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The Scenario Theory about Evidence in Criminal Law

Anne Ruth Mackor and Peter J. van Koppen

1. Introduction

In this chapter we discuss the Dutch scenario theory,¹ as it was further developed by van Koppen and Mackor.² It is a theory about reasoning about evidence and proof in criminal cases which holds that people should construct, assess, and compare competing scenarios that can explain the evidence in a case. The scenario theory has been applied to many complex criminal cases in the Netherlands.³

2. The Story Model of Pennington and Hastie

The starting point of the scenario approach is psychological research into the ways people actually reason when they have to deal with a lot of evidence. Wagenaar, van Koppen, and Crombag specifically refer to Pennington's and Hastie's story model.⁴ Therefore, we start with an exposition of that model.⁵

The story model is a descriptive psychological theory about cognitive strategies that factfinders use to process trial information in order to take decisions about evidence and proof. Pennington and Hastie claim that factfinders typically use one central strategy, namely active story construction. In doing so, factfinders impose a narrative story organization on the trial information.⁶ Their model offers an analysis both of the structure of these stories and of the dynamics of the way in which people construct and reason about stories.

Stories consist of elements, which are called episodes. Episodes consist of specific elements, namely an initiating event, a psychological response, sometimes a goal, an action, and consequences. For example, the following episode is also a simple story: a husband has an argument with his wife (initiating event), which makes him angry (psychological response). Because he intends to hurt her (goal), he beats his wife (action), which causes her death (consequence). The example illustrates that episodes have a specific structure: the

¹ Van Koppen 2011; Wagenaar, van Koppen, and Crombag 1993.

² Van Koppen and Mackor 2020.

³ See also van Koppen 2003; van Koppen and Mackor 2020, for additional references. Also see the Project Reasonable Doubt (Project Gerede Twijfel) at VU University, Amsterdam, which is led by van Koppen. Available at <https://allp.nl/projectgeredetwijfel/> (Accessed: March 29, 2021).

⁴ Wagenaar, van Koppen, and Crombag 1993; van Koppen 2011; Pennington and Hastie 1992; 1993.

⁵ This section is an adaptation of Dahlman and Mackor 2019, §2.1.

⁶ Bennett and Feldman 2014; Pennington and Hastie 1992; 1993.

elements are chronologically ordered and partly connected through physical and mental causal relationships. Stories can be thought of as a hierarchy of episodes.⁷

Pennington and Hastie built their story model on sets of three: they argue that three kinds of knowledge are relevant, that there are three kinds of reasoning procedure, and that there are three certainty principles.

Factfinders construct stories by reasoning from *three kinds of knowledge*:

- (a) case-specific knowledge, i.e., evidence;
- (b) knowledge about similar events to infer facts and causal relationships; and
- (c) knowledge about what makes a story complete: viz —knowledge about the typical elements of stories, episodes, and their elements, and about the connections in and between episodes.⁸

Factfinders use the latter two to “fill out” a story.

Pennington and Hastie mention *three types of reasoning procedures* that factfinders use to establish intermediate and final conclusions:⁹

- (a) deductive reasoning from world knowledge;
- (b) reasoning from analogy to other—experienced and hypothetical—episodes; and
- (c) reasoning by evaluating alternative conclusions that contradict the initial conclusion.

Pennington and Hastie propose *three certainty principles* that factfinders use to assess stories, namely coverage, coherence, and uniqueness.¹⁰ These principles help a factfinder to determine how acceptable a story is for him and how confident he is about the truth of the story.

- (a) *Coverage* deals with the question to what extent the story explains the occurrence of the evidence. The greater the coverage, the more acceptable the story and the more confident the factfinder will be.
- (b) A story is *unique* if it is the only coherent story that can account for the evidence. If there is more than one coherent story, all stories are in principle acceptable, but confidence in each of them will diminish.
- (c) The third certainty principle, *coherence*, has three components: consistency, plausibility, and completeness.

Consistency is about two questions, namely (1) whether the story is consistent with evidence believed to be true, and (2) whether all of its elements are consistent with other parts of the story (internal consistency).

Plausibility deals with the question whether the story fits into the factfinder’s background or general world knowledge.

Completeness, finally, is about the question whether the structure of the story has all its parts, such as episodes, elements of episodes, and causal relationships in and between

⁷ Pennington and Hastie 1993.

⁸ *Ibid.*

⁹ *Ibid.*, 195.

¹⁰ *Ibid.*, 198–9.

episodes. Missing information and lack of plausible inferences makes a story incomplete and decreases confidence in the story. Pennington and Hastie argue that consistency, plausibility, and completeness can be fulfilled to a greater or lesser degree and that the values of the three components combine to yield the overall coherence of the story.

3. Scenarios, Subscenarios, and Background Knowledge

The scenario theory starts from the story model and offers a further explication of stories, called scenarios and subscenarios and background knowledge. Scenarios range from one simple proposition of how a crime may have taken place (“John shot George with a pistol”) to complex stories about what happened, who was involved and how things developed over time. Scenarios, however, are not fixed entities with a singular meaning. Scenarios get their meaning from background knowledge people have. Also, scenarios are holistic and tend to change and develop.

Consider the simple scenario: *John had dinner in a restaurant last night*. First, that scenario entails much more than just these eight words, because we interpret and adjust the story almost automatically with the background knowledge we have. That background knowledge consists of generalizations that are usually true. People know that John probably is a man. They also know that he probably was going to have his third meal of that day. People also understand what a restaurant is, what the typical routine is when you go there—either pick your own table or are seated by the staff, order a drink, receive the menu, pay afterwards, etc.—and that there are different price classes for restaurants. Actually, we could go on for some pages what almost automatically comes to mind when one hears that simple eight-word scenario. At the same time, people may also differ to small or sometimes great extent in their background knowledge and thus in the manner in which they understand the scenario.

The scenario also raises questions. An obvious one is: was John going to have dinner alone? Most people have dinner in a restaurant in the company of others. Some people may ask such questions, as typically a police officer would in a crime investigation.

Scenarios paint a picture of an occasion that is as complete as people need to know. Usually, we do not want to have information about the salt and pepper set on the table or the people seated at the next table, but that may become an issue if we question John about whether he really was at the restaurant.¹¹ So, scenarios vary in detailedness, depending on what the scenario is for. For checking John’s alibi, a very detailed scenario may be required.

Also, scenarios are dynamic and tend to change. If we learn that John is living in a very remote area without restaurants, we may want to have information about how John travelled to the restaurant. Or if we know that John always eats out with his wife but not this time, we may want to know what happened between them. Did they have a fight?

In summary, scenarios are to some extent empty vessels that are filled with background knowledge; scenarios are holistic in the sense that they cannot be equated with or reduced to the propositions that are explicitly formulated; and scenarios are dynamic, both in detailedness and in content. Much of a scenario and the interpretation of the scenario depends on common knowledge that people have, for instance, about John and about restaurants. However, people differ, slightly or extensively, in their background knowledge. Thus,

¹¹ See for an example, Strömwall, Granhag, and Jonsson 2003.

discussing scenarios and interpreting scenarios is also a social process. That also holds for topics we will discuss later, as, for instance, testing scenarios against each other and interpreting evidence and proof.

The scenario theory is typically illustrated with Figure 15.1.¹² It shows that in the end the chain of subscenarios is anchored in general background knowledge. It should be noted that background knowledge is relevant at every level: sometimes as a direct test of an unlikely scenario; always to understand scenarios; and always to understand whether and how a subscenario supports a superior scenario. Accordingly, knowledge of the world should not be perceived, as Figure 15.1 might suggest, as a “rock bottom” but rather as an ocean or a huge cloud in which scenarios and subscenarios are floating.

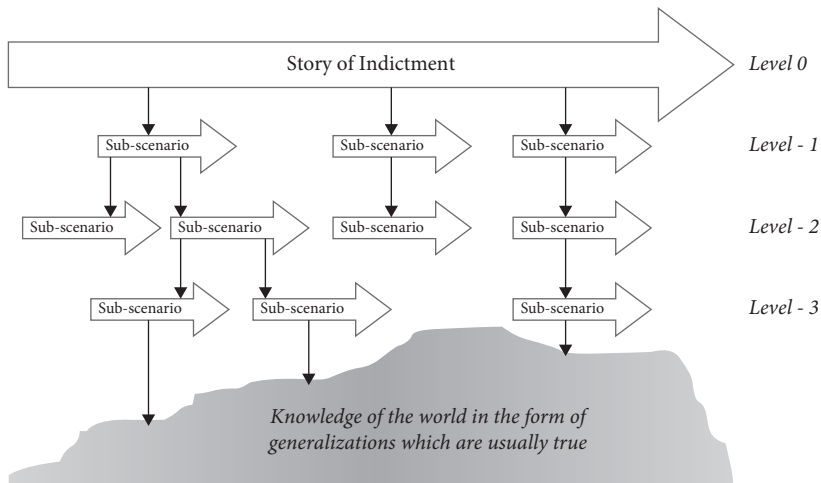


Figure 15.1 Reasoning within scenario and from scenario to evidence.

Figure 15.1 also shows that subscenarios are always the answer to the question why the indictment should be believed. For instance, if the story of the indictment is that John shot George with a pistol, and one piece of evidence may be that his fingerprint was found on the murder weapon. That answer to the question why the indictment should be believed is also a scenario, that we call a subscenario. It tells the story of the forensic detective who secured the gun at the crime scene, dusted it for fingerprints, and compared these to the one taken from John at the police station. And another subscenario is the story of the forensic detective who compared bullets from test shots with the pistol to the bullet secured from the head of the victim. And, again, these subscenarios can be probed in turn with the question why we should believe the fingerprint expert or the bullet expert. The answer will be a sub-subscenario.

The normative scenario approach instructs factfinders to keep scenarios and the evidence that is explained by a scenario separate. A scenario should not overlap with the subscenario supporting the scenario. In practice, however, people often make subscenarios

¹² This is a slightly adapted version of the figure in van Koppen 2011 and van Koppen and Mackor 2020.

part of their scenario. For example, when a man is prosecuted for killing his wife and there is evidence that they had marital problems, many people would include marital problems in the main scenario. However, the fact that they had marital problems is a piece of evidence for the hypothesis that the defendant had a motive to kill his wife. Therefore, the marital problems are part of a subscenario. On this point the normative scenario approach diverges from the descriptive theory.¹³

For these subscenarios the same holds as for the main scenario: we fill it or amend with our background knowledge of the world. We can readily accept the subscenarios, if we use the generalization that most experts can be relied on most of the time. But of course, that answer can be disputed. The questioning can go on indefinitely, in principle. But somewhere it ends. Sometimes it does because one of the participants to the trial is unaware of potential problems with evidence. Good examples are fingerprints, that have more problems than most jurists are aware of,¹⁴ and bullet comparison, that has likewise problems.¹⁵ Sometimes the probing ends because trial participants agree on the generalizations in which the evidence is anchored. And there are also practical reasons: one cannot go on forever.

Background knowledge in the form of generalizations plays an important role in the scenario theory. First, it gives meaning to scenarios because we interpret the statements by means of background knowledge—like about John and about restaurants in the example given earlier. Such is usually an automatic process that is done without discussion. Only if people differ in their background knowledge, it may become explicit and a subject of discussion.

Background knowledge is also the stuff in which the meaning and acceptance of evidence is rooted; sometimes without much ado, sometimes after a long probe into subscenarios.

Background knowledge is also sometimes a direct test of scenarios. If a scenario holds that the same individual was in one place at noon and in a place 1,000 km away at 12:30, the scenario can be dismissed as extremely implausible or impossible, because we know there is no way to cross 1,000 km in half an hour.

4. Inference to the Best Explanation

Whereas the story model and the use of scenarios is distinctive of the scenario theory, inference to the best explanation (IBE) is at the core of all explanation-based approaches such as Allen and Pardo's relative plausibility theory, Amaya's theory of inference to the most coherent explanation, Josephson's theory of abductive inference and the scenario theory.¹⁶ IBE was not explicitly mentioned in earlier versions of the scenario theory, but the central role of IBE has been emphasized in recent articles.¹⁷

Inference to the best explanation is a specific kind of abductive reasoning which is used in everyday reasoning, law, and philosophy, and also in science. It is distinguished from

¹³ Also see van Koppen and Mackor 2020.

¹⁴ Thompson, Black, Jain, and Kadane 2017.

¹⁵ Executive Office of the President's Council of Advisors on Science and Technology 2016.

¹⁶ See Allen and Pardo 2019; Amaya 2009; Josephson 2000. IBE is also part of the descriptive story model: Pennington and Hastie state that one reasoning strategy that factfinders use is to evaluate alternate conclusions that contradict the initial conclusion.

¹⁷ Also see van Koppen and Mackor 2020; Mackor, Jellema, and van Koppen 2021.

deductive and inductive reasoning. We compare and contrast deduction, induction, abduction, and IBE by means of examples:

Deduction

All A's are B's

x is an A

Therefore, x is a B

Induction

Most A's are B's

x is an A

Therefore, probably x is a B

Abduction

F is a (surprising) fact

H explains F

Therefore, we have reason to believe that H *might be* true

Or: Therefore, we have reason to believe that H *is* true

IBE

F is a (surprising) fact

H explains F

No other hypothesis explains F as well as H does

Therefore, we have reason to believe that H *might be* true

Or: Therefore, we have reason to believe that H *is* true

The distinction between the two conclusions of abduction and IBE, “might be true” versus “is true” relates to the distinction between the context of discovery and the context of justification. Factfinders can apply IBE in the investigative phase, in the context of discovery, but also in the context of justification, in the final stage when they have to decide whether the charges have been proven. In the context of discovery, factfinders can only conclude that they have reason to believe that H might be true, but typically they should make further investigations before they can conclude that they have reason to believe that H is true. Only after they have made these further investigations, factfinders can, in the context of justification, conclude that they have reason to believe that H is true.

Two caveats about the application of IBE in criminal cases. First, in criminal law, the fact that factfinders have reason to believe that a scenario is true is in itself not sufficient for a conviction. Conviction is possible only if the criminal act is proven beyond a reasonable doubt. Thus, there is an asymmetry between “proven” and “not proven” scenarios in that the best “proven” scenario does not always allow the judge or jury to conclude that the charges have been proven. Only if the prosecution succeeds in proving that the scenario in which the defendant committed the act is much better than all other reasonable

alternative scenarios and, moreover, that it can proven beyond a reasonable doubt, factfinders are allowed to conclude that the defendant committed the criminal act).¹⁸ Second, often the terms “guilt scenario” and “innocence scenario” are used. This terminology is not correct since the decision about guilt is a separate step to be taken only after the decision about the proof of the facts. Here, we are only concerned with the decision about whether the defendant committed the alleged act and not yet about the further questions whether the act is punishable and whether the defendant is guilty.

The main difference between deduction on the one hand and induction, abduction, and IBE on the other is that the latter are ampliative, that is that the conclusion goes beyond what is logically contained in the premises. The difference between induction on the one hand and abduction and IBE on the other is that in the former there is only an appeal to statistics whereas in the latter there can be an appeal to statistics, but there is always an appeal to explanatory considerations.¹⁹ The difference between abduction and IBE, finally, is that in the latter there is an explicit consideration of alternative explanations.

Abduction and IBE are both a form of indirect and explanatory reasoning. They can be contrasted with direct and evidential reasoning. In *evidential* reasoning, one reasons *directly* from the evidence to the (probable) truth of the hypothesis. In *explanatory* reasoning one first reasons from the hypothesis to the evidence and only then (and therefore the qualification *indirect* is used) from the evidence to the hypothesis. We illustrate the distinction by means of an example. We start with an example of *direct evidential reasoning*: a witness states that A and B had an argument. Therefore, we have reason to believe that the hypothesis that A and B had an argument is true. *Indirect and explanatory reasoning* would go as follows: a witness testifies that A and B had an argument. The hypothesis that A and B had an argument, explains that the witness testified what he testified and no other hypothesis (such as: the witness lied, misremembered, or misinterpreted the situation) explains that the witness testified what he testified as well as the hypothesis that A and B in fact had an argument. Therefore, we conclude that we have reason to believe that the hypothesis is true.²⁰

The scenario theory holds that factfinders must use indirect explanatory reasoning, both to explain the elements of the scenario and to explain the evidence that is presented for the scenario. In that respect, the scenario theory differs from argumentative approaches, according to which factfinders should use direct evidential reasoning, and also, for example, from Bex’ hybrid scenario-argumentative theory, according to which factfinders should use indirect causal explanatory reasoning in the relation between the elements, but direct evidential reasoning in the relation between the elements and the evidence.²¹

The scenario theory holds that in criminal cases explanations should be structured as scenarios consisting of episodes with the elements described by the story model, such as an initiating event, psychological response, goal, action, and consequences. In that manner IBE and the story model are combined. First, the elements take the form of hypotheses that

¹⁸ See Stoffelmayr and Diamond 2000. Laudan 2007 has argued that IBE cannot be used to model the standard of proof in criminal law. See Jellema 2020 for a recent rebuttal.

¹⁹ Douven 2017.

²⁰ Again, we should distinguish between context of discovery and the context of justification. For the former context, the “is” should be read as “might.”

²¹ Bex 2011.

together make up a scenario, analogously to how scientific hypotheses together make up a scientific theory. Since in a good scenario the elements are chronologically ordered and partially causally connected, they are not a random bunch of hypotheses, but form a more or less coherent whole, a holistic story about what may have happened.

Second, the scenario theory instructs factfinders to look for causal explanations. Within the scenario, the initiating conditions should offer a causal explanation of the psychological response which in turn should explain the goal and the action which in turn should explain the consequences. Since the elements are partially causally connected, factfinders can apply IBE to the relationship between the elements within scenarios. This line of reasoning is illustrated by means of Figure 15.2. The boxes are elements, i.e., hypotheses about what has happened, and the arrows depict chronological and causal explanatory relations.



Figure 15.2 causal explanatory reasoning with elements (hypotheses) within a scenario

Above we have seen that it seems quite natural to argue directly from the evidence to the hypothesis. For example, if the scenario hypothesizes that A and B had an argument (initiating event) which angered A (psychological response), it seems natural to reason directly from the evidence to the scenario. For example, if a witness states that he overheard that A and B had an argument and that he saw that A got angry we infer that the elements of the scenario are true. That is what both the argumentative approach and Bex' hybrid theory instruct factfinders to do.

The scenario theory, however, holds that factfinders have to apply IBE to the relation between the elements of the scenario and the evidence too. They should not ask whether the testimony is evidence for the scenario but rather whether the scenario can explain the testimony. In conclusion, the scenario theory instructs factfinders to apply IBE both to the relation between the elements within a scenario and to the relation between elements of the scenario and the subscenarios.

5. Popper's Falsificationism

We have seen that IBE instructs factfinders to construct and compare different explanations of the evidence at hand. It does not tell us, however, how to put the scenarios to the test. The normative scenario theory is emphatically Popperian in nature in that it holds that factfinders should not, or at least not only, look for evidence that confirms their scenario, but instead actively search for evidence that falsifies it.²²

In emphasizing the importance of attempts to falsify scenarios by putting scenarios to the test, the normative scenario theory diverges from the descriptive story model, since people are inclined to confirm, not to falsify. That is exemplified by a phenomenon like

²² Van Koppen 2011.

confirmation bias: the general human tendency to overrate information that confirms their favorite ideas and underrate information that point to the opposite.²³ As a counterweight to these biases, the scenario theory holds that factfinders should search for evidence that falsifies the scenarios under investigation. Only if a scenario has survived serious attempts to falsification (in the context of discovery), factfinders have reason to accept the scenario as true (in the context of justification).

One way to put scenarios to the test, is to derive predictions from the scenarios under investigation and thereby to also explicitly consider what kind of evidence would falsify the scenarios. Or better put: the task of a factfinder is to decide what evidence would best discriminate one scenario from the other. Does, for instance, the prosecution's scenario better predict the evidence than the defense's scenario? If the prosecution's scenario does so, it can be concluded that the prosecution's scenario is a better story than the alternative scenario. Below we discuss in more detail the difference between evidence that strongly discriminates between the scenarios and evidence that gives a weaker test of the one scenario against the other.

Accordingly, the most important instruction that follows from Popper's falsificationist theory is: seriously attempt to falsify your scenarios, by actively searching for evidence that contradicts the scenario and by formulating predictions that follow from the scenarios under consideration and seriously investigating them.

It should be noted that if the core elements of a scenario have been falsified, there is no need for inference to the best explanation. If, for instance, there is evidence that the alleged victim of a murder is still alive, such evidence is detrimental to the prosecution's case. In such a simple case, we need not apply IBE. In that case, direct and deductive reasoning from the evidence to the falsification of the scenario suffices.

Falsification

There is ample evidence that the victim is alive.

The scenario that the victim was killed is false.

6. Creation, Accommodation, Prediction

We have already stated that the scenario theory is applicable in the context of justification when factfinders have to decide whether it is rational to conclude that the criminal act is proven, but also in investigative phases.

Normally, an investigation into a criminal case starts with some piece of evidence, for example, a broken window and a laptop missing from a house. The first hypothesis, in the context of discovery, might be that a burglary took place. Perhaps a suspect, a person carrying burglar tools, was arrested nearby. The first, still incomplete, scenario that police officers create may be that the burglar broke the window and took the laptop. In the next phase, hopefully more evidence can be gathered, perhaps a drop of blood on a piece of glass, footprints in the garden or a fingerprint on the window frame. When further evidence is discovered, the initial scenario will normally have to be accommodated to fit the new evidence and alternative scenarios will be created and accommodated too.

²³ Kahneman, Slovic, and Tversky 1982; Nickerson 1998.

A sufficiently detailed scenario which chronologically orders and, at least partially, causally connects the elements allows factfinders to predict facts, analogous to how scientific theories allow scientists to make detailed and sometimes risky scientific predictions. That is in line with Popper's falsificationist instructions to search for falsification instead of (only) confirmation of one's theory we discussed earlier.

When a factfinder has to decide, in the context of justification, whether the criminal fact has been proven beyond a reasonable doubt, it seems relevant to know whether first the evidence was gathered and then a scenario was constructed, or the scenario was constructed before most of the evidence was gathered. If a scenario is constructed after the facts, it is likely to offer a neat explanation of those facts.

That is what sometimes happens when a defendant who first invokes his right to remain silent and only much later, having knowledge of all the evidence, presents a more or less plausible scenario that more or less neatly explains the evidence.²⁴ In contrast stands the defendant who at the very first interrogation, before he knows about the evidence that has already been gathered, offers a detailed statement about what has happened.²⁵ The police can use his statement as the basis for an alternative scenario and search for evidence that falsifies or confirms it. Confirmation of the statement can sometimes be interpreted as evidence for the validity of statements by defendants and witnesses. The analysis also holds for the scenario of the prosecution.

We end with two brief remarks about predictions. First, the status of predictions as superior over accommodations is still hotly debated in the philosophy of science.²⁶ There is, however, some agreement that confirmed predictions are not intrinsically superior to accommodations, but that testing theories by making predictions offers factfinders some protection against biases.²⁷ Therewith, or so it is argued, confirmed predictions can make conclusions more reliable and robust.²⁸

Second, if predictions are epistemically superior to accommodations, this confronts us with the question which role they can play in criminal cases. If a scenario was tested through predictions, should evidence that was predicted receive more weight than evidence to which the scenario had to be accommodated? Even if that is epistemically defensible, how does it relate to defendant's fundamental right to remain silent?²⁹ The most important instruction that follows from the role that predictions can play in the scenario theory is that evidence should be given especially careful consideration if it was predicted rather than accommodated.

7. Discriminating Facts and the Likelihood Ratio

In hard cases, not all of the scenarios under consideration can be straightforwardly falsified. At most it can be said that one scenario offers a better explanation of the evidence than the

²⁴ See Mackor 2017 for a discussion of a Dutch case.

²⁵ See the case discussed in van Koppen and Mackor 2020.

²⁶ See, e.g., Harker 2008.

²⁷ See Peter Lipton, *Testing Hypotheses: Prediction and Prejudice*, *Science* 307 (14 January 2005), pp 219–21..

²⁸ More on robustness in Section 9 in this chapter.

²⁹ Van Koppen and Mackor 2020; Mackor 2017.

other scenarios. The scenario theory calls a piece of evidence that one scenario can explain better than the others a discriminating fact. The better the explanation, the stronger the discrimination. If, for instance, an alternative scenario entails that that defendant was at home at the time of the crime, but a witness testifies that he saw him nearby the place of the crime around that time, that piece of evidence discriminates between the prosecution and the defense scenarios. Of course, the more the testimony of the witness can be trusted, the more it supports the prosecution's scenario. Things are different, of course, if the defense can demonstrate that the witness is mistaken or lying.

Whether evidence discriminates between scenarios depends on the specific scenarios under consideration. If in the example just given, the defendant claims that he visited a friend who happens to live near the place of the crime, the same witness statement becomes less relevant and thus less discriminating between the two scenarios.

This talk of discriminating facts sounds a lot like the likelihood ratio.³⁰ Bayesians might want to translate the two examples as follows.

$$p(E|H_{\text{-crime}}) : p(E|H_{\text{-home}}) > 1$$

$$p(E|H_{\text{-crime}}) : p(E|H_{\text{-friend}}) = 1$$

Adherents to the scenario theory have different views on the compatibility of the scenario theory and Bayesian approaches.³¹ Most adherents do not object to this translation per se, but they state it comes with a loss. First, it should be noted that the causal explanatory vocabulary of scenarios is richer than the probabilistic vocabulary.³² Even if, in the end, the goal of factfinders is to estimate the likelihood and the likelihood ratio, it seems they first need to look for a causal explanation to be able to estimate the numbers of this ratio.

A second and more fundamental objection to such a translation is that the scenario theory is holistic in nature. As the example shows, the scenario theory does allow the factfinder to zoom in and offer "atomistic" analyses of the elements of a scenario. However, it is impossible to assess and compare all the different elements and their relations in this manner. On the scenario theory, scenarios are more than argumentative schemas or Bayesian networks and they cannot be reduced to these scenarios without loss of meaning.

Again, we see a similarity with scientific theories. Both scenarios and scientific theories are a coherent set of interlinked hypotheses. A core job of scientists is to test individual hypotheses, but they also assess the quality of a theory as a whole. The latter assessment, however, is often formulated much less precisely in terms of epistemic virtues such as simplicity, consilience, and analogy.³³ In part it has to do with the fact that scientists do not only assess scientific theories in terms of what they have achieved so far, but also in terms of their future potential. Similarly, in the investigative phase of a criminal case factfinders should take the potential of a scenario into account, but when factfinders finally have to decide about a case, they should only look at what the scenarios have achieved. However, even if we

³⁰ Mackor (in press).

³¹ See Mackor, Jellema, and van Koppen (2021) for a more extensive discussion.

³² Pearl and Mackenzie 2018.

³³ Thagard 1978.

take the distinction into account between the potential of a scenario and what it has actually delivered, it is not always clear how to assess and compare the achievements of either scientific theories or scenarios: one theory or scenario might be better in one respect, whereas an alternative does better in other respects.

8. A Critical Assessment of the “Certainty Principles” of the Story Model

Since IBE is at the heart of the scenario theory, the scenario theory too is confronted with the critical question: what makes an explanation, in the form of the overall scenario, good? When is a scenario “better” than all other reasonable scenarios? Bayesians add to that the question: what makes a scenario better than the others if it is not its probability? We have just seen that the notion of discriminating facts can be translated—with loss of meaning—in the likelihood ratio.

Accordingly, the question is whether the same holds for other notions of the scenario theory. For example, can epistemic virtues be translated in probabilistic terms?³⁴ According to the story model, factfinders use the “certainty principles” coverage, uniqueness, and coherence (consistency, plausibility, completeness) to assess and compare stories. Van Koppen and Mackor have argued that factfinders not only actually do, but also should, use these principles.³⁵ In this chapter, we offer a more critical view of the criteria of consistency and plausibility and we now stress the importance of robustness as a criterion. Let us in turn discuss the criteria.

The criterion of *coverage* states that factfinders should assess whether a scenario can explain all of the evidence in a case. A scenario that can explain all of the evidence is better than a scenario that has story gaps and thus does not explain all of the evidence. A fortiori, a scenario which explains all of the evidence is better than a scenario that is inconsistent with, that is falsified by, the evidence. Please note that in most criminal cases, elements of what happened remain obscured or simple unknown. Factfinders, thus, are used to dealing with and accepting story gaps.

The criterion of *uniqueness*, the question of how many scenarios can explain the evidence, takes us to the question of how many scenarios factfinders should compare. The scenario theory does not hold that factfinders should compare all scenarios, since that is not only practically but also theoretically impossible. Factfinders only have to compare “reasonable” scenarios, scenarios that by and large seem to fit the criteria of coverage and coherence.³⁶ However, since factfinders do not and cannot compare all possible scenarios, they run the risk of choosing from a “bad lot.”³⁷ They can be accused of irrationality if their comparison is not restricted to a set of scenarios that together are both exclusive and exhaustive. However, in a criminal trial, there is seldom systematic analysis of all possible or reasonable scenarios. What is proposed by the defense and by the prosecution is also part of their trial strategy.

³⁴ Cabrera distinguishes between informational virtues (the potential of a theory or scenario) and confirmational virtues (what it has “delivered”); Cabrera 2017).

³⁵ Van Koppen 2011; van Koppen and Mackor 2020.

³⁶ Crombag and Wagenaar 2000.

³⁷ Van Fraassen 1989.

Moreover, the criterion of uniqueness does not offer guidance to assess how much confidence should diminish if there is more than one reasonable scenario. Should confidence diminish only in relation to the scenarios under consideration, or should factfinders also distribute some confidence over unconsidered scenarios? Again, the question is also whether their confidence can and should be translated in probabilistic terms.

Since a scenario in its ideal form is a set of chronologically ordered and partially causally connected elements, *completeness* of the scenario is an important criterion to assess its quality. For example, if a scenario does not contain one or more of the elements it is incomplete. By putting fairly strict constraints on the structure of a good scenario, completeness is one of the criteria that distinguishes the scenario theory from other explanation-based theories.

Sometimes it is said that the emphasis on *coherence and consistency* is a serious weakness of the scenario theory, since people are inclined to believe a coherent but false story over a true but incoherent story.³⁸ However, this objection can easily be rebutted. Both on the story model and on the scenario theory it is not sufficient for a scenario to be internally consistent; it must also be consistent with the evidence of the case and with general background knowledge. Pennington and Hastie call the consistency of the scenario with background knowledge plausibility. Moreover, we have stated that the scenario theory emphasizes that serious attempts must be made, not (only) to confirm scenarios, but also to falsify them.

However, there is a more serious objection to coherence and consistency as criteria. First it should be noted that consistency is a formal and much less demanding criterion than IBE's criterion. IBE does not demand consistency, it demands that a hypothesis can explain an item, whether that item is a piece of evidence or another hypothesis. Again, we note that the causal explanatory vocabulary is much richer, not only than that of probability, but also than the vocabulary of logical consistency.

Another objection to the criterion of explanatory coherence is that it is merely a sloppy formulation of a probability criterion.³⁹ For example, it is unclear whether and how the assessment of plausibility—the consistency of a scenario with background knowledge—differs from an assessment of the prior probability of a scenario. The same holds for the criterion of consistency of a scenario with the evidence which seems to be an imprecise formulation of the likelihood ratio. Finally, this critique also holds for the criterion of internal consistency of a scenario, for what we want from a scenario is not merely internal consistency, but a proper chronological ordering and causal explanatory relations between the different elements within the scenario.

9. Robustness: The Importance of Alternative Scenarios and Falsification

The scenario theory agrees with the story model that coverage and completeness are important criteria to assess the quality of scenarios, whereas uniqueness, consistency, and plausibility seem a shorthand for a test of the quality of causal explanatory relations.

³⁸ A true story can be incoherent, among others, because it has story gaps, or because it is inconsistent with background knowledge.

³⁹ Dahlman and Mackor 2019.

The scenario theory adds robustness as a major “certainty principle” to the certainty principles of the story model. Robustness should function as a counterweight to biases such as the confirmation bias we discussed earlier. Robustness has been defined in different ways.⁴⁰ We focus on the definition according to which a scenario is robust when evidence for it is robust, that is, when the scenario has been confirmed in multiple and independent ways. Robustness has been defined as the extent to which different pieces of evidence: (1) are independent of each other and (2) have been established by different methods, but also as the extent to which the evidence (3) discriminates between scenarios and thus allows for elimination of alternative scenarios.⁴¹

An important problem in (criminal) law is that often there is little evidence and that part of the evidence has been used to create the scenario. Moreover, the evidence is not always independent, and often the evidence partly conflicts. Therefore, findings in criminal law are not always robust enough to allow for strong support for a scenario.

In our view, robustness does not only have to do with the robustness of the evidence and the scenarios that have been presented. Robustness is primarily an assessment of the quality of the search for evidence and possible alternative scenarios. In addition to the three criteria already mentioned, robustness is about the thoroughness of the search, among others via prediction, for (4) evidence and (5) counterevidence. Next to that robustness is also the criterion with which we assess the thoroughness of the search (6) for alternative scenarios, therewith trying to diminish the risk that factfinders make a choice from a bad lot. Robustness in this sense demands that factfinders seriously think about, construct, and investigate reasonable alternative scenarios, compare their “favored” scenario to these scenarios and make serious attempts to falsify the scenarios by predicting and searching for discriminating facts. Only then, factfinders not only have reason to believe that a particular scenario *might be* true, but also that the scenario *is* true.

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⁴⁰ Calcott 2011; Woodward 2006.

⁴¹ Schubach 2018.

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