We conducted it twice using several samples from the crime scene. This additional step has been shown to reduce the error to 0.003%, which means that there is an error in 3 out of 100,000 attempts.

Question: What would be the error rate of other possible methods?
Answer: The next most reliable method has an error rate of 1.3%. This means that 13 times out of 100 attempts, there is an error. This would be almost 1000 times the error rate of the method I used.

Question: How did you ensure that there was no laboratory error or tainting of the sample?
Answer: We conducted the testing in a sterile environment and used laboratory techniques which are recommended by the National Society for Microbiology.

Question: Based on your knowledge of the field and the methods available, did you use the most reliable method possible?
Answer: Yes, I did.

c) Use of a Methodology Based on Experience or Knowledge

Some experts will be professionals in a field which does not have an easily described methodology, but may rely instead on the knowledge and intuition of the expert. This does not mean, however, that they have not conducted an analysis, no matter how informal. This analysis must be examined for indicia of reliability as well.

For example, a small company has an industrial machine which has unfortunately killed an employee. The company's owner has altered the safety mechanisms on the machine. The owner claims that the changes were meant to increase the safety of the mechanism. The prosecution claims that the changes were meant to increase productivity at the expense of the employee's safety. An expert is retained who examined the machine and is giving his analysis based on his years as a production engineer.
Question: Based on your knowledge of the field and the methods available, are there any governmentally required safety standards for this type of machine?
Answer: No, there isn't.

Question: Based on your knowledge of the field and the methods available, are there any industry association which suggests safety standards for this type of machine?
Answer: No, there isn't.

Question: Based on your knowledge of the field and the methods available, are there any published studies on the safety of this type of machine?
Answer: No, there isn't.

Question: Based on your knowledge of the field and the methods available, are there any studies on the safety of this type of machine, even if not published?
Answer: No, at least I'm not aware of any.

Question: Did you examine the machine at the owner's factory?
Answer: Yes, I did.

Question: Have you examined similar machines which have not been modified?
Answer: Yes, in fact I worked with a similar machine for 8 years.

Question: What was modified on the Owner's machine?
Answer: He removed a metal plate near a spinning blade, but replaced it with a metal grid.

Question: Did that metal plate have a purpose?
Answer: It did. It kept the operator from touching the blade and if the blade every broke loose, it would keep the blade from hitting the operator, as it did on the day that the victim died.

Question: Did you see a reason for the modification?
Answer: I could see two reasons. The grid would allow the operator to see the blade as it spinned, which allowed him to adjust the material in the machine. This would increase productivity.

Question: And how do you come to that conclusion?
Answer: I have been working in this field for over 20 years, and have seen similar modifications done to other machines. We even considered doing this to the machine I worked with.

Question: You said there was a second reason for the modification. What would that be?
Answer: The grid keeps the operator from touching the blade, but also allows the blade to remain cooler because it has more air. This also helps with productivity because the machine is operating more efficiently.

Question: And how do you come to that conclusion?

Answer: I have been working in this field for over 20 years, and have seen similar modifications done to other machines. We even considered doing this to the machine I worked with.

Question: Why did you not make this modification to the machine you worked with once?

Answer: This machine presents two safety risks to the operator. First, the operator may touch or have his clothing caught in the blade, which would injure or kill him. The grid addresses this risk effectively. However, there is a second safety risk if the blade breaks. It can be flung from the machine at over 100 meters per second. The metal plate is made of thick metal which was designed to absorb that energy and protect the operator. The metal grid was made of thin metal and was not designed to take that much energy. The blade fragments could easily pass through the grid and hit the operator.

Question: In your experience in this field, did this modification improve the productivity of the machine?

Answer: Yes, it did.

Question: Did this modification improve the safety of the machine?

Answer: No, it did not. It made it less safe. In fact, in my opinion, it removed the key protection that the operator had from a broken blade.

Question: The owner contends that this was designed to improve safety. Do you have an opinion whether this feature was designed for improving safety?

Answer: I can't say what he was thinking. However, I would not have made this modification if I was concerned about safety.

Question: In your experience, can you think of a reason why this would have been considered a safety feature?

Answer: It might be considered an improvement for the operator's visibility of the machine's operation, which could improve some aspects of safety. However, this modification ignored a real danger from the spinning blades.

Question: How prevalent are broken blades on this machine?

Answer: In the Manufacturer's manual, it states that broken blades are the primary safety concern. I don't know how often the blades break on this model.

Question: Does the manual warn operators not to remove the metal plate?
Answer: No. It never mentions the plate.

Question: You worked with a similar machine for eight years. Did the blade break on that machine?

Answer: Yes, perhaps five or six times.

Question: Would you call this a real danger of occurring?

Answer: Absolutely. It happened almost once a year.

Question: When the blade broke five or six times, did it ever harm the operator?

Answer: No. It never went past the heavy metal plate.

Question: If you had replaced the metal plate with a similar metal grid, do you have an opinion what would have happened?

Answer: The blade would have hit the operator each time. We had to replace the metal plate each time because it was nearly destroyed. It would have easily gone through anything weaker.

The expert has not referred to any studies or industry standards; however, his opinion certainly feels reliable. Why? He has given a great deal of detail about why he is an expert. He has worked in the field for 20 years and has worked with this particular machine for eight years. He refers to the manufacturers manual which states that broken blades are the greatest danger and confirms it with his own experience. He has repeated occurrences of the blade breaking, in fact, almost once a year. With this repeated experience with the machine's broken blades and the damage it did to the metal plate, his opinion gains reliability and credibility.

His methodology, in this case, is to examine the machine and determine the reasons for the machine to have the metal plate. During that method, he reviewed his past experience with the machine to explain why the metal plate is necessary for safety. If the expert had never worked with this particular machine, or had never seen the blades break, his opinion would look more like speculation.

Thus, not only should the expert have sufficient knowledge to justify giving his or her opinion special weight, but the expert should have a reliable methodology. Both of these qualities are necessary for the expert's opinion to have sufficient credibility to be meaningful. Even with these qualities, however, expert testimony can still raise special issues.

7) Special Issues related to Experts and Expertise

   a) Behavior Sciences

In recent decades, expert testimony about behavioral sciences has not only focused on diagnosis, but has provided general information about a societal condition. It then leaves the decision maker, such as the judge or jury, to decide whether the defendant fits into that condition.
Testimony about a person's mental condition can have two forms. Traditionally, the expert should examine the person with sufficient time to arrive at a diagnosis. Not only should the expert have the training, knowledge, experience and credentials to diagnose a person's mental state, but they should also be able to explain what the diagnosis means. However, some experts may be asked to give what some call "social framework" testimony, in which the expert provides information on a social or psychological syndrome. When an expert gives social framework evidence, he or she is explaining a broader social or behavioral phenomenon, but is not specifically linking it to the defendant. One example is testimony about "battered women syndrome." In State v. Kelly, a woman was accused of killing her abusive husband. A psychologist was allowed to testify about psychological studies of similar women in abusive relationships, all of which concluded that they are in constant fear for their lives. The Court held that the evidence should be heard to support her claim that she acted in self-defense.

Another form of expert testimony is to create a "profile" of a criminal from the evidence left at the crime scene, or to describe the normal behavior of a typical class of criminal. For instance, a behavioral profiler may describe their observations as coming from experience with child molesters in general, not from the specific facts of the case.

A typical form of this kind of "profile" testimony can be found in United States v. Romero. In Romero, the 36 year old defendant was accused of meeting a 12 year old boy in an internet chat room and finally convincing him to meet and run away together. An expert on child molesters from the Federal Bureau of Investigation was called, who testified about the general tendencies of child molesters. He identified two types of child molester, one who takes advantage of a situation but does not have an overriding preference for sexual contact with children (the situational child molester) and one who prefers child contact and seeks it out (the preferential child molester). The expert testified about four main qualities shared by preferential child molesters.

First, he testified that the "conduct of a preferential child molester 'is not a temporary, opportunistic kind of thing,' but 'occur[s] over a long period of time and is extremely persistent.'" Persistent child molesters, he continued, spend a great deal of time and energy to find children, target them, lower their inhibitions and gain access to them.

Second, he testified that preferential child molesters have very specific interests and focus on certain kinds of children, such as boys in a narrow age bracket, which cause them arousal. They may also focus on children from dysfunctional homes or with attention deficit disorder, because they are easier to manipulate.

Third, he testified that preferential child molesters "identify a need in the child" and then spend time and energy to fill that need temporarily in order to manipulate the child. He testified that this can take the form of expressing interest in the child's problems or telling this child that he, too, has those problems.

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77 Conley & Moriarty, infra., Pp. 234-235.
78 United States v. Romero, 189 F.3d 576 (7th Cir. 1999).
Last, the expert testified that preferential child molesters engage in fantasies and "need-driven" behavior, such as collecting child pornography and keeping records of their encounters with children. The direct testimony and cross-examination of this expert underscored that a person who merely keeps child pornography is not necessarily a child molester.

The expert never expressed an opinion about whether the defendant abducted the child with the intent to molest him, which was a main question in the case. The expert never examined the defendant, so he could not express any direct opinion. Instead, the expert broadly described the behavioral characteristics of a group of people who typically commit the crime of child molestation. He explained that his testimony was meant to more fully describe that a typical child molester does not have to be a family member or someone who grabs a child off of the street. The expert made limited conclusions from the defendant's actions, finding them consistent with a typical preferential child molester. The court ruled that the evidence was permissible and the defendant was convicted.

As we consider an expert on behavior, such as in *Romero*, we should consider the three main qualities of evidence. First, is this expert's testimony relevant to the case? What issue does this address? Does it make that issue more clear? Second, is it reliable and credible? How do we know that the expert has made an appropriate profile of a child molester? Does this profile describe all child molesters? 80% of child molesters? Less? We also must consider that the expert works for the FBI. Does this raise a question of bias towards the prosecution? Lastly, does this testimony have much probative strength? Does it make any of our inferences or conclusions more certain? Is the case more, or less, convincing because of the expert's profile?

b) Forensic Sciences

Some forensic tests were derived from existing scientific research which has many peer-reviewed articles and is well understood to be credible. This includes many medical tests, toxicology, DNA testing and drug analysis. Other forensic expert analyses "are based on expert interpretation of observed patterns (e.g. fingerprints, writing samples, toolmarks, bite marks, and specimens such as hair)."

In 2005, the United States Congress authorized the National Academy of Sciences to conduct a study of forensic science. In 2009, the committee issued a report on forensic science which raised concern about some of these "interpretive" sciences which purport to match evidence with a person or source. That committee reported that, "[w]ith the exception of nuclear DNA analysis, however, 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." It also found a great deal of variation between some of the disciplines, some of which had developed protocols such as fingerprint analysis, and others which had less protocols and research, such as the analysis of bite marks. The report's summary concluded that the "simple reality is that the interpretation of forensic evidence is not always based on scientific studies to determine its validity... Although research has been done in some

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80 *Id.*

81 *Id.*
disciplines, there is a notable dearth of peer-reviewed, published studies establishing the scientific bases and validity of many forensic methods.\textsuperscript{82}

This report is not subject to universal agreement, but it does raise an important point about expert forensic evidence. A person with training, experience and knowledge about a field may be an expert in that field. However, if that field is based on assumptions which are neither proven nor reliable, then this diminishes the validity of any expert in that field. Without prejudicing the different disciplines, though, it is worth noting some of the concerns raised in the report.

i) Friction Ridge Analysis (Fingerprints, palm prints and sole prints)

In March, 2004, terrorist bombings in Madrid, Spain attacked commuter trains. Partial latent fingerprints were obtained from plastic bags which contained detonator caps. The Spanish authorities submitted the prints to the FBI's Integrated Automated Fingerprint Identification System (IAFIS) database. The database produced a short list of potential matches, which were then given to trained fingerprint examiners. Those examiners matched the fingerprints from Madrid with a lawyer in Portland, Oregon named Brandon Mayfield, who was arrested as a material witness. An independent fingerprint examiner also positively matched the fingerprints from Madrid with Brandon Mayfield. The fingerprint examiners had testified that there was a zero error rate, based on the belief that no two people have the same fingerprints. However, the Spanish authorities identified a second suspect, an Algerian who also had matching fingerprints. Mayfield was soon released.\textsuperscript{83}

Multiple experts from the FBI and an independent, court-appointed expert had all identified Mayfield's print as a match. They all were certain that they had a 100% match. However, it was the wrong person. How was this possible?

Fingerprint analysis has a well-developed methodology. Examiners subjectively compare points of similarity in the pattern. There are "patent" prints (which are photographs of the actual patterns on the fingers) and "latent" prints, which are the marks left by the finger or hand on a surface. Most prints in forensic investigations are latent prints. There are a variety of ways to find and collect latent fingerprints at the crime scene. Once the print is collected, it can be analyzed. Fingerprints patterns have three main structures: loops, whorls and ridges, which can be compared during the analysis. Expert fingerprint examiners analyze prints using a process of analysis called ACE-V, which stands for Analysis, Comparison, Evaluation and Verification.

\textit{Analysis} of the print is the first step, which begins by determining if the print can be used at all. If it is not suitable because of its quality or it lacks available features, then the examiner reports the print as unusable. If it is suitable, the examiner identifies which features can be compared.

The examiner then conducts a \textit{comparison} of the print from the suspect or database (the known print) with that from the crime scene (the unknown print). During the comparison of the unknown print with various known prints, the examiner conducts an \textit{evaluation} where different features are determined to be

\begin{itemize}
  \item \textsuperscript{82} Id. at 8.
  \item \textsuperscript{83} Id. at 45-46, 136-145. \textit{Also see U.S. Department of Justice, Office of Inspector General, A Review of the FBI's Handling of the Brandon Mayfield Case (Unclassified Executive Summary),} (USDOJ OIG Oversight and Review Division, January 2006).
\end{itemize}
the same or not. During this evaluation, the examiner then decides whether the prints are from the same source (identification or individualization), different sources (exclusion) or whether the evaluation is inconclusive. Finally, the process is verified by another examiner independently.

It is during the evaluation phase where the examiner identifies matching features between the two prints. This is a subjective process based on the expert's experience and training. As the examiner finds more and more matching features, they eventually decide that the prints match. The National Research Council report noted that:

Latent print examiners report an individualization when they are confident that two different sources could not have produced impressions with the same degree of agreement between details. This is a subjective assessment. There has been discussion regarding the use of statistics to assign match probabilities based on population distributions of certain friction ridge features. Current published statistical models, however, have not matured past counts of corresponding minutia and have not taken clarity into consideration. As a result, the friction ridge community actively discourages its members from testifying in terms of the probability of a match; when a latent print examiner testifies that two impressions "match" they are communicating the notion that the prints could not possibly have come from two different individuals.84

However, the report noted that there is no statistical evidence to support claims that two fingerprints absolutely match, or that they could not come from two people.85 The report cautioned that experts should not testify that fingerprints "absolutely" or "positively" match or identify one person. Instead, a match should be explained as having a degree of probability. Unfortunately, there are insufficient studies to quantify the probability at this time, although the report urged that research to be taken.

The report does not discard fingerprint analysis as a tool; rather, it is concerned that it has not been subjected to rigorous scientific and statistical testing. First, it is concerned that examiners treat the ACE-V process as if it was a scientific process.

ACE-V provides a broadly stated framework for conducting friction ridge analysis. However, this framework is not specific enough to qualify as a validated method for this type of analysis. ACE-V does not guard against bias; is too broad to ensure repeatability and transparency; and does not guarantee that two analysts following it will obtain the same results. For these reasons, merely following the steps of ACE-V does not imply that one is proceeding in a scientific manner or producing reliable results.86

The report is also concerned that there is little statistical testing; in particular, it is concerned that the error rate of matching latent prints is unknown. It is also concerned that there is insufficient research to show that a print is unique or that a finger even gives a consistent latent print from one impression to another.

Error rate is a much more difficult challenge. Errors can occur with any judgment-based method, especially when the factors that lead to the ultimate judgment are not documented. Some in the latent

85 Id. (citing J.L. Mnookin, "The Validity of Latent Fingerprint Identification: Confessions of a Fingerprint Moderate," 7 Law, Probability and Risk 127 (2008)).
86 Id. at 142.
print community argue that the method itself, if followed correctly (i.e., by well-trained examiners properly using the method), has a zero error rate. Clearly, this assertion is unrealistic, and, moreover, it does not lead to a process of method improvement. The method, and the performance of those who use it, are inextricably linked, and both involve multiple sources of error (e.g., errors in executing the process steps, as well as errors in human judgment).

Some scientific evidence supports the presumption that friction ridge patterns are unique to each person and persist unchanged throughout a lifetime. Uniqueness and persistence are necessary conditions for friction ridge identification to be feasible, but those conditions do not imply that anyone can reliably discern whether or not two friction ridge impressions were made by the same person. Uniqueness does not guarantee that prints from two different people are always sufficiently different that they cannot be confused, or that two impressions made by the same finger will also be sufficiently similar to be discerned as coming from the same source. The impression left by a given finger will differ every time, because of inevitable variations in pressure, which change the degree of contact between each part of the ridge structure and the impression medium. None of these variabilities—of features across a population of fingers or of repeated impressions left by the same finger—has been characterized, quantified, or compared. 87

Of the three qualities of evidence (relevance, credibility and probative strength), this report raises questions about whether expert analysis about fingerprints or other friction ridge identification has the scientific reliability which makes it credible evidence. It does not dismiss such evidence or consider it without any use; instead, it cautions experts not to make claims about "absolute matches." According to the report, there is little research to support such claims. An expert would have difficulty demonstrating the error rate without such rigorous research. However, a fingerprint analyst can testify that, based on his or her experience, training and education, the fingerprints appear to be the same and that such matches would be rare. When taken as additional evidence which can be corroborated with other evidence or dismissed, the fingerprint examiner's testimony absolutely has value.

ii) Impression and Pattern Evidence

The report considered that expert examination of impressions or patterns included tire marks, shoe patterns, bite marks, and even the matching of marks on bullets. Each of these disciplines require the expert to have considerable knowledge which is specific to that field. For instance, the wheel of a car may leave an impression in the mud. An expert on tire impressions would not only have a great deal of knowledge and information on tire patterns, but also on the wear of tires or the impressions given by tires with different air pressures. He could compare the impression in the mud with known examples of tires, and give an opinion on the brand that gave the impression.

Other types of impression evidence doesn't require knowledge of manufactured items such as tires, tools or shoes. Analysis of some impression evidence requires other specialized knowledge of anatomy or physics, such as ear prints, bloodstain patterns, or bite marks. In general, impression evidence analysis has two goals: identify the general class of the pattern and then identify a specific source of that impression. The specific source is often identified by specific characteristics.

87 Id. at 143-4.
The specific characteristics are often due to usage, wear or accidents in manufacturing. For instance, a child is kidnapped and the police find a tire mark in the mud outside of the child's house. The pattern on the tire matches a specific model of Goodyear tire. The parent's car does not have that tire. The size of tire also suggests that the car was a sports utility vehicle (SUV).

The specific characteristics on the tire pattern suggest that the tire is well-worn, and has several cuts which may have some from the tire hitting a curb. There are also defects which appear to come from the manufacturing process. Taken together, these specific characteristics can limit the number of tires that match to a small number. If a suspect has an SUV with Goodyear tires, those tires can be examined. The examiner would then express an opinion whether the tires on the suspect's SUV were consistent with the tire marks at the scene or not.

Another form of pattern evidence involves identifying firearms from the marks left on bullets and cartridges. Likewise, the class characteristics of the bullet explain identify the bullet by its caliber and type. This excludes many of the firearms which can actually fire the bullet. Many law enforcement organizations, such as the FBI, have databases of the characteristics of bullets and cartridges found at crimes scenes. An examiner then looks at individual marks on the bullet or cartridge caused by the barrel or the firing pin of the weapon. If there are similar marks, then the examiner can conclude that the bullets probably came from the same weapon or that a particular weapon is likely to have fired a particular bullet.

The report noted that such identification evidence suffers from two drawbacks. Many of the experts conclusions are subjective and may be subject to bias. There are no specific protocols or standards which make the analysis uniform or objective. However, the report had more concern that there was little research to give scientific or statistical validity to the process. There were no known repeatable, scientific tests to either determine how probable or improbable such matches are, or to give an error rate for this procedure.88

As an example, the report relied upon a European study of footprint examiners. The examiners were given identical footprints and asked to give an opinion about the matches. "[T]here were considerable differences in the conclusions reached by different laboratories examining identical cases."89 These "considerable differences" raised concern in the Report since there is no research to explain whether a match is probable, or whether there is an unacceptable error rate.

The Report also considered Forensic Odontology, which compares bite marks left on bodies with the dental patterns, or dentition, of suspects. Dentists can be certified in the United States by the American Board of Forensic Odontology (ABFO). The ABFO has approved guidelines for collecting the evidence of bite marks from victims which are not controversial. However, the Report criticized the Guidelines for not indicating "the criteria necessary for using each method to determine whether the bite mark can be related to a person's dentition and with what degree of probability."90 It then further said:

There is no science on the reproducibility of the different methods of analysis that lead to conclusions about the probability of a match. This includes reproducibility between experts and with the same expert

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88 Id. at 149-50, 154-5.
90 Id. at 174.
over time. Even when using the guidelines, different experts provide widely differing results and a high percentage of false positive matches of bite marks using controlled comparison studies.

No thorough study has been conducted of large populations to establish the uniqueness of bite marks; theoretical studies promoting the uniqueness theory include more teeth than are seen in most bite marks submitted for comparison. There is no central repository of bite marks and patterns. Most comparisons are made between the bite mark and dental casts of an individual or individuals of interest. Rarely are comparisons made between the bite mark and a number of models from other individuals in addition to those of the individual in question. If a bite mark is compared to a dental cast using the guidelines of the ABFO, and the suspect providing the dental cast cannot be eliminated as a person who could have made the bite, there is no established science indicating what percentage of the population or subgroup of the population could also have produced the bite. This follows from the basic problems inherent in bite mark analysis and interpretation.

As with other “experience-based” forensic methods, forensic odontology suffers from the potential for large bias among bite mark experts in evaluating a specific bite mark in cases in which police agencies provide the suspects for comparison and a limited number of models from which to choose from in comparing the evidence. Bite marks often are associated with highly sensationalized and prejudicial cases, and there can be a great deal of pressure on the examining expert to match a bite mark to a suspect. Blind comparisons and the use of a second expert are not widely used.91

As with some other forensic disciplines, the Report noted that no scientific study supports the claim that forensic odontology can demonstrate sufficient detail for positive identification nor is their scientific support for the underlying assumptions that the forensic dentist makes.92 The Report noted that it had received no evidence of an existing scientific basis for concluding that forensic odontology can identify or match one individual to the exclusion of all others.93

iii) Summary

The National Research Council Report not only considered fingerprint analysis and pattern analysis, but also examination of fibers, hairs, documents and explosives, as well as the analysis of computers. Each of these disciplines had various degrees of industry standards and methodologies set by a governing body or association. The Report considered whether these methodologies were subjective or scientific in order to determine whether they are reliable.

One of the indicia of reliability to a court is whether the expert followed the methodology of an association or governing body. However, as this Report points out, practitioners and courts should be cautious when accepting this indicia as a sign of reliability and, thus, credibility. While an association of experts may agree on standard procedures or methodologies, does this really translate into scientific or statistical reliability? In the case of impression and pattern evidence, for instance, there are associations

91 Id. at 174-5 (citing, in part, C.M. Bowers, "Problem-based analysis of bite mark misidentifications: The role of DNA." 1 Forensic Science International (supplement) s104-s109 (2006)).
92 Id. at 176.
93 Id.
or other bodies which have implemented guidelines and standards. However, the Report is concerned that those guidelines and standards are too subjective or are based on scientific research.

When an expert relies upon the standards procedures and methodologies of an association or governing body, practitioners and judges should inquire further to ask whether those methodologies are based upon scientific research and whether there is an error rate associated with those methods. Courts should rely on expert evidence only after they have a better understanding of its limitations.

8) Other Perspectives on Scientific and Non-Scientific Expertise

Some have proposed four criteria to define whether discipline should be considered a science reliable enough to be given the weight that expert testimony normally receives: the discipline must be consistent, methodical, cumulative and predictive. A discipline being consistent implies that different experts from that field should not normally give conflicting answers on matters which are central to the discipline. This does not mean that experts from a field will never disagree, but that the difference of opinions will not be on central issues. This has also been interpreted to mean that the discipline should not rely solely on a single research study, or multiple studies done only by proponents of the theory. It also requires documentation of procedures and well-articulated standards or procedures for conducting the analysis and evaluating the results.

Second, the discipline must be methodical. This means that there is a recognized procedure for conducting the analysis and evaluating the results. Further, if a second expert were to repeat the analysis using that method, it should be capable of being duplicated. This does not necessarily mean that the results will be duplicated, but there should be some agreement among the discipline to explain why the results differed.

Third, the discipline should be cumulative, such that previous works in that field can be relied upon by the expert instead of repeating experiments himself or herself. In this way, the expert can cite the studies of others in the discipline as part of his or her expert testimony. For instance, an expert would not have to conduct a large study to demonstrate that 3% of the population have green eyes, if there are other studies which have already concluded this.

Fourth, the discipline should be predictive. This means that the expert’s opinion, or explanation, should be something that can be empirically tested. In other words, is the hypothesis which the expert is testifying something that can be proven false? In chemistry, for instance, the hypothesis that adding sugar to water makes gold is easily disproven. The so-called “hard sciences” tend to rely on continually trying to disprove a hypothesis. If the hypothesis survives many attempts to disprove it, in these hard sciences, the hypothesis begins to gain acceptance as the truth.

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94 Meintjes-Van Der Walt at 73-74 (citing Kenny, “The Psychiatric Expert in Court,” 14 Psychological Medicine 293, 296 (1984)).
95 Id. at 74 (citing Kreiling, “Scientific Evidence: Toward Providing the Law Trier with Comprehensible and Reliable Evidence Necessary to Meet the Goals of the Rules of Evidence,” 32 Ariz. L. Rev. 969 (1990)).
96 Id.
97 Id. at 75.
However, in social sciences, or science that depends on statistics, this characteristic is less clear-cut. We could call these “statistically predictive.” In medicine, for instance, not every person reacts the same. It depends on statistical probability to determine whether a medicine is safe, not continual testing to see if the medicine will harm people. A social science, such as economics, are also statistically predictive. There are no experiments where an economist changes the banking rules to see whether it harms the economy (and thus disproves his theory). In these fields, the experts review statistical data to determine whether something appears to be true or not. Experts who testify about conclusive findings in such disciplines should be viewed skeptically. 

9) Elaborating the Basis of Testimony

As noted earlier, there is a dilemma. On the one hand, the court relies on an expert to provide specialized information and give an opinion on matters which the court doesn’t itself have the qualifications to understand. This gives the expert opinion exceptional influence over the court. On the other hand, in order to evaluate whether the expert’s opinion is reliable and should be believed, the court must determine whether the expert’s knowledge and methods of analysis are correct. Some would say that the court needs an expert to evaluate the expert, which seems a circular and impossible task. Some practitioners and courts simply accept the expert’s opinion without any other thought. In effect, that cedes to the expert many of the roles that should remain with judges and attorneys.

In order to evaluate the opinion given by an expert, it is important that the practitioner or court ask the expert to provide the basis of that opinion. This chapter has provided several examples of expert opinions which may not have been based on a strong methodology, sufficient knowledge or untested science. If the basis for that testimony was never probed, however, the court would not be able to look for the indicia of reliability upon which it can base its trust. Thus, the mere opinion of the expert, without a deeper understanding of the reasons for his or her conclusion, has minimal value as evidence. In South Africa, for instance, an expert must give a detailed description of his reasoning before offering an opinion, as required by its high court:

Except possibly where it is not controverted an expert’s bold statement of his opinion is not of any real assistance. Proper evaluation of the opinion can only be undertaken if the process of reasoning which led to the conclusion, including the premises from which the reasoning proceeds, are disclosed by the expert.  

This principle, called the Basis Rule in common law jurisdictions, either prohibits an expert from offering an opinion without giving sufficient reasoning, or prohibits the court from assigning any weight to such baseless opinions. Some civil law jurisdictions, however, do not have explicit requirements for an expert to provide the basis for his or her opinion.

For instance, §§ 73- 93 of the German Criminal Procedure Code, or Strafprozessordnung (StPO), set forth the rules for appointing and examining experts. There is only an implicit basis in §83 StPO for the court to order a new opinion by the same or another expert if the court considers the expert’s opinion to

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98 Id. at 76-77.
99 Coopers (South Africa) (Pty) Ltd v Deutsche Gesellschaft für Schädlingsbekämpfung MBH, 1976 (3) SA 352 (A) at 370-71. See also Meintjes-Van Der Walt at 166-67. This opinion is shared in U.S. law (under Article 703 of the Federal Rules of Evidence) and case law in the United Kingdom. See, e.g., R. v. Turner [1975] 1 QB 834.
be “insufficient.” While §§ 81a-81h and §§87-93 provide some requirements for certain kinds of expertise, such as handwriting analysis or DNA analysis, there is no explicit requirement that the written report or oral testimony of the expert contain a detailed description of his or her reasoning or methodology. Implicitly, § 244(4) StPO allows the court to take additional expert evidence if the professional competence of the first expert was in doubt or where his opinion was based upon incorrect factual suppositions, where that opinion has contradictions, or if the new expert has means of research available superior to that of the first expert. Thus, the German code appears to expect the expert’s reasoning and factual suppositions to have been revealed in the report and testimony.

On the other hand, the French Code of Criminal Procedure permits the court to select experts from pre-approved lists created by the Court of Cassation or appeals courts.100 The expert “may only address the examination of technical questions.”101 However, the French Code of Criminal Procedure is much more explicit than the German StPO. It requires the expert’s report to “include a description of their methods as well as their conclusions.”102 If another expert disagrees, he must state his opinion or reservation and give reasons for it.103 In serious cases the court often orders an expert opinion to be drafted by two or three experts together to help ensure reliability of their opinions.104

Each country’s legal provisions may explicitly or implicitly require an expert to give a basis for their opinion. That basis would include a description of the evidence which the expert examined, the facts upon which the expert relied on to make the opinion, and the methodology used. The expert should also describe his or her knowledge, experience or skills which qualify him or her to make the opinion. If the expert provides a “bare opinion” without any of this information, as previously noted, it has limited evidential value and may not be credible. However, if the expert’s report or testimony clearly and fully describes the basis for his or her opinion, this provides the court with the information it needs to evaluate whether the expert’s opinion is reliable and credible. Even if the criminal procedures in a country do not explicitly require the expert to disclose this information, practitioners and judges should ask the expert to explain this basis. By failing to understand the basis of the expert’s testimony but still finding the expert a credible witness, courts and practitioners provide the expert with influence over the final adjudication of the case that he or she may not deserve.

100 Article 157, Code d’Instruction Criminelle.
101 Article 158, Code d’Instruction Criminelle.
102 Article 166, Code d’Instruction Criminelle.
103 Id.
104 Articles 722 and 763-3, Code d’Instruction Criminelle. (Opinions given by two or three experts when defendant charged with murder, rape, torture, acts of barbarity or other serious offences).
Review and Problem Set

Review:

In any legal system, once a person is called an “expert,” they are endowed with the power to give an opinion to the court. Very often, the court defers to that opinion. In some systems the court appoints the expert and in other legal systems the parties appoint an expert. In either system, there should be a balance between the neutrality of an expert and the ability to challenge the expert. Ultimately, an expert should justify the deference and special treatment by the court by being reliable and accurate.

There are two essential elements for an expert’s opinion to be considered reliable. First, the expert must have the specialized experience or knowledge in the field which makes them different than the average person. This can be demonstrated with education, training, meaningful certifications or experience. Second, the expert must use a technique or methodology that is reliable. One indication that the methodology is reliable is if it is generally accepted by a government agency or professional group. Regardless of its acceptance, the method should have a basis in the expert’s experience or a technical basis. For instance, an expert may base his opinion on a scientific method. That scientific method may have an error rate. The expert should be able to disclose that error rate. If the method results in many errors, the method and the expert’s opinion may not be very reliable. If an expert’s opinion is not reliable, then it should not be given much credibility.

Recent studies have questioned the basis for some tests used in forensic sciences. These methods and tests are generally accepted in their fields, but may not be based entirely on reliable and repeatable scientific results. Thus, there are questions about the reliability of the results. Thus, a forensic expert should be able to explain the scientific reasons that make the testing reliable.

There is a dilemma for a court. It asks for the opinion of the expert because it lacks the specialized knowledge to understand or evaluate a matter. However, in order to understand whether the expert is reliable, does the court need to have some specialized knowledge itself? This chapter provided an overview of some indications and issues with expert opinion evidence so that a court or practitioners can evaluate the reliability, and hence credibility, of the expert evidence.

Problem Set:

1. In a murder case, the victim’s voice mail has a threatening message. The voice sounds vaguely like that of the defendant. A voice comparison expert testifies that the voice on the tape matches the defendant’s voice. What questions would you ask to challenge the credibility of this expert or his opinion?
2. An expert on the value of automobiles testifies that the stolen vehicle was worth 10,000 euro. He then testifies that the contents of the stolen car, including luggage and a laptop, added another 2,000 euro to the losses. Can the expert make this claim?

3. The defense claims that the powder that the police found in the car was a headache powder and that the forensic laboratory test identifying it as cocaine was mistaken. Remember the Annie Dookhan example from Chapter 2, where the Massachusetts forensic laboratory expert lied about her qualifications and often did not conduct real tests of the drug samples, instead focusing on being the most productive expert. If you represent the defendant, what would you ask the expert to determine whether the expert’s opinion is credible?

4. An expert on accounting examined the defendant’s spreadsheets and bank statements and concludes that money had been laundered by the defendant. How would the expert explain why that conclusion is reliable?

5. An expert claims that he can identify a murderer by using extra-sensory perception, or ESP. In other words, he reads minds. He shows that he has been trained by a group based in Canada and has been working as a parapsychological examiner for over ten years. During his testimony, he carefully explained that his training lasted two years and he showed his graduating certificate. He also showed a handbook and guidelines of this Canadian group and explained that he followed these generally accepted practices. After explaining that his methodology followed the practices of this group, he gave the opinion that the defendant is guilty. What questions would you ask to determine how credible his opinion should be? Is his opinion even relevant?
Sample Answers

1. The expert should be asked to explain his experience or education in voice comparison. Is the education or experience relevant to his opinion? Further, the expert should be asked to explain the methods he used and, importantly, whether there had been any studies to determine the reliability of those methods. What is the rate of error for these methods?

2. The expert may be knowledgeable about the value of cars, but he may not be an expert on the value of other items. If an expert is testifying based on his knowledge and experience, this makes his or her expertise narrowly tailored to that specific topic. Thus, can he really give the value of the luggage and laptop computer? If so, what method did he use to find those values?

3. The expert could be asked about his or her education. What makes him or her qualified to conduct the laboratory tests? Did someone else repeat the tests to ensure that the conclusion was correct? What were the qualifications of that person? Further, the expert could be asked about the laboratory tests. What method was used? How generally accepted is that method? Does it have an error rate? Was a laboratory machine used to conduct the test? Was it calibrated? Does it have an error rate?

4. The expert could give his background. He was educated as an accountant and has a master’s degree in forensic accounting. He has been a forensic accountant for 12 years and has conducted over two thousand investigations. He relied upon the Generally Accepted Accounting Practices (GAAP) used in the country. He could then explain the steps he took to review the financial records and then match deposits, withdrawals and wire transfers to then build a picture of the movement of cash through the bank accounts. He could then explain that the defendant’s official income is far too small to have generated the amount of cash movement through these bank accounts. The expert’s education and experience provides him with the specialized knowledge to conduct the methods, and he used the accounting rules accepted by the government in the country.

5. This question shows that simply relying on a certificate or training in an expert field doesn’t make that expert field itself reliable. A practitioner would not be accusing the expert of being poorly trained or inexperienced. Rather, the practitioner would ask questions to show that the field of “parapsychological examination” is probably not reliable or accurate. The expert should be asked for scientific testing which demonstrates that there is a basis to believe in ESP. The expert could be asked for scientific studies which show that ESP can be used to solve murders. The expert could then be asked to explain the scientific methodology used to solve murders. Have those been tested? What is the error rate?

A court should only hear evidence, not opinions. It makes an exception for expert opinions, but only those with specialized knowledge that assists the court. Since this expert’s specialized knowledge is so inappropriate, it may not even be relevant.
Part III

The Body of Evidence
As the previous chapters have probably suggested, proving a crime is not necessarily a straightforward matter. Very few pieces of evidence will prove by themselves with 100% certainty that a defendant is guilty. As more evidence is collected, we can have more and more certainty. However, more evidence may also include contradictory evidence, which can lessen our certainty. We have to decide what is relevant, what we believe and how convincing each piece of evidence is.

During the investigation process, we try to find evidence. Prosecutors or investigating judges try to find evidence which primarily solves a crime and identifies who is responsible. They also try to find how much damage the crime caused to victims, and quantify that in the most accurate way possible. Defense attorneys primarily look for evidence that exonerates their client, either by finding contradictory evidence or by questioning the qualities of the main body of evidence.

During the trial, the judge or jury who adjudicates the guilt of a defendant are weighing all the evidence which is presented. This includes the direct evidence of guilt, or direct evidence suggesting innocence. This includes the evidence which indirectly suggests guilt or innocence. The adjudicating body must decide what is relevant, what they believe and what they are most convinced by.

Thus, evidence is a web. During the investigation, the strands of this web of proof are collected and placed together. During the trial or other decision-making stage, the court looks at the web and makes a judgment. That judgment is based upon the credibility and relevance of each strand. Stands which aren’t believed or are not relevant are discarded. The remaining strands are weighed against each other, and an
inference of guilt or innocence is made. A judgment is then made. We hope that we have a high degree of certainty in those inference and in that judgment. We hope that it is correct.

Much of that judgment is based upon inferences. We may not have direct proof of the murder, but we can infer from indirect proof that the defendant had the opportunity to shoot the victim. We may rely on other proof which is completely inferential, such as an expert. An expert is examining other evidence and is making an inference, or opinion, based upon his or her knowledge, experience, education and analysis. We hope that the expert’s inference, or opinion, is reliable. We look for indicia to assure us that the expert and his or her methods of analysis are reliable.

Some evidence is absolutely inferential. Statistics, which often supports scientific or expert evidence, is the mathematical science of inference and probability. Thus, we find a DNA match to be more compelling because the probability that another person could also have that match to be low. DNA found at the crime scene which matches the defendant is thus very relevant, very credible and often has high probative strength. It isn’t necessarily proof that the defendant committed the crime, but is proof that a match is very rare. We infer that there isn’t much chance that someone else did it, especially if there is other evidence.

Thus, the essence of evidence is not each individual proof. The essence of evidence is found in the web of inferences that the practitioner and judge makes. The defense attorney would like one set of inferences to be made. The prosecutor would like another set of inferences to be made, especially since the prosecutor must overcome the presumption of innocence. Understanding evidence is, in the end, understanding the assumptions and inferences that are being made about the evidence. This is also known as critical thinking.

1. Assumptions and Inferences

Human beings make thousands of small decisions a day. If we were to actually think about each decision, however, we would never be able to accomplish much. As we walk down the street, we might see dark clouds in the sky. We would then infer that it might rain. If we see a car moving towards us, we may assume that the person doesn’t see us. We infer that we may get hit, and so we move out of the way, or we yell out a warning. It is important that we understand the difference between an assumption and an inference.

a. Assumptions are merely beliefs, not evidence or proof.

Assumptions are beliefs that we have which we do not question. This doesn’t mean that they are correct. In everyday life, we live with our assumptions because it takes time and effort to learn the truth. It is simply easier to rely on our assumption, which we often learned through our own past experiences or those of others. Some assumptions are justified, some are not. When we are adjudicating a criminal case, however, we try to make the fewest assumptions possible. All of those assumptions that are made, in fact, should be justified.

An unjustified assumption, for instance, is prejudice based on race, gender or some other quality. We would all recognize that it is impermissible, for instance, for a judge to assume that a young man of a certain ethnicity is more likely to be guilty of a crime. A justified assumption, on the other hand, could
include the court assuming that firing a pistol indoors is dangerous. One assumption is based on bias, the other is based on logic and past experience.

Assumptions are not proof; rather, they are beliefs that are not supported by any evidence. They should rarely play any important part in the decisions of the court.

b. Inferences are conclusions based on facts or evidence.

An inference is a conclusion that we make based on one or more facts or assumptions. An assumption can be logical or illogical. As practitioners and judges, we hope that all of our inferences are logical. For instance, if I see that a person is aiming a gun at me, I can infer that I am in danger. This is logical.

We make inferences all of the time. In fact, we make so many inferences in our daily life that we rarely notice. We see a person smiling and we infer that they are happy. We hear the door open and we infer that our spouse has arrived home. We see a woman with a child and we assume that it is the child’s mother.

Critical thinking requires us to bring as many of our assumptions and inferences out of our subconscious and into our conscious thinking. When we are putting together the web of evidence during the investigation, or presenting evidence in an indictment or at trial, the inferences that are made must be logical. It is worth reviewing how to make inferences logically and how to avoid logical fallacies.

2. Making Logical Inferences

When people place their trust in the law, they implicitly trust that the law will be implemented logically. Likewise, evidence should be analyzed logically. Inferences should be built carefully and without fallacies. As United States Supreme Court Justice Felix Frankfurter said upon his retirement after twenty-three years on the high court, "Fragile as reason is and limited as law is as the expression of the institutionalized medium of reason, that's all we have standing between us and the tyranny of mere will and the cruelty of unbridled, unprincipled, undisciplined feeling." Logical reasoning elevates the actions of prosecutors and the decisions of court from the "unbridled, unprincipled and undisciplined" to a level of trust and justice.

Thus, as judges and practitioners evaluate the evidence before them, they will make inferences. Those inferences will strengthen certain evidence and certainly influence the direction and outcome of the case. However, not all inferences are logical. In fact, arguments and conclusions that are not logical are called fallacies. Aristotle considered there to be thirteen logical fallacies, but more recent philosophers have identified over one hundred species of fallacies. Certainly, many attractive inferences may risk being false.

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106 Id. at 140.
However, reasoning or logical inferences can be categorized in two ways: inductive and deductive. We have already mentioned these concepts in previous chapters, but it is worth defining more explicitly. While it may seem technical, these concepts are actually the line between probability and logic.

a. Inductive Reasoning

When we inductively reason, we find that a series of specific facts support a generalization which we consider to be more probable to be true than not. Thus, while we can feel some certainty in the conclusion, we cannot say absolutely that the conclusion is true. Valid deductive reasoning, on the other hand, leads to a conclusion that must be true.

Let's consider a form of inductive argument, which is called an "enumeration" argument.

Rover is a dog, and Rover is a mortal.
Fido is a dog, and Fido is a mortal.
Sammie is a dog, and Sammie is a mortal.
Scooby is a dog, and Scooby is a mortal.
Ajax is a dog, and Ajax is a mortal.

Therefore, all dogs are mortal.

This is a classic example of observing many specific facts, and then making a general conclusion. Of course, we all believe that dogs are mortal. We don't think that a dog will live forever. However, we haven't proven this conclusion from five examples of dogs. In fact, we could list hundreds of dogs and all we can induce is that it is probable that all dogs are mortal. But if we find one dog that seems to be immortal, then this inductive argument is disproven.

Let's look at another example of inductive argument.

The raven is a bird, and a raven can fly.
The parrot is a bird, and a parrot can fly.
The eagle is a bird, and an eagle can fly.
The canary is a bird, and a canary can fly.
The seagull is a bird, and a seagull can fly.
The hawk is a bird, and a hawk can fly.

Therefore, all birds can fly.
This is a very similar argument to the one above about dogs. But does it seem as true? No, we don't think it's true. In fact, we know that there are some species of bird which don't fly, such as penguins or ostriches. While we believe that most birds probably fly, we don't think that the conclusion "all birds can fly" is true.⁴⁰⁷

How does this apply to evidence, however? In our examples, each bird or dog is a piece of evidence supporting a conclusion, either than birds fly or dogs are mortal. When we collect many pieces of evidence together that indicate that someone might be guilty, we are doing something similar. Often, it does not logically prove that someone is guilty, but it suggests that it is probable. An example of an enumeration argument in a criminal case might be:

On Monday, Defendant worked at the bank and money was missing.
On Tuesday, Defendant worked at the bank and money was missing.
On Wednesday, Defendant worked at the bank and money was missing.
On Thursday, Defendant worked at the bank and money was missing.
On Friday, Defendant worked at the bank and money was missing.

Therefore, Defendant took the money.

This does not prove that the defendant took the money. It simply suggests that it is possible. If the police had checked each day for the past year that money was missing, and it corresponded with every day that the defendant worked, would it make it a stronger argument?

Enumeration arguments, such as these, are fraught with error. It can be disproven with one counter-example. For instance, what if the Defendant was home sick from working at the bank, but money was still missing. The enumeration argument simply suggests a probability that the conclusion is true, in this case the conclusion that the Defendant took the money. However, it does not logically prove it.

Inductive reasoning is simply proceeding from a series of smaller facts to some broader conclusion. In a criminal case, the conclusion of guilt or innocence is often based on a series of different, smaller facts. We considered a series of different proofs in the "Desert Eagle" example in past chapters. None of that evidence was conclusive, but formed a series of indirect facts. It could be read something like this:

The Defendant recently bought a Desert Eagle pistol.
The Defendant says he lost that Desert Eagle pistol.
The Defendant was seen near the Petrol Station.

A Desert Eagle Pistol was found at the Petrol Station's garbage can.

⁴⁰⁷ An observant reader would notice the similarity between an "enumeration argument" and statistics. As there are more specific examples, there is greater certainty about the conclusion. However, there is never 100% certainty.
Therefore, the Desert Eagle Pistol belongs to the defendant.

Is this conclusion absolutely certain? Is it logically proven? No. But we believe that the conclusion is probable, because this argument is inductive. The four facts are only loosely connected to each other, but together suggest that a conclusion is probable. Inductive reasoning allows us to infer that a conclusion could be true. However, sometimes a conclusion can be deduced from other facts which is logically proven, and therefore must be true.

b. Deductive Reasoning

When we deductively reason, we find that a series of general or specific facts support a specific conclusion which must be true. Deduction is a strict, logical process of conclusion. Deduction can only be applied to certain sets of related evidence, following the rules of logic which we will discuss. However, there are also many traps where a conclusion is falsely reached. Practitioners and judges should know how to correctly deduce a logical conclusion and how to avoid the common false conclusions, or fallacies.

Deductive reasoning follows a strict structure, called a syllogism. A syllogism has premises and a conclusion. The ancient Greek mathematician, Euclid, first explored syllogisms. A syllogism has three segments or terms: the major term, the minor term and the middle term. The middle term is a bridge between the major term and minor term. A syllogism also has a conclusion. This sounds very technical and abstract, however. It is better to explain this with a famous example.

Major Premise: All men are mortal.
Minor Premise: Socrates is a man.
Conclusion: Socrates is mortal.

You will notice that there is a "bridge" or relationship between the major premise and the minor premise: the term "man." Thus, the conclusion can be made because the major premise and minor premise are linked by that term. However, not all terms with linkages create deductive arguments. Consider this example:

Major Premise: All bread is baked in an oven.
Minor Premise: The meat was baked in an oven.
Conclusion: Meat is bread.

We know that this argument is not true. Meat is not bread. What's the difference between this argument, and the argument above? In the first argument, there is a large group called "mortals" and all men belong to that group. In the second, there is a large group of things which are "baked in an oven," and all bread belongs to that group. In the first argument, the smaller subgroup "men" is the link. In the second argument, the large group "baked in an oven" is the link. But that link does not mean that everything that is baked in an oven must also be bread.

The correct argument would, instead, be:
Major Premise: All bread is baked in an oven.

Minor Premise: Cornbread is a kind of bread.

Conclusion: Cornbread is baked in an oven.

In this argument, the largest possible group are things which are baked in an oven. "Bread" is a thing within the group "baked in an oven." "Cornbread" is a thing within the group "bread." Since cornbread is within the larger group "bread," which is within the group "baked in the oven," we can say with logical certainty that cornbread is baked in the oven. The difference is shown in the diagram below.

This seems very obvious, of course. However, we do not communicate in pure logic. Instead, we express these terms as "since the cornbread is a bread, we bake it in the oven," "cornbread is a bread that we bake in the oven" or something similar. Let's think about our Desert Eagle example again. Is the following evidentiary conclusion logical?

Major Premise: The victim was killed by .44 caliber bullets.

Minor Premise: The defendant's gun is a .44 caliber pistol.

Conclusion: The defendant's gun killed the victim.

While the conclusion may be true, it isn't logically proven. Why? This conclusion is similar to "meat is bread." Let's compare it to another argument.

Major Premise: .44 Caliber bullets from the victim match Desert Eagle pistol

Minor Premise: That Desert Eagle belonged to the defendant.
Conclusion: The defendant's gun killed the victim.

Another important quality of such logical thinking is not merely connecting evidence, but it can also exclude. As an example:

Major Premise: The victim was killed with .44 Caliber bullets

Minor Premise: This gun shoots 9mm bullets.

Conclusion: The victim was not shot by this gun.

In this instance, the logical conclusion is to exclude the pistol as the murder weapon.

Thus, for a conclusion or inference to be logically true, there must be a connection between the two quanta of evidence which makes the conclusion inescapable. If it isn't logically true, then the inference you are making is inductive because you are basing your belief on the probability that it is true.

For a logician or a philosopher, the forms of deductive logic are enough to fill several books. However, we can define some important elements of deductive logic, especially as it applies to evidence. The most common and important form of deductive syllogism is the *categorical syllogism*. What does this mean? In our examples above, we have used categorical syllogisms to conclude that:

A is B
B is C

Therefore A is C

In this form, there are certain rules. If those rules aren't followed, there cannot be a guarantee that the conclusion is true.
Rule 1: There must be three propositions.

In this case, there are the two premises (A is B, B is C) and the conclusion (A is C). Where there are more than three propositions, then the argument is invalid and probably not true.\(^{108}\) In fact, this creates a logical fallacy, which we will discuss later in this chapter.

For example:

(A) The victim was killed (B) with .44 caliber bullets.

(B) Those .44 caliber bullets (C) match this Desert Eagle Pistol

Therefore, (A) the victim was killed (C) by this Desert Eagle Pistol.

Rule 2: There must be three terms.

In this case, A, B and C.

For example:

(A) The victim was killed

(B) .44 caliber bullets.

(C) Desert Eagle Pistol

In evidentiary terms, there is a dead body, there are bullets which killed the victim, and there is a Desert Eagle Pistol. The first proposition (that the victim was killed with those .44 caliber bullets) is a proposition that is also evidence, in this case from the medical examiner. The second proposition (that the bullets match the Desert Eagle Pistol) is also evidence, in this case from a forensic report of ballistic testing. The conclusion is not actually voiced by any witness or expert, but instead is a logically true conclusion which the court should make.

Rule 3: Each of the three terms should appear in two of the propositions.

In other words, the terms should "link" the three propositions.

For example:

(A) The victim was killed (B) with .44 caliber bullets.

(B) Those .44 caliber bullets (C) match this Desert Eagle Pistol

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\(^{108}\) The exception to this is the forms of polysyllogism, which is discussed later. Polysyllogisms, however, are simply chains of deductive reasoning where the conclusion is left until the end. They can otherwise be broken down into a series of these categorical syllogisms. We tend to make our logical arguments polysyllogistically, saving our conclusion until the end, but critical thinking requires the practitioner or judge to break down the logical arguments to their most simple state.
Therefore, (A) the victim was killed (C) by this Desert Eagle Pistol.

Term A (The victim was killed) is normally in the first proposition and the conclusion.

Term B (the .44 caliber bullets) is normally in the first proposition and the middle proposition. This bridging term is often called the middle term.

Term C (the Desert Eagle Pistol) is normally in the middle proposition and the conclusion.

Rule 4: The middle term should be universal, or at least, specifically true.

By universal, it should be true for the entire class, such as the statement "All men are mortal" or "No man is an island." Such words as "All" or "No" indicate that the term is universal for the class "men."

Thus, this makes the following syllogism true:

- All men are mortal
- Socrates is a man

Therefore, Socrates is mortal.

It would not be valid or true if the middle term was not universal. For instance, the following syllogism would be invalid.

- Some men are mortal
- Socrates is a man

Therefore, Socrates is mortal.

If only some men are mortal, we don't know whether Socrates is one of the men who is mortal, or one who isn't. Using logic to assess evidence, however, does not necessarily require such universality. It simply needs the terms to be specifically true.\(^{109}\) What is meant by specifically true? It means that the validity of the logic depends on the statement being true. Since we are evaluating evidence, rather than simply considering the logic of hypothetical statements, we can take these issues into account. Consider our example:

(A) The victim was killed (B) with .44 caliber bullets.

(B) Those .44 caliber bullets (C) match this Desert Eagle Pistol

Therefore, (A) the victim was killed (C) by this Desert Eagle Pistol.

Has the prosecutor proven that the victim was killed with .44 caliber bullets? Do we believe that they haven't been tampered with, or that there were other bullets also in the body? If so, then the next

\(^{109}\) In logical terms, the first term in our example has constricted the universe to only those bullets which killed the victim. It wouldn't be relevant to speak about "all bullets" when only a handful of bullets were involved in the crime.
statement should be considered for its validity. The forensic report which matched the bullets from the victim's body to the Desert Eagle Pistol. Do we believe that the methods used are reliable? Do the methods have scientific validity? Do we believe that the expert who conducted the test was knowledgeable? Do we believe the results of the expert test? If so, then we can make the logical deduction that the victim was killed by the Desert Eagle Pistol.

**Rule 5: A Syllogism cannot consist of two negative premises.**

As we noted above, you can have a universal premise ("All men are mortal") or a negative premise ("No man is immortal"). If there are two negative premises, however, the logic falls apart. Why? Let's examine an example.

No man is immortal
Socrates is not a man
Socrates is immortal.

Is this true? It is not logically valid because there is no overlap, or link, between the two negative statements. We know that no man is immortal. We also know that Socrates is not a man. We don't know what he is. But we can't make the logical leap to say whether he is, or is not, immortal.

Let's consider this in terms of evidence by slightly altering our example.

(A) The victim was not killed (B) with 9mm bullets.
(B) No 9mm bullets (C) match this Desert Eagle Pistol

Therefore, (A) the victim was killed (C) by this Desert Eagle Pistol.

As you can see, the first and second premises are true. The victim was not killed with 9mm bullets, and no 9mm bullet will match the Desert Eagle Pistol, which has a different caliber. But there is no real connection between these two statements, and there is no basis to give any conclusion. If there is only one negative statement, however, a logical conclusion could be made.

(A) The victim was not killed (B) with 9mm bullets.
(C) The Defendant's gun (B) is 9mm

Therefore, (A) the victim was not killed (C) by the Defendant's gun.

**Rule 6: If either Premise is negative, then the Conclusion must also be negative.**

As noted in the example above, if either of the premises are negative, then you cannot draw a positive conclusion. We conclude that the victim was not killed by the defendant's gun because that caliber bullet was not used to kill the victim.

It would not make any logical sense to say something like:
(A) The victim was not killed (B) with 9mm bullets.

(C) The Defendant's gun (B) is 9mm

Therefore, (A) the victim was killed (C) by the Defendant's gun.

Why is this invalid? The conclusion asserts something positively (that the victim was killed by the defendant's gun) when one of the underlying premises is negative and, thus, can only exclude.

A logical deduction is simply a step-by-step process of taking two related premises that are linked, and then drawing the appropriate conclusion. If the deduction is logical, then the conclusion can be trusted to be true. If the deduction is invalid, however, it cannot be trusted. Logical deduction is a careful and methodical process which most people tend to blur together. As long as the logical structure still exists, this blurring can still create logically valid conclusions. Logicians have identified these as polysyllogisms and sorites.

c. Polysyllogisms and Sorites

Sometimes the logical conclusions have to be step-by-step. Such logical steps are called logical chains. This can include polysyllogisms and sorites. These logical chains are vitally important to logically solving, and proving, cases. Let's consider an example from the Desert Eagle case.

I

Premise: The killer shot the victim.
Premise: The victim's body contained .44 caliber bullets.
Conclusion: Therefore, the killer used .44 caliber bullets.

II

Premise: The killer used .44 caliber bullets.
Premise: Those .44 caliber bullets match a Desert Eagle pistol.
Conclusion: Therefore, the killer used that Desert Eagle pistol.

III

Premise: The killer used that Desert Eagle pistol.
Premise: The Desert Eagle pistol was found in the garbage at the Petrol Station
Conclusion: The killer (or accomplice) threw the pistol into garbage at the Petrol Station.

IV

Premise: The killer (or accomplice) threw the pistol into garbage at the Petrol Station.
Premise: The garbage at the Petrol Station was searched 4 hours after the murder.

Conclusion: The killer (or accomplice) was at the Petrol Station within 4 hours of the murder.

As you can see, we have taken evidence (bullets and a gun found in the garbage) and built a logical chain of facts which must be true. Most of the time, however, we make these connections far less informally. We would say that the murder weapon was found at the Petrol Station, so we know that the killer or an accomplice had been there just after the murder. However, as we think critically about the evidence, we need to understand these logical chains of reasoning. Each of the two premises lead to a conclusion. That conclusion becomes the premise of the next stage, and so on. As long as you have true premises, based either on evidence or logic, then you can build the chain of reasoning and have confidence in the conclusion.

In some ways, you could represent the chain of evidence in this way:

I
Premise: "A" means "B"
Premise: "B" means "C"
Conclusion: "A" means "C"

II
Premise: "A" means "C"
Premise: "C" means "D"
Conclusion: "A" means "D"

III
Premise: "A" means "D"
Premise: "D" means "E"
Conclusion: "A" means "E"

IV
Premise: "A" means "E"
Premise: "E" means "F"
Conclusion: "A" means "F"

In this case, we know that "A" - that the killer shot the victim, can lead to another conclusion. In this case, we can deduce "F," or that the killer, or at least an accomplice, was at the Petrol Station within 4
hours of the murder. If any of the links of that chain were untrue or unproven, however, we couldn't have any confidence in that conclusion.

Let's look at another example, which is called a Sorites. Logicians would define a sorites as a chain of arguments where the conclusion is saved until the end. In fact, we tend to make our logical arguments in the form of a sorites, rather than in the more formal polysyllogism which we used above.

Premise: The killer shot the victim.
Premise: The victim's body contained .44 caliber bullets.
Premise: The killer used .44 caliber bullets.
Premise: Those .44 caliber bullets match a Desert Eagle pistol.
Premise: The killer used that Desert Eagle pistol.
Premise: The Desert Eagle pistol was found in the garbage at the Petrol Station
Premise: The killer (or accomplice) threw the pistol into garbage at the Petrol Station.
Premise: The garbage at the Petrol Station was searched 4 hours after the murder.
Conclusion: The killer (or accomplice) was at the Petrol Station within 4 hours of the murder.

The primary concern with deductive reasoning, no matter its form, is that each premise leads to an conclusion which must be true. When making deductive conclusions with evidence, the evidence must be relevant and credible. However, the deductive reasoning must also be logical, which means that it is free of fallacies. Thus, the truth of the different quanta of evidence is separate from the logical deductions. We can see that the quanta of evidence can be absolutely true, but the resulting conclusion may be false because of poor logic. In order to avoid these logical mistakes, we need to examine different common fallacies.

\(^{110}\) In the field of logic, there are two types of sorites: Aristotelian and Glolienian. Either form is valid. In Aristotelian sorites, the first premise is specific, with the rest of the premises general.

\[
\begin{align*}
A & \text{ is } B \\
\text{All } B & \text{ is } C \\
\text{All } C & \text{ is } D \\
\text{Therefore, } A & \text{ is } D.
\end{align*}
\]

In Glolienian sorites, the first premises is general and the remainder are specific.

\[
\begin{align*}
\text{All } A & \text{ is } B \\
B & \text{ is } C \\
C & \text{ is } D \\
\text{Therefore, } A & \text{ is } D.
\end{align*}
\]
c. Logical Fallacies

A logical fallacy is a failure in the logic of an argument. Too often, a conclusion will seem logically sound but in the end, the conclusion is untrue. In criminal evidence, especially, the inference made from the evidence will seem sound, but later it is discovered that the defendant was actually innocent. Let's look at a simple example.

Premise: The killer used a .44 caliber pistol.
Premise: The defendant has a .44 caliber pistol.
Conclusion: The defendant is the killer

Clearly, both of the premises can be true. However, this doesn't mean that the conclusion must be true. Why? There is no connection between the two premises. While it is true that the killer used a .44 caliber pistol and the defendant has a .44 caliber pistol, it isn't necessarily true that it is the same .44 caliber pistol. It is neither universally true or specifically true. This is a simple form of a fallacy which shouldn't convince any judge.

In general, an argument is logically invalid if any of the rules for a syllogism are broken. Many fallacies are, in fact, unintentional. "Fallacies are dangerous because they are false conclusions or interpretations resulting from thinking processes that claim or appear to be valid, but fail to conform to the requirements of logic."\(^{111}\) They are dangerous, especially when interpreting evidence. However, there are a number of other fallacies to consider. The list of possible logical fallacies are long, and often the obscure domain of philosophers, but the most common fallacies and errors are below.

i. Premises are wrong

While not a fallacy per se, the practitioner or judge should always ensure that they examine each premise, evidence or fact. In evidence, for example, the quality of the evidence should be examined first, especially its credibility. If the evidence is not believable, there is no good reason to make any deductions from that evidence.

ii. Premises are inconsistent

In this fallacy, the argument seems to lead to the conclusion being true, because there is no instance where the two premises are true but the conclusion is false. However, this is usually because the two premises are inconsistent or in contradiction. In fact, any conclusion could be made, but none are logically supported. For instance:

All A is B
No A is B
The Defendant is guilty

All pistols have bullets
No pistol has bullets
This pistol has bullets

This pistol killed the victim.

or

All pistols have bullets
No pistol has bullets
This pistol has bullets

iii. Fallacy of Four Terms
In this fallacy the argument has four terms and not three. This means that the connection between the premises is no longer present. For example:

A means B
C means D
Therefore, A means D

Drawing upon the "Desert Eagle" example, this fallacy could occur if a prosecutor argued:

\( \text{(A) The victim was killed (B) with .44 caliber bullets.} \)
\( \text{(C) The Desert Eagle Pistol (D) is the Defendant's gun} \)

Therefore, \( (A) \) the victim was killed \( (C) \) by the Defendant's gun.

Since there is no connection between the first statement ("The victim was killed with .44 caliber bullets") and the second statement ("The Desert Eagle Pistol is the Defendant's gun"), there is no basis to make the conclusion.

iv. Fallacy of the "undistributed middle term"

If there are three terms, this does not necessarily mean that the argument is logically sound. As you may recall, there needs to be a bridge, or link, between the first and second statement. A proper logical syllogism looks like this:

All A means B
B means C
Therefore, A means C

However, when the middle term is not universal or specifically true, then the argument will look like this:

All A means B
C means B
Therefore, A means C

In terms of our "Desert Eagle" example, this fallacy can be demonstrated in the following way:

\( \text{(A) The Desert Eagle Pistol (B) was at the Petrol Station} \)
\( \text{(C) The defendant (B) was at the Petrol Station} \)

Therefore, the Desert Eagle Pistol belongs to the Defendant.
v. Fallacy of Illicit Process

The relationship of the terms with each other is crucial to logical deduction. This fallacy, and the fallacy of "undistributed middle term," above, focus on those relationships. This can include either one of two forms:

All A means B  
No C means A  
Therefore, no C means B

In this form, every A must mean B. However, no C can mean A. But does this really lead to the conclusion? It seems logical, but in fact it isn't. Perhaps an example can clarify this.

All dogs are mammals  
No cat is a dog  
Therefore, no cat is a mammal

Since cats are clearly mammals, we realize that this isn't logical. However, an evidentiary syllogism can easily fall into this trap. Another form of this fallacy is shown below.

All A means B  
All A means C  
Therefore, all C means B

In this form, every A means B. This means that "A" is part of a bigger group, "B." However, "A" is also part of another larger group, "C." But you cannot make any logical statements about the relationship between those two larger groups, "B" and "C," as seen in this example.

All cats are felines  
All cats are mammals  
Therefore, all mammals are felines

As with many other fallacies, the result is familiar. The practitioner or judge believes that one fact connects two propositions correctly, such as "cat" in the example above. However, the connections do not result in the conclusion being true.

d. Conclusion

While tangible evidence or testimonial evidence is important, the body of evidence is often built with deductive reasoning and inductive reasoning. Those deductive and inductive conclusions are often the interim inferences or final objectives of the case. If properly done, the deductive conclusions must be as true as its supporting evidence. Thus, any deductive conclusion has the same weight and credibility as other evidence. In many ways, the deductive conclusion is evidence.

Deductive reasoning must follow certain rules of logic for the conclusion to be valid. A statement may look logical, but the reasoning may actually be faulty. Such faulty logic is called a fallacy, which
invalidates the conclusion. This chapter has described many of the most common fallacies. The review
and problem set provide more opportunities for the reader to practice.

Inductive reasoning, however, does not result in a conclusion that must be true. Instead, inductive
reasoning creates a probability that something is true. The actual degree of probability, however, is often
inexact. There is a great deal of similarity between statistical probability, though, and the probability of
inductive reasoning. In both statistics and inductive reasoning, many specific points are observed and a
general conclusion is made. The more observations that are made, the more accurate the general
collection will be. In our normal day-to-day life, we make inductive conclusions based on a relatively
small number of observations. For example, if we see the bus come by the house at 8:05am every day for
a week, we would conclude that it will always come at 8:05am, even thought there are only seven
observations. In a criminal trial, inductive conclusions should be made more rigorously.

In the next chapter, the entire web of evidence will be described, including the proper place for
deductively reasoned conclusions and inductively reasoned inferences.
Review and Problem Set

**Review:**

Evidence by itself is meaningless without the ability to draw logical conclusions from it. It also means that a practitioner should be able to distinguish between an assumption and an inference. An assumption is simply a belief that something is true. An inference is a conclusion made from evidence and facts. An inference can be made inductively or deductively. Inductive reasoning draws a probable conclusion from a series of other facts. The conclusion of inductive reasoning is not certain, but there is a degree of probability. Deductive reasoning, on the other hand, applies logic to premises and makes conclusions that must be true. Thus, inductive conclusions from evidence results in conclusions (or intermediate inferences) which are probably true, while deductive conclusions must be true. Deductive conclusions, in fact, have the same role in a case as actual evidence.

Deductive reasoning at its most basic follows a simple form: A is B, B is C, therefore A is C. However, one should be cautious of committing a fallacy. A fallacy occurs when the reasoning appears to be logical, but in fact it is false. A conclusion of a fallacy does not have to be true.

This chapter is relevant to understanding evidence because inductive and deductive reasoning helps to build the body of evidence. Further, the conclusions of a court, such as guilt or innocence, are based on inductive and deductive reasoning, even if the judge is not consciously applying logic. Just as a practitioner should know how to describe the qualities of evidence, he or she should also be able to describe the inferences and conclusions being made from that evidence.

**Problem Set:**

1. An elderly woman is found dead. The medical examination concluded that she died from an overdose of medicine. Her daughter checks on her every day and testified that her mother took a new prescription medicine. She had marked down on a calendar the days she took it. She was prescribed the medicine 10 days before she died. On the ten days between, she wrote down “took new pill, 50mg.” What conclusion can you make? What form of reasoning is this?

2. The court hears the following evidence: A witness saw a red Ford Escort drive away from the bank robbery. The defendant owns a red Ford Escort. The Court concluded that the Defendant robbed the bank. Is this logical? Why or why not?

3. The court hears the following evidence: A witness saw a blue Renault drive away from the bank robbery. The defendant has a history of robbing banks. The court concludes that the defendant is guilty of the bank robbery. Is this logical? Why or why not?
4. The court hears the following evidence: A witness saw a green Mercedes drive away from the bank robbery. No green Mercedes are registered to the defendant. The court concludes that the defendant is not the robber. Is this logical? Why or why not?

5. The court hears the following evidence about money was stolen from a locked safe: nobody without a combination could open the safe. The defendant had the combination. The court concluded that the defendant opened the safe and took the money. Is this logical? Why or why not?

6. The court hears the following evidence about money was stolen from a locked safe: nobody without a combination could open the safe. Only the defendant had the combination. The court concluded that the defendant opened the safe and took the money. Is this logical? Why or why not? How is this different from question 5?
1. This is an example of inductive reasoning. There are a number of facts (the notes on the calendar) from which a probable conclusion is reached. That conclusion is that on the last day she probably took her normal dose. However, this is not certain. It is only a probability.

2. This is not logical. While it appears to be logical, in fact there is no connection between the two premises. In the first, “a witness saw a red Ford Escort drive away from the bank robbery,” it appears that the red Ford Escort will be the linkage between the two premises. In fact, the “defendant owns a red Ford Escort” is the second premise. However, there may be many red Ford Escorts in the city. This “fallacy of four terms” is the most common fallacy. It just appears that there are three terms (Defendant, red Ford Escort, person leaving the crime) but in fact it is four (Defendant, red Ford Escort 1, red Ford Escort 2, person leaving the crime). If there was another syllogism showing that red Ford Escort 1 and red Ford Escort 2 are the same car, then this would be a logical chain.

3. This is not logical. There is no connecting term between the two premises. This is also the “fallacy of four terms.” However, on this question it is more obviously four different terms.

4. This is logical. The suspect drove away in a green Mercedes, but there is nothing that connects the defendant to any green Mercedes. (However, if there was additional evidence of the green Mercedes having been borrowed or stolen, this may change the conclusion.)

5. This is illogical for some of the same reasons as question 2. We know that the defendant is one person who has the combination to the safe. We do not know if there are more people. We do not know how many more people. Thus, if the court relied only on this evidence, the court has made an illogical conclusion.

6. The court has made a logical conclusion here. The important difference is that there is only one person with a combination to the safe: the defendant. If it is true that the safe could only be opened with a combination, the conclusion that the only person with the combination could have taken the money is logical.
As should be evident by now, evidence is contextual. A pistol by itself is just a pistol. A still-warm pistol found near the murder scene is evidence. It is the information that makes it relevant, credible and probative, such as being found near the murder while still warm. That information is also evidence. Evidence can also be testimony, documents, physical evidence, and so much more. However, all of that additional evidence is also contextual. Some of the information that a court uses to determine guilt, innocence or some other important issue is the product of inductive or deductive logic.

Thus, a body of evidence is not simply a collection of different pieces of evidence. It is a web, or network, of evidence, deduction, inferences and probabilities. Simply considering different pieces of evidence by themselves is not enough. The entire web of evidence, deductive conclusions, inferences, probabilities and other information tends to give a broader and more nuanced understanding of "the truth."

In an earlier chapter, we considered how a court finds "the truth." Without a time machine to travel back in time to view the crime, or without the ability to read minds to determine motive, "the truth" is never exact. "The truth" as found by a court is may be an approximation, but is subject to the information available to the court and the inferences that the court must make. In order to make this approximation of the truth as accurate, transparent and understandable as possible, practitioners and judges should adopt a methodology that is sensible and comprehensive.
This suggests a holistic approach to evidence which is common to any system of criminal justice, regardless of the form of criminal procedure or specific provisions in a local code. Such a holistic approach should identify the elements which need to be proven, examine the qualities of the evidence which is gathered, make logical deductive conclusions, infer inductive conclusions, and finally make a decision based on the body of evidence. The holistic approach should influence the gathering of evidence during investigations in order to strengthen the body of evidence through corroboration or to expose weaknesses by discovering contradictory evidence. The approach should also improve the final judgment by a court by allowing it to approximate "the truth" in the most complete and transparent method possible.

This holistic approach can be described in nine steps:

1. **Based on the initial allegations, consider what must be proven, such as the elements of the criminal offence.**

   As Chapter 1 noted, one of the initial steps should be to determine exactly what needs to be proven. This not only includes the elements of the alleged crime, but additional considerations. Those additional considerations can include proof of the damages suffered by the victim of the crime, proof of aggravating circumstances which justify an increased sentence, proof of mitigating circumstances which justify a decreased sentence, or proof of ownership of funds or property which should be confiscated. It can also include specific requirements under the procedural code, such as proof needed to justify pre-trial detention. This usually requires proof which not only establishes grounds to believe the defendant committed a crime, but also grounds to believe that the defendant might threaten a witness, destroy evidence, commit another crime or leave the jurisdiction of the court.

   These elements and other considerations are objectives of the investigation. Proof should be obtained of these objectives. A practitioner must know what needs to be proven before he or she begins collecting evidence. This creates a map for the investigation. This doesn't mean that the map can't be changed if the evidence suggests other criminal activity, but it does provide a clear understanding of what really must be proven. Further, it allows the practitioner to build a truly robust body of evidence that is well corroborated and proven.

   **2. Gather the evidence, including testimony, physical evidence, expert opinions and documentary evidence.**

   Depending on the rules of the criminal procedure code or evidence code, the investigating judge, police or prosecutor begins building the case against the suspect. This should not simply involve taking the testimony of the victim, witnesses and defendants. If there is a crime scene, proper forensic techniques should be used to photograph the scene, preserve evidence found at the scene, and test that evidence in a forensic laboratory. Computer evidence should be obtained with similar regard for forensic standards to preserve data and prevent tampering. In all cases, the police or forensic examiner should be able to explain what was collected, how it was collected, where and when it was collected, and that the evidence

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112 Certain systems, such as those operating under Sharia Law, have very formal restrictions on evidence. Evidentiary analysis in these criminal justice systems may still be holistic, but will have restrictions.
Financial evidence, telephone records, wire interceptions and other more sophisticated evidence should be obtained if it will be relevant to the case and authorized by law.

Expert evidence should be used to assist the court in making a decision. It should never supplant a decision of the court. Thus, an expert should not offer an opinion about a defendant's guilt, but can offer an opinion to answer a question about a scientific, technical or other specialized topic. An expert must have sufficient knowledge on that topic to justify the court entrusting him or her with such power. This generally means that the expert has education and experience in a topic that is far different than the average person. Further, there should be some actual analysis of other evidence so that the expert is not simply giving general information to the court, but that the opinion is relevant to the criminal case. That analysis should use a methodology that is reliable. The reliability of that methodology can be demonstrated by its acceptance within the expert's field or by based on scientific principles which are well understood and accepted. The topic of expert opinion evidence is discussed in Chapter 9.

3. Examine the qualities of the evidence, such as its relevance, credibility and probative strength.

In Chapter 4, we explored the basic qualities of evidence, which are contextual. What does this mean? This means that evidence has more or less meaning depending on the rest of the body of evidence and the objectives. There are also intermediate inferences that can be drawn in order to reach those objectives. This creates a web, or network, of evidence. They are interdependent, and the qualities of a piece, or quantum, of evidence can be effected by that network.

A primary quality of evidence is its relevance. The relevance of an piece of evidence simply considers whether it affects whether an intermediate inference or objective in the case is more, or less, probable. In a murder case, a bullet found at the scene of the murder is relevant because it has an effect on determining how the person died and what murder weapon was used. A bullet found in another city, however, is probably not relevant. They could be identical bullets - same manufacturer, same weight, same caliber - but one is relevant and one is not. Why? There is no sign on one bullet which says "relevant" and on the other which says "irrelevant." One was found at the scene of the murder, and another was found in a field two cities away. It is the contextual information about the bullet which makes it relevant. It is that bullet's effect on the elements of the crime, or some other objective, which makes it relevant.

Another quality of evidence is its credibility. The credibility of testimony can differ from the credibility of physical evidence or documentary evidence. Testimonial credibility depends, in part, on what the person says and how he or she says it. It also depends on whether the witness has a basis for his or her testimony. Did he or she have the ability to observe what they now report? Can they remember it well? Are they accurate? Are they consistent? Are they believable? Do they have biases?

Physical or documentary evidence also have the quality of credibility. In other words, do you believe that the evidence is real and authentic? Was the bullet at the scene of the crime really the same bullet that was analyzed by the forensic lab? Was the document offered as evidence really seized from the defendant, or was it altered or forged by someone else? Some evidence, such as bank records, are believable because the process by which they are created is reliable. The bank employees and computer systems enter the

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113 Authentic evidence simply means that the evidence collected at the scene is the same as the evidence tested in the laboratory or offered as evidence to the court.
data accurately into the financial database and then retrieve it accurately and without error. However, if that bank employee is prone to errors, the resulting bank records are less believable.

The last major quality of evidence is its probative force, which is sometimes called its "strength" or "weight." Simply stated, this measures how convincing the evidence is. Like relevance, this quality is contextual. Some evidence is seen to be strong because it fits with the normal expectations of a judge or prosecutor. Things that are unusual or irregular need additional explanation to overcome the lack of "fit." Further, things that are corroborated by other evidence is seen to be far stronger than evidence which sits alone. Further, a coherent, internally consistent story tends to be seen as stronger than one which appears inconsistent. All of these aspects tend to increase the probability of the allegation or inference being true. Thus, when we say that a piece of evidence is "strong," what we are really saying is that we consider it to have a greater probability of leading to something which is true.

A judge or practitioner should consciously consider all three of these qualities for every piece of evidence. Further, during the investigation and, later, the trial, these qualities should be tested. The relevance of the evidence should be ensured through proper questioning. The credibility should be explored to make sure that the court believes what it should, and discredits what it shouldn't. Last, the probative strength should be tested during the investigation and trial so that strong evidence prevails over weaker evidence, and proper deductions and inferences are made.

4. Look for other evidence which corroborates, or strengthens, the evidence.

As the investigation continues, do not be satisfied that one witness or one piece of evidence satisfies an element of the criminal offence. If there are more than one witness or evidence, these can corroborate each other and make the case stronger. It is not improper or wasteful to find additional evidence to prove a point, nor does this make that evidence redundant. It adds to a critical and important quality of the evidence and makes the body of evidence far stronger.

5. Look for other evidence which contradicts, or weakens, the evidence.

A prosecutor generally has a duty to search for evidence of guilt, but also evidence of innocence. A defense attorney, on the other hand, should be looking for evidence of their client's innocence or evidence which weakens the prosecutor's case. A prosecutor can look for evidence which weakens the defendant's assertions as well. Just as corroboration can strengthen evidence, contradictions and weaknesses in the evidence can also affect the probative force of the evidence. A body of evidence which was gathered only with an eye towards proving guilt is as unlikely to be "the truth" as a body of evidence gathered only to prove a defendant's innocence. Balance is not only required by human rights and fair trial rules, but also in order to fulfill the purpose of evidence.

6. Reconsider what can be proven, or what must be proven. Is other evidence needed to prove this? At this point the intermediate inferences and final objectives should be much more clear.

Not only is evidence contextual, but the gathering of evidence should be regularly re-evaluated. Many investigations become focused on the initial allegations only and do not expand or change the investigation as it discovers new criminal activity. Thus, the practitioner should consider some basic questions. Did the evidence already gathered suggest that another crime had occurred rather than the originally alleged crime? Does it suggest that additional crimes have occurred? Does it suggest that there
are additional potential defendants? Does the evidence suggest that there are additional funds or properties which should be confiscated as instruments or benefits of the crime? Should the investigation be expanded? Should it be changed or, indeed, closed?

In addition, the practitioner should have a clear idea what the final objectives of the investigation and the intermediate inferences needed to establish the elements of the crime and the other necessary objectives to be proven. If the evidence already gathered suggests that these objectives be expanded, reduced or otherwise changed, then the practitioner should make those changes and seek additional evidence before the indictment.

7. When the evidence gathering is concluded, make **deductive conclusions from the evidence to see what conclusions must be true**.

When the evidence has been gathered, it is appropriate for the practitioner to make valid, logical deductive conclusions from that evidence. It may be appropriate to ask an expert to make the conclusion or it may be appropriate to simply argue to the court that the deductive conclusion is logical and should be made. For instance, it is logically valid to say the following:

*A red Ford Escort with a broken rear window drove away from the crime scene.*

*There is only one red Ford Escort registered in this city.*

*The defendant owns that red Ford Escort. It has a broken rear window.*

*Therefore, the defendant's car drove away from the crime scene.*

There is no witness who will testify to this deductive conclusion, but all of the other evidence can be provided to the court. If the conclusion is logically valid, it must be true. Thus, the court should be able to rely on the logically valid deductions from evidence which if finds to be relevant, credible and probative.

8. **After deducing what must be true, make inductive conclusions from the evidence to see what probably is true. The probative value of evidence and credibility of the evidence may be influenced by this process.**

If the underlying evidence is true and the logic is valid, deductive conclusions must be true. A practitioner should look at the evidence that he or she has, and the valid deductions that can be made, and then determine what is proven directly, either with direct evidence or a deductive conclusion. Often, there will be some final objectives or intermediate inferences which are not directly proven. Sometimes there is evidence which is contradictory or weak. When the facts are not clear or the evidence is incomplete, the practitioner and judge must use inductive reasoning. They must infer based on probability. The probability may not be mathematical, but based upon the experience and knowledge of the judge. Sometimes these inductive decisions are based on a misunderstanding of probability or biases of the judge. When the legal system depends on an inductive judgment to be made, the practitioners and judges should be conscious not only that they are making a guess based on probabilities, but should aware that the decision is indeed based on evidence which is proven, or deductive conclusions which are logical.
Using the previous example, the Court has deduced that the red ford that left the crime scene belonged to the defendant. This was based on evidence and deduction. However, it does not know if the defendant was driving the car. The defendant claims that he doesn't know who was driving the car, but he was with his mother shopping.

By using other evidence (the car was never reported stolen, he only has one set of keys, and the defendant is the same height as the masked bank robber), the court makes the inductive conclusion that the defendant was driving the car and, indeed, was the bank robber. While the court may reason that it simply didn't believe the defendant, in truth the court has assessed the probability that the defendant was the driver of the car to be quite high. It has also assessed the probability that the defendant's car was stolen or borrowed for the crime by someone else to be a very low possibility. As such, it did not believe the defendant and therefore found him guilty.

The process of breaking down the evidence into discrete pieces, assessing the qualities of the evidence, making logical deductions and then finally making an inductive assessment is a systematic process called "critical thinking," which is a skill which lawyers and judges should hone and practice daily.

9. Determine whether the intermediate inferences and final objectives are answered (such as the elements of the crime and, thus guilt or innocence).

The final stage of this process is to ask whether all of the questions have been answered? Have all the elements of the criminal offence been satisfied? Has the evidence directly proven those elements? Have the intermediate inferences been proven? Are the elements of the criminal offence satisfied because there it is deduced to be true? Has there been an inductive conclusion that it is probably true?

If the elements of the criminal offence have been satisfied, does the evidence demonstrate mitigating or aggravating factors which influence the court's decision to a lighter or heavier sentence? Does the evidence and the deductive and inductive conclusions also justify the confiscation of money or property?

The above framework is not a method that only one practitioner or judge can practice in a system. Evidentiary thought is not simply a way to describe evidence or a method to gather and evaluate evidence. Instead, evidence is also a language spoken in the court. If a defense attorney says that testimony is not relevant, it is a meaningless objection if the prosecutor or judge does not share that same vocabulary. Likewise, if the prosecutor asks the judge to consider evidence to be corroborated, if that concept is not well understood by everyone in the courtroom, it is unlikely that the judicial process will be conducted properly. Thus, it is important for attorneys, prosecutors and judges to all share the same vocabulary and framework of concepts. This is why this book was written.

Uniform understanding and usage can only occur after the majority of judges, lawyers and prosecutors describe evidence in a similar way, and begin to consider evidence as a concept: a web of testimony, physical evidence, deductions and inferences which help to approximate the truth about a crime. This is the language of the law as it is practiced daily, critically evaluating the evidence which is available in order to make decisions that everyone can understand.
Without evidence, law has no meaning. It operates in a dark room, devoid of air, sound, light, scent, heat or taste. It is abstract, distant and arbitrary. This is not how we view law. We view law as society's rules, applied to each citizen fairly and accurately. At least, this is what we hope. If evidence is poorly understood by practitioners or judges, the law will almost certainly be misapplied. If judges, lawyers and prosecutors do not have the same vocabulary about evidence, or share the same concepts, then the law will also be misapplied.
Chapter 12
Epilogue

The purpose of this book is simple: to illuminate a poorly understood but absolutely vital element of any modern system of criminal justice. Even the simplest medieval legal system had basic rules for evidence, although some were unfair or based on poor assumptions. The various legal systems of today also have evidentiary rules which vary. Common law systems have detailed rules of evidence meant to protect a lay jury from hearing testimony or seeing evidence which is false, biased or otherwise inaccurate. Civil law systems rely on the concept of "free proof," which was promoted by Jeremy Bentham's *Rationale of Judicial Evidence*. ¹¹⁴

Free proof was a reaction against the restrictive evidentiary canons of Roman law based "in important part on the belief that the probative weight of evidence is a matter too unruly to obey the lawgiver's rein, too contextual to be captured in a web of categorical legal norms."¹¹⁵ In the wake of the French Revolution, "the very idea of legally controlling proof became both intellectually discredited and politically suspect."¹¹⁶ Instead, under the Continental view the judge relies on "the infinite particularity of experience" to make probative judgments on evidence.¹¹⁷ This free evaluation of evidence has assumed in many Continental countries "the form of a revered regulatory principle," particularly in criminal

¹¹⁶ *Id* at 21.
¹¹⁷ *Id.* at 22.
procedure. This book is not suggesting that this "revered principle" be replaced. Rather, it seeks to understand and explain how judges rely on their "infinite variety of experience" to evaluate evidence and make decisions.

The first concept which this book explores is that evidence rarely, if ever, permits complete certainty of the court's decision. Thus, a court's search to absolutely ascertain "the truth" is quixotic. A court which could travel back in time, watch the crime occur and read the minds of the criminal offenders, may come closest to finding the "truth." Prosecutors and courts cannot do this. In order for justice to be done, and for the law to be applied, something less than "the absolute truth" is all that is possible. Facts can only be understood from the evidence which is available and which is gathered during an investigation. Prosecutors, attorneys and judges must understand the limits and potential of evidence so that a court's judgment is based on as close an approximation of "the truth" as is possible.

The second concept which this book explores is that evidence is contextual. A solitary piece of evidence, by itself, has very little meaning. A gun is simply a gun. It only means something in relation to other evidence, such as a dead body, a bullet hole, and other evidence. It means even more if it matches the caliber of the bullet found in the body. It means a lot more if marks on the bullet match that test bullets fired from the gun. If it is registered to the defendant and found in a garbage can, it may even be more meaningful. However, the gun itself, without all that other information, tells the court very little.

Further, the context of the evidence does not just rely on other evidence, but on the allegations and the elements of the crime. The evidence is only relevant if it helps prove or disprove an element of the crime, or some other necessary factor such as the harm of the victim or an issue important to sentencing or confiscation. The gun found on the defendant may be interesting, but if he is charged with tax evasion it really isn't relevant.

The third concept which this book explores is how to describe a piece of evidence. The qualities of evidence are those aspects of the evidence which determine its importance and place within a legal court case. The first quality, which has already been mentioned, is its relevance. If an evidence is not relevant, it should not be heard in a case. Such evidence wastes the court's time and can be unfairly prejudicial. The second quality is the evidence's credibility. In other words, should the evidence be believed? This book explained the factors which makes testimony or physical evidence more, or less, credible. Evidence might be relevant, but if it isn't believable, it should not play any role in the final judgment of the court or the decisions of a prosecutor. Practitioners and judges should be aware of factors which make various evidence credible. A prosecutor may argue that evidence is credible, while the defense may argue that it isn't. If both sides are intelligently arguing about the credibility of an important witness, for instance, the court can make a much more informed judgment.

The last quality of evidence is its probative force, or how convincing it is. This tends to be a measure of its internal consistency, how well it fits with our normal expectations and whether there are other corroborating evidence. If the evidence has high probative force, it can be said to have great weight or

\[118\] *Id.* But cf. J. Jackson & S. Summers, *The Internationalisation of Criminal Evidence* (Cambridge Univ. Press 2012). Jackson and Summers suggest that human rights laws, such as those under the European Convention of Human Rights, are imposing changes in national evidence laws.
that it is strong evidence. If it has poor probative force, it is often described as weak evidence. The probative force can thus depend on other evidence. If more evidence says that something happens, we consider all of the evidence to be stronger.

When probative force is analyzed, a common human trait becomes clear. People naturally calculate the probability that something is true. If evidence makes that probability seem high, we would consider it strong evidence. If evidence makes that probability seem low, we consider it weak. To our earliest ancestors, a shadow shaped like a tiger would seem like strong evidence that we were in danger. If there were bones of other victims nearby, the probability of being attacked by a tiger seems even stronger. If we heard the growl of a tiger, the evidence would be corroborated and our caveman ancestor would feel certain that he was in eminent danger.

Thus, there is a way to describe evidence that has deep meaning in a courtroom. At a minimum, this book would be successful if practitioners and judges develop and use a common vocabulary to describe evidence. A judge should feel free to consider some far-flung evidence irrelevant, while focusing only on evidence which supports the elements of the criminal offence. A prosecutor or defense attorney should be able to ask a witness questions which explores the credibility of that witness, or argue to a judge that a document should not be believed. Finally, practitioners and judges should not only know how to weigh the probative value of evidence, but should have the common words and concepts to debate it.

If judges, prosecutors and attorneys can all have the common vocabulary and framework of concepts to critically examine evidence and debate its qualities, this will lead the justice system to better find "the truth." It will also lead to convictions based on higher-quality evidence and the rights of defendants being more stringently observed. This is a minimum goal of this book; however, it offers much more.

In Part II of the book, it considers how to challenge evidence by either finding contradictory proof or by exposing and questioning the qualities of the evidence being offered. If the practitioners and judges have a common vocabulary and framework, they should then move to the next stage: using that vocabulary and those concepts to improve the evidence heard by the court. Improving this evidence includes making it stronger through corroboration, or making it weaker by questioning its credibility.

Part I also explores the inferences that evidence requires us to make. This is a major theme of the rest of the book. The body of evidence that is gathered in an investigation and offered at trial requires the practitioner and judge to deduce certain conclusions and to infer other conclusions. Deduction requires logic, while the inferences require us to assess probability. When we logically deduce that something is true, we give that deduction the same weight as the underlying evidence. In other words, that deduction becomes the equivalent of evidence. However, when we infer something, we provide that conclusion with a probability. It may be a high probability, or it may be a low probability, but we don't consider it absolutely true.

Some kinds of evidence, by their nature, are always inferential. This means that there is always a chance it could be wrong, but we consider there to be a probability that it is true. Statistical evidence is the best example of this. We don't normally consider statistical evidence to be a basis for a criminal conviction, but in fact, statistics are the keystone to many forms of evidence. DNA, for instance, is a form of statistical evidence. There is a small chance that a match between DNA at the scene of a crime and DNA
obtained from a defendant is erroneous. Thus, it isn't correct to say that a DNA match means that the defendant is the criminal. Instead, the DNA match should be seen as very rare, and that there is a high probability that the defendant is the criminal. The first statement (known as the "prosecutor's fallacy") assumes an absolute truth, while the second statement infers that the defendant is probably guilty.

As we move away from the rarity of a DNA match towards other forensic sciences, this book examines whether the forensic expertise should be given absolute deference. Some forensic sciences would create a match with a much higher rate of error than a DNA match. In other forensic sciences, that rate of error may not be known. This effects the reliability of the expert's analysis. In the evidentiary vocabulary we learned in Part I, this means that the credibility of the expert's conclusions may be problematic. In other words, we may not believe that the expert's conclusions are correct. We may only give very little probative value to such evidence, as we don't believe that there is a high probability that the expert's opinion is true.

On the other hand, an expert with great knowledge and experience in a subject, using well-accepted and scientifically valid techniques, can give an opinion which is quite valuable. If the expert can explain that the methods he or she used has an error rate that is low, the judge may feel confident that the expert's opinion is credible and should be given great weight.

Finally, in Part III the book considers how we stitch together evidence to make a final conclusion in a criminal case. Further, it suggests a process by which prosecutors, attorneys and judges can build and assess a body of evidence. This process encapsulates this entire book. First, the allegation should be analyzed to determine the elements of the criminal offence and other requirements to be proven. Like any journey, we should know where we want to go before we begin. Second, as evidence is collected the practitioner should consider the qualities of the evidence. Those qualities will change as additional evidence is collected. At some point, the practitioner should re-evaluate whether the evidence supports the original allegation or if some other criminal offence may be more appropriate. The necessary intermediate inferences and final objectives should be set. As the body of evidence grows, the practitioner makes a decision that there is enough evidence to satisfy the final objectives.

The evidence which is collected will support certain logical deductions. The practitioner should make those conclusions and be ready to support those conclusions to the court. Once all the evidence and deductive conclusions are understood, the practitioner and the court makes inferences. This means that some conclusions are considered to be true, while others are considered to be probable. If the court believes that the probability is high enough that the defendant committed the criminal offence, it will find the defendant guilty. If the probability is not high enough, the court will acquit.

This book offers a practitioner sophisticated viewpoints about evidence. There are discussions about statistics, science, human psychology and logic as it relates to the evidence before a court. A practitioner who best understands evidence can either create the best case before a court or can undermine the evidence offered by the opposing party. He or she can limit or undermine an expert's opinion, or strengthen the expert's credibility or weight. He or she could convince a court that a conclusion is illogical, improbable or unsupported by evidence. However, if there is not a common vocabulary and common understanding about evidence within the legal system, an advanced practitioner may become frustrated.
It is hoped that this book is read by practitioners and judges. It is also hoped that this book is read in law faculties and by law students, if only to create that common vocabulary and a shared understanding about evidentiary concepts. The concepts in this book are not unique to any legal system; rather, they are common to evidence in most systems. It is not meant to create rules of evidence or further any one legal system; instead, this book should foster more understanding and better evidence before the courts. This can only start with a common vocabulary about evidence and a willingness to debate the quality of evidence in court, in educational facilities and among colleagues.
Glossary

A

Accuracy
The tendency of evidence to correctly depict the true facts. A process can also be accurate if it consistently depicts things correctly.

Aggravating Circumstances
Additional information which legally or logically justifies a higher sentence for a criminal offence than normal.

Assumption
An assumption is a belief that something is true without evidence to support that belief.

Average
A general statistical term that measures the middle of a set of data. This can include the median, mean and mode, although “average” is also used to describe the median.

Authenticity
Evidence which is authentic has not been altered, re-created or copied. Physical evidence is authentic if there it can be demonstrated that it has not been altered, re-created, copied or switched between the crime
scene and its presentation as evidence in court. Documentary evidence is authentic if it is the original document. Local law may permit a document which has been notarized or otherwise certified to be an exact copy of an original document to be considered authentic.

B

Basis for Testimony

Information which explains how a witness knows the facts about which he or she is testifying. This can include the witness’ ability to perceive the events, their ability to see or hear the events, or their experience or knowledge on the subject.

Bayes Theorem (or Bayesian Statistics)

A statistical theorem which shows that determination of probability is more certain with additional information. This is relevant to the principles of evidence because it shows that corroboration of evidence is critically important to increasing the certainty of court decisions.

Benefits of Crime

Property or money which has been obtained by a criminal as a result of their criminal activity.

Bias

The tendency for a witness or other evidence to be influenced by another factor. This can include the influence of a person, the influence of political leanings, the influence of a pre-existing idea, the concern about financial harm or gain, or the influence of any other consideration.

Body of Evidence

The collected set of testimony, documents, physical evidence, inferences and deductions in a case.

Burden of Proof

A legal presumption that one party must demonstrate their allegations with evidence. In criminal cases, the prosecutor has the burden of proof to establish that the defendant committed a crime. This is related to another legal presumption, the presumption of innocence. The prosecutor’s burden of proof means that he or she must overcome the presumption that the defendant is innocent. See also Standard of Proof.

C

Challenge

In an adversarial system, the act by one party of offering contradictory evidence or questioning the qualities of evidence in order to negate or clarify the evidence offered by another party.

Conclusive Presumption (See Presumption)
Confidence

The substantiated belief that evidence is accurate. This is often used with statistical evidence and is expressed as the “Confidence Interval” or “degree of confidence” which measures how likely the data is to be accurate. A Confidence Interval is also provided with a “Margin of Error.”

Consistency

The quality of agreement, compatibility or harmony with other facts, form or characteristics.

Contradiction

Direct opposition to a fact or assertion.

Contradictory Evidence

Evidence which directly opposes other evidence being asserted in a case.

Corroboration

The act of offering different evidence to establish the same fact, or to provide greater confidence in a fact which one quantum of evidence establishes. For example, a witness who testifies to a murder is corroborated by other evidence which supports his testimony and makes it appear to be more valid, such as other people hearing the gunshots at the same time. Corroboration is an important factor to improve the probative strength of evidence, or make the evidence more convincing.

Credibility

The quality of being believable or trustworthy. In evidence, this can be analyzed differently between the credibility of a person’s testimony or the credibility of documents or physical evidence.

Critical Thinking (or Critical Logic)

The process of rationally examining a collection of facts or assertions, including the qualities of the individual parts, the inferences and the logic of the conclusions.

Cross Examination

Cross-examination is the questioning by an opposing party of a witness. Rules of evidence or procedure may influence how cross examination can be conducted. Cross-examination often focuses on conflicting information, the credibility of the witness, the relevance of the testimony, the probative strength of the testimony, or exploring the possibility of alternative versions of the testimony.

Damages

In accordance with local law, the harm done to victims in a criminal case. Damages can also refer to the compensation which a court orders a defendant to pay as a remedy for that harm.
Deductive Reasoning

A specific form of logical reasoning where two propositions lead to a conclusion which must be true.

Descriptive Statistics

Mathematical measures about a group of data which gives current or historical information, but does not predict future or unknown information.

Direct Evidence

Evidence which proves an ultimate objective, such as an element of the criminal offence, without any intervening steps.

Document

Evidence which records (or documents) other information and is offered to prove that recorded information. A document may not only be words written on a sheet of paper, but can also be a photograph, computer-generated text, or recorded material. In many legal systems, documentary evidence includes papers, passports, licenses, video-recordings, audio-recordings, email, bank documents, border crossing records, and other similar recorded information. Documents may be less reliable if they might have been forged or if the process of recording the information on the document is faulty.

Elements of Criminal Offence (or Elements of the Crime)

Specific components of a criminal offence which should all be proven in order to establish that a crime occurred.

Error Rate

In a scientific test or process, the percentage of times that the test or process is wrong. A scientific test with a high error rate is not reliable. A scientific test with a low error rate is more reliable. A test which does not have a known error rate cannot demonstrate whether it is reliable.

Expert (or Expert Witness)

A person with sufficient specialized education, experience or knowledge about a subject that a court can rely on his or her opinion to answer a specified question relevant to a legal case.

Expert Analysis

The investigation by an expert of other evidence or information in a case in order to support his or her opinion to the court. This analysis should be in accordance with accepted methodologies within his or her field of expertise.
Expert Evidence (or Expert Opinion Evidence)

Normally witnesses describe information that they saw, heard or otherwise perceived about actions taken to commit a crime. An expert gives an opinion to the court, contrary to the evidence normally given by other witnesses. Opinion evidence is not evidence based on their direct perceptions of the crime, but is an expression of their professional judgment after reviewing and analyzing other information or evidence in the case.

Expert Qualifications

The basis of the expert’s unique or specialized knowledge on a subject. This can include education, training, experience, or certification received after testing.

Fallacy

In deductive logic, two propositions can lead to a conclusion which must be true. However, this can only result from those two propositions having the appropriate logical connections. A fallacy is when the two propositions do not logically lead to the asserted conclusion. There are many types of fallacies, some of which were given as examples in Chapter 10.

False Positive

In a test or experiment, a result is obtained which supports one conclusion but is not correct. Often in medical or forensic tests, a positive result might conclude that a patient has a disease or is a match for the criminal. However, for reasons related to the accuracy of the testing, that positive result is incorrect. See also Error Rate.

Final Objective (or Ultimate Probandum)

In a criminal case, the final objective of analyzing the body of evidence is to establish or disprove the elements of the crime, damages, assets to confiscate, mitigating circumstances, aggravating circumstances or other component of the criminal case which must be proven.

Fit

Fit is a quality of evidence related to probative force. Evidence has “fit” when it is in keeping with the normal expectations of the community. When the evidence being presented requires the court to suspend its normal experience and expectations, it does not have good fit. Such evidence is not compelling because it does not make sense to the adjudicator. Evidence with poor fit requires additional information to explain why it is so unusual.

Forensic Science

Professional fields of analysis which examines evidence and, using laboratory testing or specialized analysis, results in a conclusion related to a criminal case.
Friction Ridge Analysis (or Fingerprint Analysis)

The analysis by a trained examiner of prints left by parts of the skin. Skin has “friction ridges” or “fingerprints” which can leave unique patterns on objects, called “prints.”

Impression and Pattern Evidence

Expert analysis of marks left by tools, teeth, or other objects at the crime scene. Comparison between the marks left at the scene and marks on a suspect object can support an expert’s opinion that they match. Ballistic matching, or the matching of a fired bullet with the marks left by the barrel of the gun or the firing pin is a form of impression or pattern analysis.

Indirect Evidence

Evidence which supports an intermediate inference in a case.

Inductive Reasoning

A form of logical reasoning which compares many instances of an event or object and draws a conclusion. While the conclusion in deductive reasoning must be true, in inductive reasoning there is only a probability that the conclusion is true. Inductive reasoning is similar to predictive statistics.

Inference

The process of deriving a logical or probable conclusion from facts or premises.

Inferential Evidence

Evidence for which the evidentiary value does not come from the facts themselves, but from the inference or conclusion that the facts support. This includes statistical evidence, expect evidence or forms of proof which have the same effect as evidence, such as judicial notice.

Intermediate Inference (or Penultimate Probandum)

A conclusion made from evidence offered in a case which is an important intermediate step towards proving the final objectives in a case. Evidence which indirectly prove a case can instead support intermediate inferences. Those intermediate inferences, if true or probable, then support the ultimate conclusions in the case.

Internal Consistency

Internal consistency is a quality of evidence related to probative force. It is the general agreement or harmony of different assertions or facts from one source of evidence. A witness, for example, might be internally consistent if he or she does not having conflicting assertions in his or her testimony.
Instruments of Crime

Items used during the commission of a criminal offence which might be subject to confiscation.

Judicial Admission (or Stipulation)

In accordance with local law, the acceptance as proven any fact which all relevant opposing parties agree to be true, or at least agree not to contest it to be false.

Judicial Notice

The acceptance by a court as true certain facts which are notoriously known to be true, or which no reasonable person would contend to be false.

Logic

A field of philosophy which investigates the principles governing correct and reliable inferences and deductions.

Match Probability (or Match Frequency)

In forensic or scientific testing, the statistical probability or likelihood that a random person would have the same characteristics as the sample. For instance, a DNA test may have a match probability of 1 in 100 million. This means that if a random person were selected, there would be a 1 in 100 million chance that he or she would match the DNA sample being tested.

Material or Materiality

Materiality is a synonym for relevance. See Relevance.

Mean

One of three measures of central tendency, or average. The mean is calculated by adding the value of all of the data into one total, and then dividing by the number of data points. For example, if there is one bushel of apples with 30 apples, another with 25 apples and another with 32 apples, the mean would be calculated by adding 30 plus 25 plus 32 and dividing by 3. The mean would thus be 29. The mean is the most common measure of central tendency and often is synonymous with the idea of “average.”

Measure of Central Tendency

The mathematical term for average. Since there are numerous ways to calculate an average of a group, this category is meant to calculate the “center” of the group. Thus, this is the measure of “central” tendency. These measures indicate where the center of the group of numbers are, and can describe a mathematical trend in conjunction with measures of dispersion.
Measures of Dispersion

The mathematical term for measuring the “spread” of numbers. This includes range, variance and standard deviation. In conjunction with measures of central tendency, this can describe both the center of a group of numbers and how broadly that group varies from that center.

Median

One of three measures of central tendency, or average. The median is simply the middle point between the highest and lowest number in a group. Thus, if the bushel of apples with the highest number of apples contains 45 and the lowest contains 28, then the mode is the middle point between those two numbers, in this case, 36.5.

Memory Reconsolidation

A theory of neuroscience which considers memories to be chemical bonds within the brain which are reconstituted every time they are recalled. If correct, this theory has implications for witness memories and testimony.

Methodology

In expert analysis, the process by which the expert examines the existing evidence and applies specialized procedures and techniques to support his or her expert opinion.

Mitigating Circumstances

Additional information which legally or logically justifies a lower sentence for a criminal offence than normal.

Mode

One of three measures of central tendency, or average. The median is simply the most frequent number of the group. Thus, if there are 10 bushels of apples with 5 bushels containing 30 apples, 3 bushels containing 34 apples, and 2 bushels containing 29 apples, then the mode for this group would be 30 apples.

Monty Hall Dilemma

A problem which demonstrates that probability is not intuitive. The problem is described in detail in Chapter 8.

Objectivity

The condition of evidence where bias is minimal or nonexistent.
Observational Sensitivity

The ability of a witness or other source of evidence (such as a camera or other system) to perceive actions or information.

Opinion Evidence (*See also Expert Opinion Evidence*)

Normally witnesses describe information that they saw, heard or otherwise perceived about actions taken to commit a crime. Thus, the witness has a basis to testify about facts. However, if a witness testifies about things they did not hear, see or otherwise perceive, then this is their opinion. With the exception of expert opinions, which are based upon their specialized knowledge and analysis, courts normally do not hear or base their decisions on opinions.

Penultimate Probandum (*See Intermediate Inference*)

Perception (*See also Observational Sensitivity*)

The ability of a witness or other source of evidence (such as a camera or other system) to observe actions or information. Perception also includes the conditions which may alter the way in which the witness views and remembers the observations, such as bias, prior interests, or the conditions in which the observation is made.

Physical Evidence (*or Tangible Evidence*)

Evidence whose existence or qualities are proof which are relevant to the intermediate inferences or final objectives in a criminal case. For example, the existence of a gun is proof in a criminal case. The qualities of that gun, such as the location where it was found, the caliber of the gun, the serial number, or fingerprints found on the gun are also proof in the case.

Polysyllogism

In deductive reasoning, an argument made up of a chain of syllogisms.

Population

In predictive statistics, the larger group for which a prediction is made. For example, a scientist wishes to predict the percentage of people in the city who have allergies. He measures a smaller group (the sample) in order to predict the larger group (the population.)

Posterior Probability

In Bayesian statistics, the probability that you believe something is true before you assess new evidence. For instance, the evidence you have leads you to conclude that there is a 30% chance that the defendant is guilty before the fingerprints are matched. After you see that the fingerprints from the crime scene match the defendant, you now believe there is a 90% chance that he is guilty. The 30% chance was the posterior probability.
Predictive Statistics

Statistics which draws upon known data to extrapolate something which is unknown or in the future. Thus, a sample of 200 people are tested for allergies. 40% of the people have allergies. The doctor then extrapolates that about 40% of the people in the city also have those allergies, even though he hasn’t tested them.

Prejudice (or Prejudicial)

_Noun_. Partiality or a preconception. _Verb_. To render a person or case negatively. For example, the witness prejudiced the defense because she accused him of murder. Most evidence prejudices one side or another in some way. This prejudice should be acceptable as long as it is relevant and credible.

Presumptions

An inference which the law says must be made in favor of a particular fact. A presumption may be conclusive or rebuttable. A rebuttable presumption is one which the law requires the court to conclude that the fact exists unless the opposing side is able to establish reasons to conclude that the fact does not exist. For instance, a law states that a person is presumed to have died if they were missing for over five years and have not contacted friends or family. That presumption can be rebutted by showing that he is, in fact, alive.

Probability

Likelihood that some event will occur or has occurred. This can also be the likelihood that a hypothesis or belief is true.

Probative Force (or Probative Strength or Weight)

A quality of evidence. The probative strength of evidence measures whether a quantum of evidence is convincing. This often relates to whether the evidence is important in a case, whether it is a proposition that is supported by many different corroborating evidence, whether it fits with the normal expectations of the court, and whether it is internally consistent. If a quantum of evidence has high probative force, then that evidence makes an intermediate inference or final objective more probable to be true. This probability is improved when other evidence corroborates that inference.

Proof

The establishment of a fact by evidence. This is sometimes used as a synonym for evidence.

Propositions

In logic, a proposition is a statement with two terms. Two propositions with three terms (one term being shared between the two propositions) leads to a conclusion. For example, A is B. B is C. Therefore, A is C. The two statements “A is B” and “B is C” are propositions.
Prosecutor’s Fallacy

The mistaken claim that a very high (or very low) statistical chance equals a definitive proof of guilt. For example, a prosecutor who claims that a DNA test which matches the defendant to the scene proves that the defendant was guilty is committing the Prosecutor’s Fallacy. The DNA test, instead, simply proves that it is exceptionally rare to have a match between a crime scene sample and a defendant.

Quantum of Evidence (or Datum of Evidence)

(pl. Quanta of Evidence) The division of evidence into basic parts which prove discrete details or factors. For example, a pistol is evidence; however, there are different quanta of evidence which it represents. The fingerprints represent one quanta which proves one element: who held the pistol. The serial number may prove another element: who owned the pistol. The location the pistol was found may be another quanta which adds another detail to the story.

Range

One of three measures of dispersion, or the spread of a group of numbers. The range is simple the difference between the highest and the lowest number in the group. If there are ten bushels of apples with the most full containing 45 and the least full containing 5, then the range is 40.

Rebuttable Presumption (See Presumption)

Relevance

A quality of evidence. The relevance of evidence is related to the inferences or objectives to be proven. Evidence is relevant if it is possible that its inclusion in the case will make an inference or objective more or less probable. Evidence is irrelevant if its absence from the case will have no possible effect on the outcome of the case or any important result in the case.

Reliability

Worthy of trust or confidence due to accuracy or honesty.

Representative Sample

In predictive statistics, the size of the sample used influences how much confidence can be had in the prediction. Thus, if a scientist wishes to predict the number of people in a city who have allergies, he cannot rely upon a sample size which is too small. He would need to have sampled hundreds of patients in order to have confidence that the sample can represent that larger population.
Sample

In predictive statistics, the group that is questioned, tested or measured. For example, a scientist wishes to predict the percentage of people in the city who have allergies. He measures a smaller group (the sample) in order to predict the larger group (the population.)

Sample Size (See Representative Sample)

Sensitivity

When considering a system which collects information, such as a video surveillance system or bank records, the accuracy and completeness of the input to that system. For example, a video surveillance system had very poor lighting. Because the video it took was so poor, the system was not sensitive.

Shifting Burden of Proof (or Reversing Burden of Proof)

A legal presumption that one party demonstrates a low standard of proof, after which the burden shifts to the other party to affirmatively disprove the presumption. See also Standard of Proof.

Sorites

In deductive logic, a form of argument having numerous premises and one conclusion. If a sorites was rewritten into a chain of syllogisms, the conclusion of each syllogism would be the premise of the next.

Standard of Proof

A theoretical degree of confidence that a legal condition has been proven. For example, a person is convicted in the United States if the prosecution proves the defendant is guilty “beyond a reasonable doubt.” The standard of proof for criminal convictions in the United States is “beyond a reasonable doubt.” However, for a criminal proceeding to be initiated in Europe, the European Convention on Human Rights required that there be, at least, “reasonable suspicion.” This is another standard of proof.

Standard Deviation

One of three measures of dispersion, or the spread of a group of numbers. The standard deviation is the square root of the variance. A standard deviation measures the spread from the mean, or average. If the standard deviation is large, the group of numbers is very highly dispersed. If the standard deviation is low, then the group of numbers is highly compact.

Stipulation (See Judicial Admission)

Substitute Evidence

In accordance with the law, the use of a true, accurate and reliable copy, photograph or other description of evidence in court. For example, a hand grenade is dangerous. It should not be shown in court as an
exhibit. However, a photograph of the hand grenade and a forensic report showing that it was a live grenade which was capable of exploding may be a substitute for that hand grenade as a trial exhibit. As another example, a ship is large. It will not fit into a courtroom. A photograph of the ship may, instead, serve as substitute evidence as long as it is a true and accurate depiction of the ship.

Summary Evidence

Evidence which collects information from numerous sources of evidence and displays it on a table, list, chart or other manner. Summary evidence is often used to show a pattern in the evidence which would not otherwise be seen by the court. That pattern is thus a separate kind of evidence which the summary evidence demonstrates. For instance, an investigator reviews thousands of bank records and finds a pattern of transfers of funds between a businessman and a city’s mayor, depicting bribes. Those thousands of bank records would not easily reveal the pattern, but a chart showing the movements from each of the bank records would. The summary evidence should be based on admissible and reliable evidence and should be a true and accurate depiction of the information drawn from the body of evidence.

Syllogism

In deductive reasoning, an argument with two premises and three terms. If the rules of logic are followed, the resulting conclusion must be true.

Tangible Evidence (see Physical Evidence)

Testimonial Evidence

Evidence given by a witness. In accordance with some legal systems, testimonial evidence can also be the spoken or written statements given by a person in a recording, email, notes or letters.

Tests for Rarity

A forensic or scientific test which either excludes a person as a suspect or provides a match. Depending on the match probability, the test can also determine how rare a match is. A match does not prove a causal connection between the sample and the person or item being tested; instead, it simply proves how rare it would be to find a match. If the probable of the match if extremely low, though, a court may deem that no other match is likely and conclude that the match does indeed prove guilt. See Prosecutor’s Fallacy and Error Rate.

Transactive Memory (also known as Group Memory)

The psychological process of using a group or other device, such as the internet or email, as a form of human memory. Instead of knowing a fact or memory, the person only remembers where to look for that fact or memory. For instance, a father may not remember how to operate the television, but he knows to ask his son. Even though he has seen the process numerous times, his memory is transactive. He knows to rely on the group for that information, rather than committing it to memory. This is relevant to evidence because it improves our understanding of how witnesses may remember facts and, thus, testify.
One of three measures of dispersion, or the spread of a group of numbers. This is explained in Chapter 8.
principles of evidence

Legal disputes are resolved by applying the law to the available evidence. Thus, practitioners should not only know the law, but understand evidence. This goes beyond simply knowing any rules of evidence that a legal system may require. Understanding evidence requires a practitioner to be able to describe the qualities universal to all evidence, such as its relevance to the case, its credibility or its strength. These qualities answer the question: Does this evidence matter to this case? Should I believe this evidence? Should I believe this evidence more than another, conflicting piece of evidence? Is this evidence convincing? Could the evidence be more convincing?

This book does not discuss rules of evidence. In fact, this book is not specific to any particular legal system. Instead, it discusses universal principles of evidence and how they apply to criminal cases. Some of these principles are fundamental, while some of these principles are not as obvious. However, all of these universal principles affect witnesses, documents, physical evidence and experts. Understanding these principles can improve the clarity, strength and relevance of the evidence being presented in court.

This book is appropriate for seasoned practitioners, law students, or anyone who wishes to better understand one of the most fundamental materials of any legal system: evidence.