Appendix: The Logic Behind the Inferential Test

In the Introduction, I stated that the basic underlying problem with forensic doctors is so easy to understand that even a twelve-year-old could understand it. What I present in this appendix, however, is a little more on the technical side — beyond the knowledge base of a typical twelve-year-old. This is for those of you who want to peak under the hood and understand the logic behind what I have written in this book.

You may recall my mention of the Inferential Test. It is the statement that I believe should be written on the wall of every courtroom in plain sight of all judges and forensic doctors. The Inferential Test (IT) is:

> One can be reasonably certain if witness accounts of the past are consistent or not consistent with physical evidence in the present, but one cannot reliably surmise past events from physical evidence unless there is only one plausible explanation for that evidence.

This statement is really nothing new. It is simply an expression of elements of statement logic. Statement logic consists of “rules” that can be applied to show whether or not statements used in support for an argument — *premises* — can reliably support a final statement in an argument — a *conclusion*.

Statements are sentences or phrases that are either true or not true. Statements can be represented in symbolic logic by letters. For example, the letter ***p*** can represent statements like:

> Two is added to two.
>
> I reached into a bag with all white beans and grabbed some beans.
>
> The witness accounts of the past in a case are entirely true.

Some kinds of statements are known as *conditional statements.* These are statements that have the words, *if* and *then*. "If ***p**,* then ***q**"* could also be written as $p \rightarrow q$. Here are some conditional statements:

> If two is added to two, then the sum should be four.
>
> If I reached into a bag with all white beans and grabbed some beans, then the beans in my hand should be white.
>
> If the witness accounts of the past in a case are entirely true, then the witness accounts should be consistent with the physical evidence from that case.

The statements above may look familiar to you. The first two statements should remind you of examples I used in the chapter, "Reasoning Backwards." One statement uses simple arithmetic, and the other is an illustration used by logician, Charles Sanders Peirce. The third statement has to do with the Inferential Test.

The letter ***q***, of course, can represent "the sum should be four," "the beans in my hand should be white," and "the witness accounts should be consistent with the physical evidence from that case." In the third example, comparing witness accounts of the past in a case with the physical evidence from those past events is reasoning forward: where one starts with the train of events offered by witnesses and then compares them to the clues.

The portion of the conditional statement following the little word, if, is called the *antecedent.* It is what comes before, or in the case of past events, came before. What follows the word, then, is called the *consequent.* It is the result of the antecedent.

In statement logic, there are *valid deductive argument forms* that use conditional statements. In valid deductive argument forms, if the statements before the conclusion — the premises — are true, then the conclusion is certain to be true. The first half of the IT ("One can be reasonably certain if witness accounts of the past are consistent or not consistent with physical evidence in the present…") uses two valid deductive argument forms: *modus ponens* (MP) and *modus tollens* (MT). Note that these are words in Latin. Expressions in Latin are typically expressions that have been around for a long time, even centuries. MP and MT go back into antiquity.

Modus ponens is short for *modus ponendo ponens* or "the way that affirms by affirming." MP using symbols is:

> ***p***
>
> ***p*** → ***q***
>
> ∴ ***q***

The symbol, ∴, means "therefore." It indicates the conclusion. The two statements before the conclusion are the premises used in support of the conclusion.

Translated into English, the symbols mean:

> Statement ***p*** is true. If statement ***p*** is true, then statement ***q*** should be true. Therefore, statement ***q*** is true.

> Two is added to two. If two is added to two, then the sum should be four. Therefore, the sum is four.

> I reached into a bag with all white beans and grabbed some beans. If I reached into a bag with all white beans and grabbed some beans, then the beans in my

hand should be white. Therefore, the beans in my hand are white (I am certain of this even before opening my hand).

The witness accounts of the past in a case are entirely true. If the witness accounts of the past are entirely true, then the witness accounts should be consistent with the physical evidence from that case. Therefore, the witness accounts are consistent with the physical evidence from that case (I am certain of this as I offer testimony to a reasonable degree of medical or scientific certainty in a court of law).

Using this ancient argument form, the conclusion is certain to be true as long as the premises are true.

Note that I used the words, “should be,” in the conditional statement and replaced those words with “is” in the conclusion. This is to indicate that a conditional statement is both predictive and tentatively applied to the case. Conditional statements in the testimonies of forensic doctors are typically statements of science. Science, unlike logic, not only changes over time as more is learned but can also be misapplied in any given situation. Still, because MP is a valid deductive argument form, the conclusion can be certain (“is”) if the premises are true.

The other valid deductive argument form used in the first half of the IT is *modus tollens* (MT). *Modus tollens* is short for *modus tollendo tollens* which means “the way that denies by denying." It can also be thought of as *denying the consequent*. MT using letters and an arrow is:

$$p \rightarrow q$$

$$\sim q$$

$$\therefore \sim p$$

The "squiggles" in front of the letters above are negations, meaning "not ***q***" and "not ***p***." Translated into English, the symbols mean:

> If statement ***p*** is true, then statement ***q*** should be true. Statement ***q*** is not true. Therefore, statement ***p*** is not true.

> If two is added to two, then the sum should be four. The sum is not four. Therefore, two is not added to two.

> If I reached into a bag with all white beans and grabbed some beans, then the beans in my hand should be white. The beans in my hand are not white. Therefore, I did not reach into a bag with all white beans and grab some of those beans (I must have done something else).

> If the witness accounts of the past are entirely true, then the witness accounts should be consistent with the physical evidence from that case. The witness

> accounts are not consistent with the physical evidence from that case. Therefore, the witness accounts of the past are not entirely true (I am certain of this as I offer testimony to a reasonable degree of medical or scientific certainty in a court of law).

Because of MP and MT, a scientist, forensic doctor or anyone ("one") "can be reasonably certain if witness accounts of the past are consistent [MP] or not consistent [MT] with physical evidence in the present." Still, I have a few words of warning.

The first part of the IT only allows someone to be *reasonably* certain and not *absolutely, 100 percent, without-a-single-possible-doubt* certain. Valid argument forms are as certain as certain can possibly be, but there are no guarantees that a forensic doctor or anyone else is working from premises that are truthful. If the premises are *fact*-based, however, they are more likely to be true than premises that are *belief*-based. *Facts* are items that are observed. An example of a fact is "some infants die suddenly and unexpectedly." When witnesses or scientists describe what they observed, they offer facts. *Beliefs*, in contrast, are items that are *not* observed that may or may not be true (and are often not true). An example of a belief is "some parents kill their children by shaking them." Forensic doctors should use facts as much as possible and avoid using beliefs as premises when analyzing evidence. Evidence — what is considered in a court case — means evident, observable and factual and not fanciful or speculative. Still, a forensic doctor may get his facts mixed up or may learn more facts at a later date that may change his opinions.

Even evidence-based science, as powerful as it is, does not reach the level of absolute certainty. Science changes as more is learned. Inserting the word, “reasonably” in front of “certain” recognizes these human limitations.

During a passionate courtroom delivery, some forensic doctors claim to be absolutely or 100% certain of their opinions. At that moment, these doctors throw away their credentials as scientists. Being absolutely or 100% certain means that no additional evidence could possibly change their opinions. We have an expression for that: it is called being “close-minded.” Being a scientist or a forensic doctor is supposed to mean being open-minded to additional evidence and newly-discovered science. Regardless of what is on a forensic doctor’s résumé, the courts should not accept statements of absolute certainty as evidence nor should they allow the testimonies of scientists and doctors who say that they are absolutely, 100%, without-a-single-possible-doubt certain.

There is also something else.

The first part of the IT only guarantees that witness accounts can be consistent, but it cannot guarantee the truthfulness of witness accounts. Being “consistent” and being “true” are not the same thing. This is because many different varieties of past events can lead to the same physical evidence. Being “consistent” means that the past events presented by witnesses **can** result in the physical evidence and are one of possibly an infinite number of ways that can result in the same physical evidence. There is no guarantee that those events are what actually happened when numerous sets of events can lead to the same result.

Still, a very strong argument can be made inductively that the witness accounts are probably true if they are consistent with the physical evidence in their entirety, particularly if there is a lot of information in the case. An *induction* is concluding to what is *probable*, in contrast to a *deduction* which is concluding to what is *certain.* If the witness account has a lot of items in it, it would be exceedingly difficult for someone to invent a complicated scenario that is entirely consistent with the science and all the physical evidence in the case, especially if they do not know science or what all the physical evidence in the case is. Hardly anyone is that much of a mastermind, if anyone is at all. It takes only one false item out of many items in a witness account to make the witness account **not** consistent with the physical evidence (MT).

Still, if a forensic doctor plays an appropriate role in the courtroom, explaining to a judge or jury what is possible or consistent and what is impossible or not consistent according to science and the evidence, then the judge or jury has a better chance of learning the truth after they hear the entire case.

On the other hand, if the forensic doctor acts like Sherlock Holmes by reasoning backwards — by surmising past events from physical evidence — then the logical process of the courtroom proceeding becomes derailed.

The second half of the IT states, "…but one cannot reliably surmise past events from physical evidence unless there is only one plausible explanation for that evidence." Building a theory for past events from physical evidence involves the *invalid* deductive argument form known as the *fallacy of affirming the consequent* (AC). AC is the converse or reverse of MP. It looks like this with symbolic notation:

$\boldsymbol{q}$

$\boldsymbol{p} \rightarrow \boldsymbol{q}$

~~$\therefore \boldsymbol{p}$~~

The strikethrough above means that the conclusion is not valid. It is not a reliable conclusion even if the premises are true.

Here it is translated into English:

> Statement ***q*** is true. If statement ***p*** is true, then statement ***q*** should be true. Therefore, statement ***p*** is true (but this is not valid).
>
> The sum is four. If 1.25 is added to 2.75, then the sum should be four. Therefore, 1.25 is added to 2.75 (but this is not valid: two can also be added to two to get a sum of four, so can many other combinations of numbers).

I open my hand and see that the beans are white. If I reached into a bag with all white beans and grabbed some beans, then the beans in my hand should be white. Therefore, I reached into a bag with all white beans and grabbed some beans (but this is not valid: there may be many different reasons why my hand may have white beans; reaching into a bag with all white beans is not necessarily what happened).

The physical evidence in this case is entirely true (because the forensic doctor saw it with her own eyes). If her theory of what happened is correct, then the theory should be consistent with the physical evidence in this case (doctors try to invent theories that are consistent with the physical evidence). Therefore, her theory of what happened is correct (but this is not valid: there may be many theories that could be consistent with the physical evidence in any case, including the train of events that she did not learn that was described by witnesses).

If you look carefully at the argument form of AC, you will see that ***p*** was not offered independently by someone other than the scientist as a premise but was offered by the scientist as a hypothesis (***p*** → ***q***) **after learning *q*.** The antecedent ***p*** offered in the hypothesis is not based on an independent witness account but is simply the invention of the doctor who observed ***q*.**

You might think that AC does not have much going for it, but it would be a mistake to think that AC is bad. Even though AC is a deductive fallacy, it still may be useful as an *induction* — for drawing conclusions that may be probable even if they are not certain. Without AC, we would not have any scientific discovery, nor would we have medical care. Scientists and clinical doctors have to offer hypotheses ($\boldsymbol{p} \rightarrow \boldsymbol{q}$) after observing something startling ($\boldsymbol{q}$) that may be the result of something else ($\boldsymbol{p}$). AC is a part of the time-honored scientific method, and it is the diagnosis part of the diagnostic and treatment approach of clinical medicine. Also, investigators and doctors in law enforcement and death investigative agencies need to float hypotheses in order to develop leads in an investigation. Law enforcement officers and forensic doctors affirm the consequent all the time in an investigation, and this is fine.

But AC turns into a disaster when doctors use it on the witness stand to *affirm the consequent for complex past events* (ACCPE). By the time the case is offered in a court of law, the investigation has been completed. At that point, it is no longer appropriate or even allowed for forensic doctors to float hypotheses as opinions made to a "reasonable degree of medical certainty" — the requirement for medical testimony stated by the courts. Hypotheses about complex past events — a succession of even as few as two events — are highly unlikely to be true, as I have demonstrated multiple times throughout this book. Claiming to be certain of such hypotheses is disastrous and unjust.

With AC, there are exceptions that makes it deductively valid. One of those is mentioned in the IT with the phrase, "…unless there is only one plausible explanation for that evidence." This is known as the *biconditional* or the *if and only if* exception to the fallacy of affirming the consequent. It looks like this:

$\boldsymbol{q}$

$\boldsymbol{p} \leftrightarrow \boldsymbol{q}$

$\therefore \boldsymbol{p}$

Although a conditional arrow could be thought of as a "one-way street," the biconditional arrow allows travel in both directions. The statement, $\boldsymbol{p} \leftrightarrow \boldsymbol{q}$, means in English, "if statement ***p*** is true, then statement ***q*** is true AND if statement ***q*** is true, then statement ***p*** is true." In other words, "statement ***p*** is true *if and only if* statement ***q*** is true."

A biconditional arrow is like an equal sign in mathematics because with an equal sign, you can switch left and right numbers in a balanced way on either side of the equal sign. Notice the word, *only*, in the phrase, *if and only if*. This is like, "…unless there is *only one* plausible explanation."

Here is an example used previously in this book.

$$2 + \_\_ = 4$$

> If the blank in two plus blank is two, then the sum is four, AND if the sum is four, then the blank in two plus blank is two. In other words, the blank in two plus blank is two *if and only if* the sum is four.

The use of the biconditional exception to AC in a court case can be thought of in the same way as the simple equation above: If all the events leading to and away from the criminal incident are witnessed, and if all the physical evidence is studied, then the *single* criminal event that is not witnessed may be the only explanation. Such a case is a *circumstantial evidence* case.

Proving something to be the only explanation is a heavy burden of proof because considerable work has to go into an investigation to declare something finally as the only explanation, but if such a feat is accomplished by the state or other government in bringing a case before a jury, they could argue the truth of it "beyond a reasonable doubt." Still, such a situation even falls short of certainty in most cases. Why? Because we don't know what we don't know: there may be other information out there that could change the case entirely.

The IT recognizes this by using the word, *plausible*, between "only" and "explanation." Plausible means "seemingly probable." The level of probability may be unknown, but the item that is not witnessed seems probable — even to the point of being "beyond a reasonable doubt."

This is not the kind of conclusion for a forensic doctor to draw with certainty for several reasons. First, forensic doctors don't know what they don't know, so this already makes this kind of conclusion less than certain. Second, forensic doctors do not know everything about the case, even though they may know the information that involves them. The doctor should not draw "only plausible explanation" conclusions unless the doctor knows all that is known about the case. That never happens. Finally, twelve jurors get to apply this exception as an ultimate issue — not one or a few doctors. The ultimate issue is the decision that will put a person in jail or release them as not guilty. This is why instructions like "beyond a reasonable doubt" are instructions given to jurors for ultimate issue determination and not to scientific experts. "Beyond a reasonable doubt" instructions do not apply to scientific experts. "Beyond a reasonable doubt" implies what is plausible for truth after a consideration of **all** the facts as implied in the biconditional exception of the IT. Doctors are not expected to serve as the judge or jurors in the case or to weigh all the facts in a case as these people are expected to do for a final judgment. Frankly, forensic doctors should not be allowed to influence the jury in their ultimate decision with notions that are not fact based.

Finally, there is one more fallacy that is not directly mentioned in the IT but is referred to in this book. That is the *fallacy of denying the antecedent* (DA).

Even though AC may be useful, there is nothing about DA that is useful. The form of DA is the converse or reverse of MT:

$p \rightarrow q$

$\sim p$

~~$\therefore \sim q$~~

Here are examples in English:

If statement ***p*** is true, then statement ***q*** should be true. Statement ***p*** is not true. Therefore, statement ***q*** is not true (but this is not valid).

If two is added to two, then the sum should be four. Two is not added to two. Therefore, the sum is not four (but this is not valid: one and three are not two and two, but the sum of one and three is four).

If I reached into a bag with all white beans and grabbed some beans, then the beans in my hand should be white. I did not reach into a bag with all white beans and grab some of those beans. Therefore, the beans in my hand are not white (but this is not valid: not grabbing beans from a bag leads to who knows what?)

If the witness accounts of the past are entirely true, then the witness accounts should be consistent with the physical evidence from that case. The witness accounts are not entirely true. Therefore, the witness accounts are not consistent with the physical evidence from that case (but this is not valid: even

> though witness accounts may not be entirely true, those accounts may still be consistent with the physical evidence).

In the chapter entitled, “Good Cop, Bad Cop,” I discussed what happens when law enforcement officers or forensic doctors *presume negatively* — by considering someone at the outset of an interrogation as a criminal, by presuming guilt rather than innocence. One of the 169 recommendations from the Goudge Inquiry mentioned in the chapter, The Perils of Pediatric Forensic Pathology, was to “think truth” rather than to “think dirty.” Negative presumptions lead to chaos, and there is nothing good that can be said about them.

Presuming someone to be innocent before proof of guilt — something that is expected of courts in the United States and some other countries — is not only fair but also logical. It is just as logical for law enforcement officers and forensic doctors to presume innocence as it is for the courts. To presume negatively at the outset of an investigation is to *deny the antecedent for complex past events* (DACPE). Too often, fallacies of logic used for complex past events — ACCPE and DACPE — are often used together by the good cop and the bad cop; when they are, they lead to disaster. Both law enforcement officers and forensic doctors hopefully will learn one day not to do either.