Analyzing Stories Using Schemes
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1 Introduction

Since the early nineteen eighties stories, or sequences of states and events, play an important part in theories on how judges, jurors or police investigators reason with the evidence in criminal cases. Authors such as Bennett and Feldman (1981) and Pennington and Hastie (1986, 1993) argue that decision making in criminal cases is done by constructing stories about 'what happened' using the evidence in the case and then comparing these stories, thus trying to find the best story, that is, the story which is accepted as most probable. A good story should not only be supported by evidential data (e.g. testimonies, forensic data) but it should also be well-structured and plausible; a well-structured story is built in such a way that is easily understandable and a plausible story correctly describes a general pattern of states and events one expects to come across in the world. Crombag et al. (1993, 1994) also argued that a well-structured and plausible story is important in judicial decision making. However, they also found that in many cases a good or plausible story which is insufficiently supported by evidence wins over a bad or implausible story which is supported by evidence. To overcome this problem, Crombag et al. proposed their anchored narratives theory (ANT), according to which a story should be sufficiently anchored in reality using safe generalizations[1]. This anchoring of stories in reality also plays an important part in the investigative phase of a case (de Poot et al. 2004), where stories serve as guidelines in the search for new evidence. Twining (1999) and Anderson, Schum and Twining (2005) maintain that stories are psychologically necessary in the determination of the facts of a case, in that a story is used to organize and present the evidence in such a way that it is easily understandable. Like Crombag et al., they point to the dangers of stories and develop a simple protocol for analysing the plausibility and evidential support of stories.

In sum, the main idea in the research of the last decades seems to be that while stories play an important part in evidential reasoning, one should be wary of the dangers involved in reasoning with stories: in Twining's (1999) words, stories are 'necessary but dangerous'. In order to overcome the danger of a good story pushing out a true story, stories have to be critically analysed – both the plausibility (whether or not the story conforms to safe general knowledge about the world around us) and the evidential support (whether or not the story conforms to the specific evidential data in the case at hand) are important to consider.

Pennington and Hastie as well as Anderson et al. agree that these two aspects of stories, plausibility and evidential support, can be tested and analysed separately. Crombag et al. make a less clear distinction between these two aspects but they mention two types of generalizations in which stories can be anchored. Of the first type are generalizations which point to the plausibility of the story irrespective of the evidential data in the case; these generalizations can be causal generalizations, which are about the chain of events in the main

[1] Generalizations are general 'rules' about how we think the world around us works (Anderson et al. 2005). They can be based on empirical research but they can also be drawn from everyday experience. Not all of these generalizations are safe as they can be based on prejudices and dubious ideas about the world. Examples of generalizations are 'coroners can usually determine for how long someone has been dead', 'witnesses under oath usually speak the truth' and 'people from Suriname are more prone to becoming involved in crime than Dutch people'.

story itself, or other generalizations which cover the point of the story or a specific event in the story. Of the second type are evidential generalizations, which link a story to the available evidence. Bex, Prakken and Verheij (2006, 2007) have clarified this distinction between the two types of generalizations and argued that a story's plausibility can be analysed by looking at the causal generalizations in the story itself while the evidential support can be analysed by looking at the evidential generalizations linking the sources of evidence to the story. However, the causal links between the events in a story are not always explicit so it is not always possible to immediately analyze the causal generalizations in the story. In its most basic form a story is a sequence of events which are ordered in time and thus the only relations between the events are temporal. In such a case, where the causal relations between the events are not explicitly mentioned, these generalizations will have to be made explicit and/or other ways will have to be found to analyze the story's plausibility.

Pennington and Hastie argue that a story's plausibility also depends on the extent that it conforms to what they call an *episode scheme*. This idea of an episode scheme is based on the idea of a script or explanation pattern. Schank and Abelson (1977; Schank 1986) argue that knowledge about the world can be expressed as a script or explanation pattern, which specifies the elements a typical story has. A scheme can be abstract or more specific; for example, a scheme for 'intentional actions' specifies a pattern of event types that a typical story about some intentional action contains and a 'restaurant' scheme describes a pattern of events that a typical story about a visit to a restaurant contains (e.g. ordering, eating, paying). The relations between the events in a story scheme can be causal but a very basic story scheme does not contain causal information so it can be used to asses stories which do not contain causal information. Furthermore, a story scheme can also help to make the implicit causal relations in a story clearer; if a simple, temporally ordered story fits the sequence of a story scheme then the causal relations between the events in the story are also based on the causal generalizations in the scheme.

The aim of this article is to investigate the notion of *story schemes*, a pattern of events or event types similar to the episode scheme or explanation patterns. Story schemes, their structure and features, will be modelled in a semi-formal way and it will be examined how these schemes can be useful in the analysis of stories. The similarities and differences between the notion of story schemes and my previous work (Bex et al. 2006; 2007) will be discussed, and I will also add two simple but not trivial operations to the framework from (Bex et al. 2007).

While this article does not concentrate on the specific roles story schemes and an analysis using these schemes can play in reasoning about evidence, some ideas about the possible roles of story schemes in different contexts will also be briefly discussed.

Because of the important role the plausibility of stories plays in reasoning with evidence, this article is devoted to analyzing and assessing this plausibility. The plausibility of a story can be determined irrespective of the evidence in a case; as was argued before, plausibility and evidential support are different aspects of a story. However, this does not mean that I consider the evidential support of a story and the analysis of this evidential support unimportant; when reasoning with evidence in a criminal case, the evidential support of a story is the most important part, as we do not want good stories that have little or no evidential support to win over bad stories that have more evidential support. In our previous work (Bex et al. 2006, 2007), which will be briefly summarized in section 2, we already

extensively discussed how evidence can support a story through evidential generalizations, how these generalizations can be tested and how the evidence can influence the choice between different stories.

The rest of this article is organized as follows: section 2 discusses the existing research on the use of stories in legal reasoning, including the previous more formal research on stories and evidence (Bex et al. 2006, 2007) in section 2; at the end of section 2 I will give examples of two operations on causal generalizations that can aid in the analysis of such generalizations. The first part of section 3 briefly summarizes existing work on story grammars, scripts and explanation patterns; the second part of section 3 discusses the features of story schemes, which are derived from the earlier work on explanation patterns. In section 4 an example will be given of how the analysis of stories using schemes can take place and it will be discussed how the plausibility of a story scheme can be tested. Section 5 discusses some of the possible roles story schemes and an analysis using story schemes could play in different kinds of evidential reasoning and section 6 concludes with a discussion and some ideas for future research.

2 Stories: necessary but dangerous

In this section existing research on the use of stories in legal decision making and crime investigation will be summarized, showing the different ways in which stories can be used in reasoning with evidence. In this summary, the focus will be on how in the existing research the plausibility of stories is defined and assessed. This section is divided into two subsections: first, the research from legal psychology and legal theory on stories and story plausibility will be discussed and in section 2.2 my previous work on developing a logical model of this research will be summarized.

2.1 Stories in legal evidential reasoning

By analysing the way all kinds of different decision makers in criminal trials (judges, jurors, attorneys) reason and make decisions about the case at hand, Bennett and Feldman (1981) found that judicial decision making depends on the construction of different stories around the available evidence. According to Bennett and Feldman, a story is organized around a central action or central event, which is essential to the plot of the story, and the rest of the story should act as the context to this central action. Background knowledge about the world allows us to establish connections between the central action and the other elements of the story. A plausible story is a story in which all the necessary connections between the elements of the story are present and these connections are based on unambiguous world knowledge; thus a plausible story is, in Bennett and Feldman's words, 'structurally unambiguous'.

An interesting observation by Bennett and Feldman is that the most plausible story is the story that is often taken to be true. Bennett and Feldman show this with an experiment: they asked 85 students to assess the truth of a number of stories that were told by the other students. Some of these stories were really true (that is, the events recounted had really happened) and other stories were made-up. Some of the stories (both true stories and made-up stories) were complete and unambiguous but other stories were incomplete and ambiguous. It turned out that there is a significant relation between the structural ambiguity

of a story and its credibility. That is, the more plausible a story, the higher the probability that the story is judged true, irrespective of the *actual* truth of the story.

Pennington and Hastie (1986, 1993) further developed the idea of a story in a criminal context. They proposed a model of judicial decision making based on stories and tested it on human subjects. The model proposed consists of three stages which represent the stages a legal decision-maker goes through when evaluating evidence. First, the decision makers construct stories using the available evidence, knowledge about story schemes and knowledge about similar events. These stories are then evaluated using certainty principles and the best story is then matched to a verdict.

In Pennington and Hastie's work, a story has a standard structure: the basic form of a story is a simple sequence of events and a scheme can be imposed upon such a sequence. This scheme divides the different events in the story into different categories, where each category stands for a different role that an event or a sequence of events can fulfil. Such a scheme is called an episode, and is a basic model about intentional actions (figure 1). This scheme is a simplified version of the scheme Pennington and Hastie proposed in their earlier work (Pennington and Hastie 1986). The links in this model are causal links and thus the model imposes a simple causal structure upon the basic story in accordance with the meaning of and relations between the separate states and events.

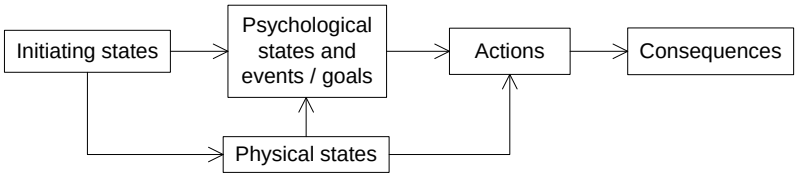

Figure 1: Pennington and Hastie's episode scheme

After a number of stories have been constructed around the evidence, the decision maker should decide which story to accept. Pennington and Hastie proposed two certainty principles for determining 'what the best story is': coverage and coherence. The story's *coverage* stands for the extent to which the story conforms to the evidence presented at trial. The idea here is that the more evidence covered by the story, the more confidence a decision-maker will have in that particular story. A story's *coherence*, which is similar to the notion of plausibility mentioned before, depends on three factors: consistency, plausibility[2] and completeness. A story should be consistent in that it does not contain internal contradictions between different parts of the story. A story is plausible if it conforms to the decision maker's general knowledge of the world[3] and a story is complete when all of the elements from figure 1 are part of the story.

The final stage in Pennington and Hastie's model involves matching the chosen story to a verdict category. For example, if there is a story of one man killing another, the decision maker can choose between the verdict categories of first-degree murder, second-degree murder, manslaughter and self-defence (not guilty). In the table below an example of one of

[2] Pennington and Hastie see plausibility as a 'sub-criterion' of coherence; my definition of plausibility in this article is similar to Pennington and Hastie's coherence.

[3] In Pennington and Hastie's definition, a story's plausibility is relative to the person assessing the story. An objective definition of a story's plausibility is more problematic, see the end of this section.

their verdict categories is given.

Verdict Category	Identity	Mental State	Circumstances	Actions
First-degree murder	Right person	- Intent to kill - Purpose formed - Resolution to kill	- Insufficient provocation - Interval between resolution and killing	- Unlawful killing - Killing in pursuance of resolution

Notice how the different attributes of the verdict category correspond to the elements of the episode scheme from figure 1: the Mental State corresponds to the psychological states and goals, the Circumstances correspond to the initial states and physical states and the Actions correspond to the actions in the episode scheme.

Pennington and Hastie tested their model on 26 jurors whom they asked to look at a re-enactment of a murder trial. From the tests it followed that almost all subjects organized the evidence as a story of 'what happened' before deciding on a verdict and that most stories followed the episode structure as shown in figure 1. An interesting observation was that the subjects filled in certain elements of the episode scheme to make complete stories. On average, a story constructed by a test subject consisted for about 55% of elements which were directly inferred from evidence and about 45% of the elements of a story – mainly psychological states and goals – were not inferred from evidence but added by the subjects to make a more complete story.

From Bennett and Feldman's as well as Pennington and Hastie's tests it follows that stories play an important part in reasoning with evidence, in that they help people organize the evidence and make sense of a case. Constructing stories also helps people to fill gaps in a case, as Pennington and Hastie's experiment shows. For example, it is often hard to directly infer from evidence that the suspect had bad intentions. In most cases, these intentions must be inferred from the actions that the suspect performed; in other words, these intentions can be inferred from the story. However, this research also shows that there are dangers inherent to stories, as Bennett and Feldman found that a good story can push out a true story.

Bennett and Feldman argue that a story's plausibility can be tested by looking for ambiguous connections in the story. This is, in my opinion, too vague, especially because the notion 'ambiguous connections', or unsafe background knowledge, is not defined. Rather, in Bennett and Feldman's theory classifying a connection as such is done intuitively, as if decision makers are naturally adept at analysing general knowledge about the world around us. Furthermore, Bennett and Feldman's work does not discuss the evidential support of stories.

Pennington and Hastie give clearer criteria for assessing stories: the criteria of completeness and consistency are clearly defined and ensure that the story is structurally sound and conforms to a general scheme of human intentional action we expect to find in the world. It is still unclear, however, how a story should conform to general knowledge of the world and thus when a story can be considered plausible.

Crombag, van Koppen and Wagenaar (1993, 1994) further investigated how we can make sure that a story is plausible in that it corresponds to general knowledge of the world. They argued that a story should fit and conform to the general episode scheme proposed by Pennington and Hastie. However, a story also has to be anchored using general knowledge of the world around us, and accepting a story is done by accepting a number of generalizations which act as anchors to the story. This is best explained by an example. Consider the case about Haaknat, adapted from Crombag et al. (1994, 138):

John Haaknat is a drug addict who is desperately in need of money. He knows that the owner of the local supermarket brings his earnings to the bank every Friday, so he decides to rob the owner when he exits the supermarket. Together with a friend who owns a car, they wait outside the supermarket. When the owner exits the supermarket with the money to go to the bank, Haaknat get out of the car and points a gun at the owner, shouting 'give me the money'. The owner fears for his life so he hands Haaknat the money. Haaknat then gets into the car and drives off in the direction of a nearby park. The police start searching for Haaknat in the park and they find him hiding in a moat.

If we decide to believe the story about Haaknat, we also believe the generalization 'eye-witnesses can reliably identify people', as Haaknat was identified by the owner and other witnesses. Crombag et al. consider only one type of generalization, namely those that link the evidence, in this case a testimony, to the story.

Crombag et al. argue that the generalizations which act as anchors have to be safe for the ultimate decision to be rationally better motivated and not based on dubious generalizations. Say, for example, that there is evidence that at the time of the robbery it was dark outside. The generalization 'eye-witnesses can reliably identify people' can be made more specific: 'eye-witnesses can reliably identify people they saw in the dark'. Clearly, this generalization cannot be regarded as safe knowledge about the world.

Crombag et al. discuss in detail how generalizations can be analysed in this way and decision makers are urged to make the world knowledge they use to come to their decision explicit, so that the ultimate decision is better motivated and not based on dubious generalizations. However, exactly when a generalization is safe is not made clear and the details of what part the generalizations play in a story are left untreated.

Twining (1999) and Anderson, Schum and Twining (2005) argue that a story is 'widely regarded as appealing to intuition or emotion and as a vehicle for irrational means of persuasion'. However, they recognize that stories are psychologically necessary in that they help people make sense of the world and of the events that happened in a particular case.

Anderson et al. give a simple protocol for analysing the plausibility, coherence and evidential support of stories. This protocol consists of a list of questions; some questions point to the evidential support for the story, for example 'to what extent does the evidence support the story?' and 'is there evidence that conflicts with the story?' Other questions are meant for analysing the plausibility of the story, for example 'is the story supported by plausible background generalizations?' or 'does the story fit a familiar story such as Cinderella and what is the relevance of this?'. So in Anderson et al.'s work, story plausibility is tested by looking at the background generalizations; here, a story's plausibility is not tested by looking at whether it fits a plausible episode scheme, but it is tested by analyzing the generalizations which act reasons to accept the story. For example, If we decide to believe

the story about Haaknat, we also believe the generalizations 'people fear for their lives when they have a gun pointed at them' and 'people value their life higher than money' – this explains the owner's behaviour. These kinds of generalizations can also be made more specific. Say, for example, that there is evidence that Haaknat used a pink toy gun to threaten the owner of the supermarket. The generalization 'people fear for their lives when they have a gun pointed at them' can be made more specific: 'people fear for their lives when they have a pink toy gun pointed at them'. Again, the more specific generalization cannot be regarded as safe knowledge about the world.

Furthermore, Anderson et al. argue that well-known stories, such as Cinderella, also affect our judgement of a story's plausibility. However, like the other authors mentioned here they do not give a thorough analytic account of how exactly these background generalizations and general stories serve as a tool in the analysis of stories.

The research discussed in this section seems to agree on the fact that the plausibility of a story can be analysed by looking at to what extent the story conforms to plausible background knowledge of the world. However, the notion of 'plausible world knowledge' is somewhat problematic. According to Cohen (1977), the plausibility of our world knowledge depends on our 'stock of knowledge', which is accepted through a cognitive consensus within a given group of people (for example, a society): if a generalization or episode scheme conforms to this stock of knowledge, it can be judged as plausible. Anderson et al. (2005) argued that this cognitive consensus about the stock of knowledge is a problematic notion: in any given group of people there will always be disagreements about which knowledge to accept as plausible and the idea of a general consensus is almost impossible in a dynamic, multicultural and multi-class society. However, it is possible and necessary to accept that there is a certain consensus about knowledge of the world; otherwise we would not be able to draw any conclusions. To meet any dangers posed by differences or arguments regarding generalizations or episode schemes, these generalizations should be as explicit and elaborate as possible. So while the ultimate conclusion about the plausibility of a generalization or episode scheme depends on the person(s) making this decision and their stock of knowledge, this conclusion about the plausibility is stronger to the extent that it is based on explicit and detailed generalizations.

2.2 Formal argumentative story-based analysis of evidence

In (Bex et al. 2006, 2007), we aimed to construct a theory that combines causal stories[4] and evidential arguments. The main reason for developing this combined theory was to give sources of evidence, or evidential data, a more prominent place in a theory for reasoning about evidence with stories. This combined theory, which will be briefly summarized below, also allows for the critical analysis of the causal links within in the story.

The basic idea of the combined approach is as follows. A logical model of abductive *inference to the best explanation* (IBE)[5] takes as input a causal theory (a set of causal rules or

[4] It should be noted that we use a naïve interpretation of causality; sometimes a causal link does not represent a much stronger relation than temporal precedence.

[5] See (Lucas 1997) for an overview of abductive reasoning and (Thagard 2004) for a slightly different take on IBE.

generalizations) and a set of observations that has to be explained, the explananda, and produces as output a set of hypotheses that explain the explananda in terms of the causal theory. The combination of hypotheses and causal theory can be seen as a story about what might have happened. These hypothetical stories or *explanations* can then be compared according to the plausibility of their causal generalizations and the extent to which they conform to the sources of evidence in a case. These *sources of evidence* (e.g. witness testimonies, forensics reports) are connected to the stories by defeasible arguments, that is, arguments which can be attacked and defeated. For example, an argument with the premise 'the owner testified it was Haaknat who robbed him' and the generalization 'eye-witnesses can reliably identify people' has as its conclusion 'Haaknat who robbed the owner of the supermarket'. This conclusion is an event in the story on page 6. Note that evidential generalizations can also be attacked by arguments. For example, if we have evidence that the robber wore a mask during the robbery, the generalization that eyewitnesses can reliably identify people can be attacked.

Defeasible arguments are also used to attack explanations: the causal rules of the theory are not just given but their applicability can become the subject of an argumentation process. For example, the causal generalization 'people fear for their lives when they have a gun pointed at them' can be attacked by arguing that in this case the generalization is not applicable because the gun was a pink toy gun.

Figure 2 shows an abstract graphical notation of stories as causal networks and arguments. In the figure, events that are not supported by evidence are in a dotted box and events that are supported by evidence in a box with a solid line. This is a semi-formal way of representing them, but a formal translation into well-known formalisms is straightforward (see Bex et al. 2007).

If there is more than one explanation for the explananda, they must be compared according to their plausibility and their conformity to the evidence in a case. The plausibility of an explanation is judged by looking at the plausibility of the causal generalizations in the causal theory. If a causal generalization is deemed implausible, it can be attacked with an argument: the more causal generalizations are attacked by arguments the less plausible a story is.

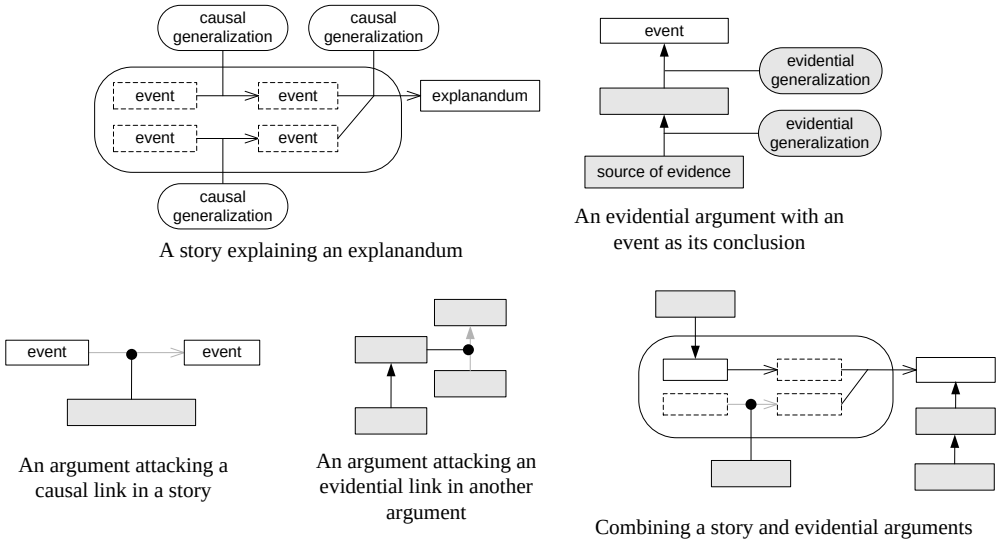

Figure 2: stories, arguments and generalisations

An explanation's conformity to the evidence in a case, or its evidential support, can be measured by looking at how many events in the explanation are supported by an argument that is not attacked: the more events in the story follow from evidential arguments, the better the story is.

In the model of (Bex et al. 2007), the causal generalizations in a story cannot be changed; they can only be attacked. Bex and Prakken (2004) defined two ways of refining generalizations in an argumentation context; these same operations can be defined for causal generalizations. Firstly, a causal generalization can be made more specific by explicitly adding the 'hidden conditions'. For example, say that we have a generalization 'if someone wants to rob another person, this may cause him to threaten that person with a gun'. One of the preconditions for this causal inference to be made is that the person who threatens with a gun actually has a gun, viz.:

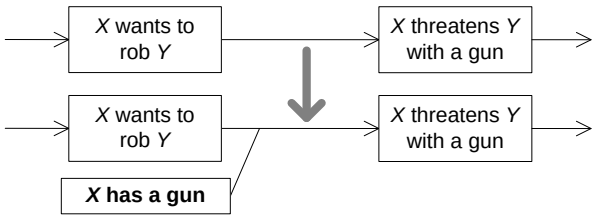

Figure 3: adding hidden conditions to a generalization

Thus the generalization is changed into 'if someone wants to rob another person *and he has a gun*, this may cause him to threaten that person with the gun'.

Secondly, a causal generalization can be changed into a more specific generalization by 'unpacking' it, changing one causal link into a causal chain:

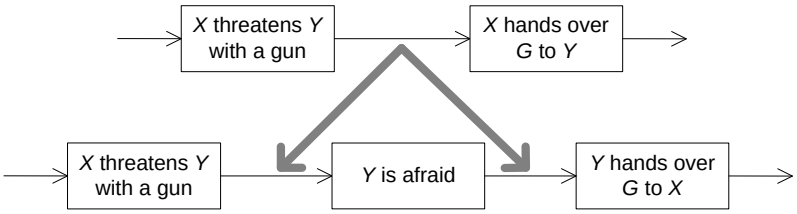

Figure 4: unpacking a causal generalization

Here the causal generalization 'If someone (*X*) threatens another person (*Y*) with a gun, this person will hand over his belongings (*G*)' is changed into two generalizations, namely 'If someone threatens another person with a gun, this person will be afraid' and 'If a person is afraid, he will hand over his belongings'.

To summarize, evidential arguments require one to make explicit the evidential generalizations used and exceptions to these generalizations can be given, thus allowing for a critical analysis of the connections between the evidence and the story. Explicitly modelling the causal generalizations in the causal theory allows for a thorough examination of these generalizations: they can either be changed by exposing hidden conditions or by unpacking, and they can be can be questioned by attacking the generalizations with arguments. However, as was mentioned in section 1, a story's causal generalizations are not always explicit, so ways will have to be found to make these generalizations explicit or other ways will have to be found to analyse a story's plausibility. Furthermore, the current formal theory also does not allow us to measure the extent to which a story conforms to the intentional episode in the way that Pennington and Hastie proposed. To allow these other ways of analyzing stories, the formal theory must be expanded by introducing story schemes. In the next section, this will be discussed and in section 4 it will be shown how stories based on schemes can be analyzed in more ways than stories based on causal theories.

3 Story schemes

In the seventies of the last century, the fields of cognitive science and artificial intelligence also took an active interest in stories. This research first mainly focused on developing formal grammars for describing the structure of a typical story. Pennington and Hastie's episode schemes borrow heavily from the story grammars proposed by Mandler and Johnson (1977) and Rumelhart (1975). These story grammars also divide stories into episodes, which consist of a beginning, development (containing mental responses, goals and actions) and consequences. The episodes consist of either other episodes or individual events. The events linked by causal as well as a temporal links, as both sentences of the form 'event A THEN event B' as well as 'event A CAUSE event B' can be constructed in the grammars.

In later research the attention shifted towards story understanding by using a set of 'general action sequences' or scripts (Schank and Abelson 1977; Schank 1986). While Schank and Abelson (1977) also use a basic episode scheme, they also argue that story understanding is also done by using more specific and detailed information about standard patterns of actions when reading and understanding stories. These standard patterns or sequences are modelled as scripts; the much quoted 'restaurant-script', for example, contains information about the standard sequence of events that take place when somebody goes to dine in a restaurant. Scripts help us to understand stories by filling in missing information. As

an example, take the following (very short) story:

Nicola went to a restaurant. He asked the waitress for a plate of spaghetti. He paid the check and left.

This story is understandable because it references to the restaurant script. Not all of the details (Nicola taking off his coat, Nicola reading the menu etc.) have to be mentioned because they are assumed to happen when somebody goes to eat in a restaurant.

In his later work, Schank (1986) talks about *explanation patterns* (XPs), which contain information to understand the different events in the story and why they happen as they do. These XP's are similar to scripts in that they contain a standard sequence of events. An important difference is that Schank explicitly mentions that XPs are used to explain an event: they connect the event with world knowledge, namely an explanation that has been used in the past to explain the event. As an example, take the XP for 'robbery' (in the broadest sense of the word):

Robbery explanation pattern:

1. **Event that the pattern explains:** person *Y* loses (physical) ownership of goods *G*
2. **Events which are necessary for the pattern to be a valid explanation:** *Y* loses ownership of *G*, person *X* robs person *Y*
3. **Events under which the pattern is likely to be relevant:** *X* wants *G*
4. **Pattern of actions:** *Y* owns *G* – *X* wants *G* – *X* wants to rob *Y* of *G* – *X* has an opportunity to rob *Y* – *X* robs *Y* – *Y* loses *G*
5. **Other relevant information:** the time of the robbery, the place of the robbery, the type of force employed, the nature of the goods *G*
6. **More specific kinds of robbery:** armed robbery, mugging, carjacking

This XP is slightly different from Schank's version of an XP but the main idea is the same. Element 1 is the event that the pattern explains. Note that a pattern can explain more than one event; for example, the robbery XP can also be used to explain the fact that '*X* has *G*'. Elements 2, 3, 5 and 6 speak for themselves. Element 4 is perhaps the most important part of the XP; as Schank puts it, the pattern of actions, or *scenario*, is "essentially a little story that is a carefully constructed causal chain of states and events [that explains the event to be explained]". While the examples of patterns of actions Schank gives all seem to be causally or at least temporally ordered, the exact causal relations between the events is often left implicit.

Both the episode schemes proposed by Pennington and Hastie and the explanation patterns proposed by Schank can be seen as instances of something which I will call *story schemes*. These schemes divide the different events in the story into different categories ranging from abstract (Pennington and Hastie's episode scheme) to more specific schemes (explanation pattern-schemes). In this article, story schemes will be modelled as an ordered list of events or types of events together with the possible relations between these events[6].

[6] In this article, story schemes are represented through figures, where elements of a scheme are represented by boxes and (causal) relations are represented by arrows. This is a semi-formal way of representing them, but a formal translation along the lines of (Bex et al. 2007) is straightforward.

These relations will usually be causal relations, but they can also be temporal relations. Like the causal theories from section 2.2, which can abductively explain events, story schemes can also be used to explain certain events; an explanation pattern includes an explicit element 'event to be explained'. In this way, story schemes can explain events without the use explicit causal information.

Story schemes can be abstract or specific; for example, the robbery scheme contains general instances of quite specific events (e.g. '*X* robs *Y*'), while Pennington and Hastie's scheme for intentional action (figure 1) contains more general event types (e.g. 'actions'). The more specific schemes can sometimes be seen as instances of the more abstract schemes; for example, a robbery is an instance of an intentional action. In this way, different story schemes can be said to *match* each other: a story scheme S_1 matches a story scheme S_2 to the extent that the elements in S_1 correspond to the elements in S_2. The correspondence relations between the elements of the intentional action and the robbery scheme are shown in figure 5:

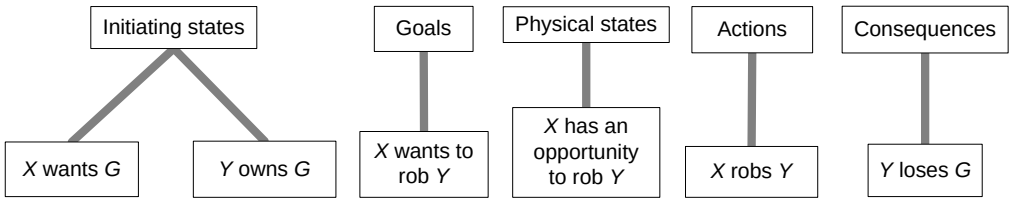

Figure 5: the correspondence relations between the intentional action and the robbery scheme

These correspondence relations between the elements of the different schemes can be expressed as generalizations. For example, '*X robs Y* expresses an action'. These generalizations have to be plausible: when such a generalization is implausible, the two schemes do not match. For example, the correspondence generalization '*Y owns G* expresses a goal' is not plausible so there is no correspondence relation between these elements. Note that correspondence relations and generalizations can be attacked by arguments in the same way that evidential and causal generalizations can be attacked (see section 2.2).

Sometimes two matching schemes only differ on one or two elements. For example, the element '*X* robs *Y*' in the robbery scheme can also be modelled as two separate elements, '*X* threatens to use force against *Y*' and '*Y* hands over *G* to *X*', thus making the concept of 'robbery' more specific.

Another aspect of story schemes that has to do with the correspondence between different elements of schemes was already noted by Pennington and Hastie: the so-called hierarchy of episodes. Story schemes are hierarchical, in that each component of an episode may correspond to an episode itself. In figure 6, this recursiveness of the intentional action scheme can be seen. For simplicity's sake, some elements of the episode have been left out.

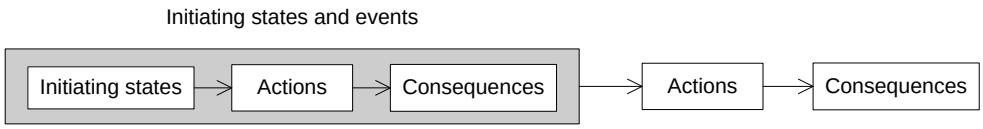

Figure 6: recursive story schemes

Here, the Initiating states and events correspond to a separate sub-episode.

If two story schemes match, there is usually also a correspondence between the causal relations in the different schemes. For example, the causal relations of the intentional action scheme (figure 1) can be inserted in the robbery scheme because the elements of the intentional action and the robbery scheme correspond:

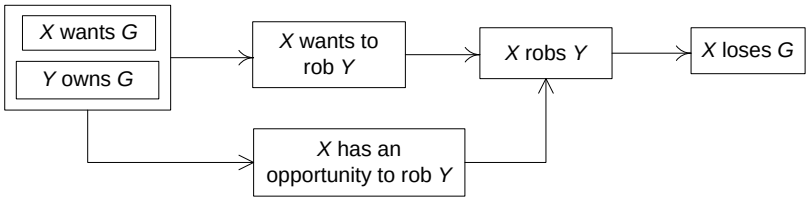

Figure 7: the robbery scheme with a more detailed causal structure

In this way, more abstract schemes which causal relations are generally agreed upon can be used as a tool for making the causal generalizations in a specific story scheme more explicit. Note that figure 7 also contains an example of a hierarchical episode: 'A wants G' and 'B owns G' are a separate sub-episode of the robbery scheme. In the figure, the causal relations in this sub-episode have been left implicit.

In this section the basic structure and features of story schemes have been discussed as well as ways to specify story schemes. Story schemes are similar to causal theories as discussed in section 2.2 in that they can be used to explain events. However, explaining events with story schemes is perhaps somewhat simpler: where in a causal theory all the causal generalizations have to be made explicit story schemes allow us to explain events by providing only the general pattern of events. This carries a risk, as implicit causal generalizations can be of dubious quality. Using more abstract schemes as a tool for making the causal generalizations in a specific story scheme more explicit allows us to analyze and assess the more specific causal generalizations and thus part of this risk is overcome. In the next section it will be shown how the plausibility of simple story schemes can be analyzed and assessed.

4 Analysing stories

A story is essentially a particular version of a story scheme, where the variables have been replaced by constants. Recall that in section 3 a story scheme for robbery was given; the Haaknat story is a particular instance of this scheme, viz.:

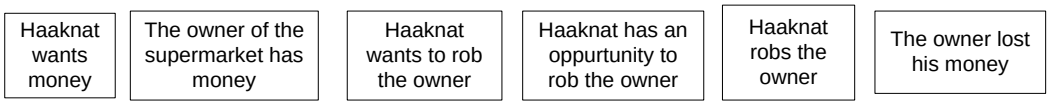

Figure 8: the Haaknat story

Here *X* in the scheme has been instantiated with 'Haaknat', *Y* has been instantiated with 'the owner' and *G* has been instantiated with 'money'. In this way, each story has an associated story scheme of which it is an instance. Here, the parallel between a story scheme and a causal theory as defined in section 2.2 can be seen. A causal theory is a collection of causal generalizations which, when the variables are instantiated, forms a story. A story scheme is similar to a causal theory, but in a story scheme the different events are not always linked and

if there is a relation between events this relation is not necessarily causal but sometimes temporal. In this way, a story scheme is a less specified version of a causal theory that also allows for stories that do not contain explicit causal information.

In section 2.2 it was argued that the plausibility of a story can be analyzed by looking at the plausibility of the underlying causal theory, so in the same way it can be argued that analyzing the plausibility of a story that is based on a scheme can be done by looking at the plausibility of the underlying story scheme. Schank (1986) also argues that a plausible explanation pattern provides the natural context for the event it explains in the belief-goal-plan-action chain. If this condition for the plausibility of story schemes is added to the earlier condition that the individual causal generalizations in the scheme or theory should be plausible and sufficiently detailed, there are two criteria for determining whether or not a story scheme (and thus a story based on the scheme) is plausible. Firstly, a story scheme should match the intentional action scheme; this ensures that the scheme adheres to the general goal-action chain as proposed by Schank and it also ensures that the scheme conforms to Pennington and Hastie's intentional episode scheme. Secondly, the causal structure and the causal generalizations of the scheme should be plausible and sufficiently detailed. So a story is plausible and sufficiently detailed if its associated story scheme matches the intentional action scheme and if the causal generalizations in the associated story scheme are plausible and sufficiently detailed. In the rest of this section, a story is said to *fit* a story scheme S to the extent that its associated story scheme matches S and vice versa. For example, Haaknat's story as detailed above completely fits the intentional action scheme because the story scheme associated with Haaknat's story, the robbery scheme, completely corresponds to the intentional action scheme and vice versa (see figure 5).

The causal structure of the Haaknat story as shown above is not very detailed. However, it can be matched to the robbery scheme from section 3; often, a story does not contain explicit causal information but a story scheme does and matching the story to the scheme can give the story an explicit causal structure. As long as the story itself contains no explicit causal relations that contradict the causal relations in the story scheme, the causal relations from the scheme can be used in the story. In this way, the Haaknat story can be updated with the more detailed causal structure from figure 7, providing us with the following story:

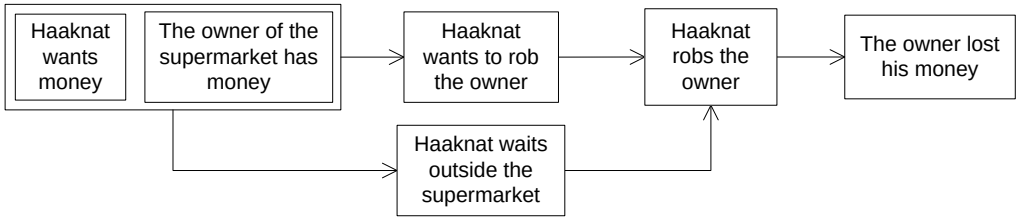

Figure 9: The Haaknat story with a clear causal structure

Note that in figure 9, 'Haaknat has the opportunity to rob the owner' has been replaced with 'Haaknat waits outside the supermarket'. This story still fits the robbery scheme because waiting outside the supermarket can be seen as having an opportunity to rob the owner of that supermarket.

To give an example of a less plausible story, consider Haaknat's version of the events that

explains why he was found in the moat. Haaknat testified that an hour before he was found, he had an appointment with Bennie, who owed him some money. Bennie did not want to pay back the money and Haaknat and Bennie got into an argument, during which Bennie drew a knife. Haaknat felt threatened by Bennie and he ran away. After a while, Haaknat sees the police officers looking for someone in the park, and he jumps into the moat to hide. Some time later, the police find Haaknat in the moat. The story scheme associated with this story can be written down as follows:

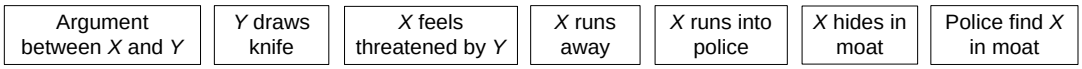

Figure 10: the 'hide after threatened' story scheme

The story can be represented in the same way by instantiating *X* with Haaknat and *Y* with Bennie. This story can be modelled as two episodes, where the first episode is 'Argument between *X* and *Y* – *Y* draws knife – *X* feels threatened by *Y* – *X* runs away' and the second episode is '*X* runs into police – *X* hides in moat – police find *X* in moat'. However, when we model the story in this way, it does not fit the intentional action scheme, because the psychological states/goals element does not correspond to events in the story:

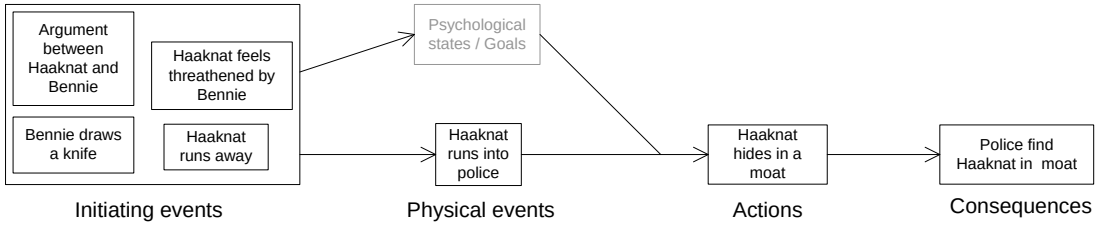

Figure 11: Haaknat's version of the story matched to the intentional action scheme

Alternatively, one could argue that 'Haaknat feels threatened by Bennie' is the psychological state in the above story scheme; then the story is modelled as a single episode:

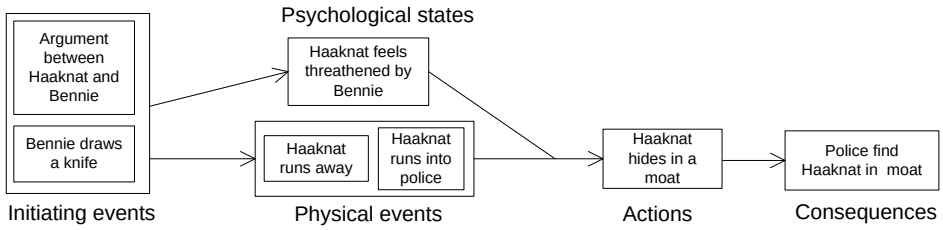

Figure 12: the story matched to the intentional action scheme differently

If the story is modelled in this way it does fit the intentional action scheme. However, recall that another requirement for a story to be plausible was that the individual causal generalizations on which the causal relations are based must be plausible. If we look at figure 12, it seems that there is a causal relation 'X feels threatened by Y $\wedge$ X runs into police $\rightarrow$ X hides in a moat'. Expressed as a generalization, this would read 'Someone who feels

threatened by another person and encounters the police will hide'. This seems a strange generalization, because one would expect the person who was threatened to seek help from the police. So the story is less plausible because one of its internal causal generalizations is implausible.

During the case Haaknat said that the reason for the fact that he hid in the moat was that he thought the police were looking for him because of the argument with Bennie and that he did not want to be arrested. The story from figure 11 can be updated with this event, filling in 'Haaknat does not want to be arrested' as a psychological state.

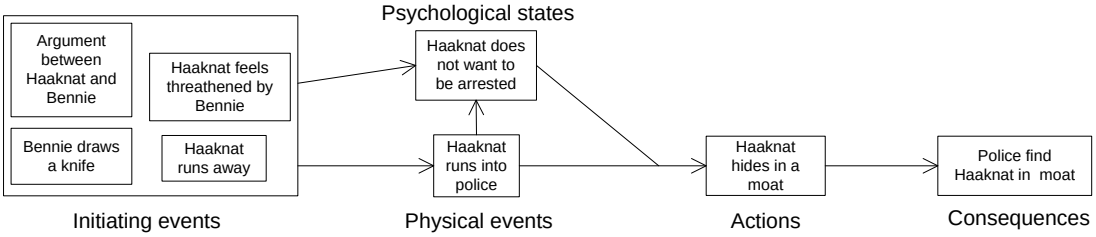

Figure 13: the updated Haaknat story

However, this explanation still is not completely plausible: the fact that it was Bennie who drew the knife and Haaknat who felt threatened makes it less plausible that Haaknat was afraid to be arrested. People who are threatened with a knife usually want the police's help, even if they were in a fight themselves. Here, the initiating events are a separate episode with its own causal structure.

In the above example it can be seen that trying to match the story to the intentional action scheme requires a careful analysis of the story and even if a story fits the scheme, it is still important to carefully analyse the causal relations in the story. Matching a story's associated scheme to the intentional action scheme requires one to make the causal relations between the events explicit so that they can be carefully assessed. This approach to analysing the plausibility of a story is perhaps closest to the method Crombag et al. and Anderson et al. propose: make explicit and analyse the generalizations that serve as the basis for the story.

In this section some general features of story schemes and some of the ways in which story schemes can be changed have been discussed. The story scheme approach proposed in this section makes the analysis easier. As was shown in the example in figure 12, the plausibility of causal relations is often dependent on events earlier in the story. So it seems that often it is not just an individual generalization that is implausible but rather a pattern of successive events which are connected by generalizations. Instead of taking one causal generalization and updating by adding further (hidden) conditions, schemes, or chains of generalizations, are added to the model. Take the example in figure 13, where all the events in the 'initiating events' box together with 'Haaknat runs into police' can be taken as conditions of a single generalization: 'If there is an argument between person *X* and person *Y* and *Y* draws a knife and *X* feels threatened by *Y* and *X* runs away and *X* runs into the police then *X* will hide'. However, if these initiating events are modelled as a pattern of events: 'argument between person *X* and person *Y* – *Y* draws a knife – *X* feels threatened by *Y* – *X* runs away – *X* runs into the police – *X* will hide', it is easier to insert and assess the causal relations between the different events. If it is modelled as a single causal generalization with

five conditions, the temporal and causal information contained in the 'initiating events' sub-episode is lost and it is impossible to insert and assess any causal relations between the different conditions.

5 Story schemes in evidential reasoning

Story schemes can be used in different ways in evidential decision making and crime investigation. Their use often depends on the particular goals the person using the story schemes has; a judge or juror can use schemes to analyse a particular story, a lawyer can use schemes to build a persuasive story and an investigator can use schemes as possible hypotheses of what happened in a particular case. It is not my intention to provide a full overview of the different ways in which story schemes can be used for decision making, persuasion and investigation. The main aim of this section is to briefly discuss some of the uses of the different ways of analysing stories and to provide ideas for future work.

In the decision-making phase, stories put forward by the parties can be critically analysed using schemes, as was illustrated in the previous section. Furthermore, it is also the decision maker's task to see if the prosecutor's story fits a story scheme that contains the charge in the case at hand. In many jurisdictions, an act or a series of acts which are punishable are defined, often with the required psychological states. Pennington and Hastie argued that these possible verdicts are much like a story scheme, and that the story should be matched to the verdict category in the same way that a story fits other story schemes. Story schemes can also be used by the different parties in court to explain 'what happened' in the case: a sequence or pattern of events can be given as the cause for an event that is to be explained. At the end of the previous section it was made clear that giving a pattern or chain of events as an explanation is more natural and provides more possibilities than modelling the causal relation as a single generalization, giving a conjunction of causes for why a certain event happened as it did.

In an investigation context, story schemes are important in that they serve as possible hypotheses for what happened. According to de Poot, Bokhorst, van Koppen and Muller (2004), a criminal case which has to be investigated is often interpreted through different scenarios, or reconstructions of 'what happened'. When the investigators are faced with a case, different hypothetical scenarios have to be constructed, which can be done by using story schemes. The fact that story schemes can be used to explain events can also be used in the analysis of stories. For example, in Haaknat's version of the story, the event 'argument between Haaknat and Bennie' is not explained. However, we know that the argument was because of money that Haaknat lent Bennie, so the argument between Haaknat and Bennie can be explained using the following scheme:

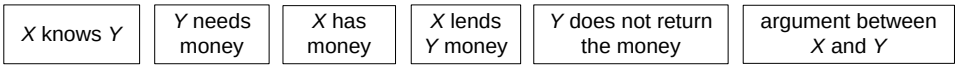

Figure 14: the 'argument about money' story scheme

In this way, the story can be expanded and further analyzed and in this way the search for evidence is guided. For example, if the scheme from figure 14 is used to explain the fact that Haaknat and Bennie had an argument, there must also be evidence for the fact that 'Haaknat knows Bennie'. Note that this was also possible in the formalism discussed in section 2.2 but

story schemes allow us to explain events without using abductive inference and thus schemes allow us to build stories without explicit causal information.

6 Conclusion and future research

From the research on stories in legal reasoning it follows that stories are clearly 'necessary but dangerous'. Relatively simple patterns of events are easier to handle than complex argument trees. As Anderson et al. (2005) noted, our stock of knowledge contains not just generalizations but also other models of the world and Schank argues that our memories of past events are often organized as stories. So stories serve as a useful addition to, for example, argument trees such as the ones proposed by (Anderson et al. 2005; Wigmore 1931). In the investigation phase, stories play more than just a psychological role, because they serve as scenarios that guide the search for evidence. Whichever role stories are used for, it is imperative that their plausibility and evidential support is constantly tested and analysed.

In my previous work, the analysis and assessment of the plausibility of stories was done by attacking generalizations in a causal theory; at the end of section 2 I have shown another way of analyzing these causal generalizations by exposing hidden conditions or unpacking the generalizations. However, this way of modelling stories and background knowledge can be complicated as we are dealing with complex causal networks containing elaborate generalizations with many conditions. Furthermore, stories do often not contain explicit causal relations between states and events which can be modelled in a causal theory.

In this article, I have proposed another way of modelling background knowledge, namely as story schemes. This has led to a list of features of story schemes and of the analysis of stories using these schemes:

- Story schemes can be modelled as ordered lists of elements, which are events or types of events, together with the possible (causal or temporal) relations between these elements.
- Story schemes can be used to explain events in the same way as causal theories.
- Story schemes range from *abstract* to *specific*. In more abstract schemes, the elements of the scheme are *general types of states and events* (e.g. actions or goals). In more specific schemes, the elements of the scheme are *specific states and events* (e.g. *X* threatens *Y* with a gun).
- Specific story schemes *match* more abstract story schemes and vice versa to the extent that there are correspondence relations between the elements of the different schemes. These correspondence relations, which can be expressed as generalizations, have to be plausible for the schemes to match.
- If two story schemes match, there is usually also a correspondence between the causal relations in the different schemes.
- Each story has an associated story scheme of which it is an instance (cf. figure 5 and 8).
- A story *fits* a story scheme S if its associated story scheme matches S and vice versa.
- A story is plausible if it fits the intentional action scheme and if its internal causal generalizations are plausible
- A story is sufficiently detailed if its causal structure is sufficiently detailed.

It must be said that explaining events with simple, less causally connected schemes is somewhat of a blessing in disguise: not having to give a detailed causal theory allows for the quick construction of different scenarios about what happened but care must be taken that the scenario or the story based on it is sufficiently detailed; the causal structure and the causal generalizations of the scheme should be sufficiently detailed[7].

An important parallel can be drawn between story schemes and argumentation schemes (Walton 1996), which are schemes that represent stereotypical patterns of human reasoning through generalizations. Stories and story schemes can be likened to arguments and argumentation schemes, respectively; an argumentation scheme is a general scheme for arguments of a particular kind just as a story scheme is a general scheme for stories of a particular kind. In (Walton 1996) a number of argumentation schemes drawn from real world examples is given. In future research it will also be important to define more types of story schemes. Furthermore, argumentation schemes also have critical questions which can be used to test the inference and it would be interesting to see if similar questions that can be used to test a story scheme can be defined.

Another subject that has not been discussed in this article is that it is also possible to construct and discuss defeasible arguments about the plausibility of stories. The criteria that a story should fit a plausible story scheme and that a story should be supported by evidence through plausible evidential generalizations are meant to be guidelines for the analysis of stories. For each individual case, the person performing the analysis has to determine which story and what evidence he or she trusts. This decision is also dependent on the task for which the stories are used; maybe an incomplete story will not convince a judge or juror but in a police investigation such a story can be a reason to look for other evidence to make the story complete. While it is impossible to give hard-and-fast rules for which story is the better one, it is possible to argue about the 'goodness' of the different stories, using the above criteria as guidelines. These arguments would be on a separate level. For example, arguments could be constructed for or against a single story (e.g. 'your story is not complete' or 'your story is implausible') or stories could be compared (e.g. 'even though my story is not complete, it covers the evidence much better so my story is the best'). Verheij and Bex (this volume) discuss how these kinds of arguments about the plausibility and evidential support can be formulated using argument schemes.

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[7] Note that exposing hidden premises and unpacking generalizations does exactly this: it makes the causal structure more detailed.

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