ABSTRACT

BAE, BYUNG CHULL. A Computational Model of Narrative Generation for Surprise Arousal. (Under the direction of Professor R. Michael Young).

This dissertation describes work to develop a planning-based computational model of narrative generation designed to elicit surprise in the mind of a reader. To this end, my approach makes use of two narrative devices – flashback and foreshadowing. While surprise plays an important role for attention focusing, learning, and creativity, little effort has been made to build a computational framework for surprise arousal in narrative. In my computational model, flashback provides a backstory to explain what causes a surprising outcome, while foreshadowing gives hints about the surprise before it occurs. In this work I focus on the arousal of surprise emotion as a cognitive response which is based on a reader's cognitive appraisal of a given situation. In this dissertation I present Prevoyant, a planning-based computational model of surprise arousal in narrative generation, and analyze the effectiveness of Prevoyant. To build a computational model of the unexpectedness in surprise, I adopt a cognitive model of surprise based on expectation failure.

There are two contributions made by this dissertation. First, I present a computational framework for narrative generation designed to elicit surprise. The approach makes use of a two-tier model of narrative and draws on Structural Affect Theory, which claims that a reader's emotions such as surprise or suspense are closely related to narrative structure. Second, I present a methodology to evaluate surprise in narrative generation using a planning-based approach based on the cognitive model of surprise causes. The results of the experiments that I conducted show strong support that my system effectively generates a discourse structure for surprise arousal in narrative.

A Computational Model of Narrative Generation for Surprise Arousal

by
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A dissertation submitted to the Graduate Faculty of
North Carolina State University
In partial fulfillment of the
Requirements for the degree of
Doctor of Philosophy

Computer Science

Raleigh, North Carolina

June 26, 2009

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DEDICATION

To
my parents,
my wife Yuna,
and
my precious daughter Hyunji (Iris)

BIOGRAPHY

Byung Chull Bae grew up in Seoul, South Korea, where he developed his love of music, stories, and movies. He attended Korea University majoring in Electronics Engineering, which provided the curriculums of introductory Computer Science and advanced Computer Engineering. He earned his Bachelor's Degree in Electronics Engineering in 1993 and then continued his graduate study under the advisement of Dr. Duk-Jin Kim at Korea University. He earned his Master's Degree in Electronics Engineering in 1998 with his thesis, A Study on Internetworking between PSTN and B-ISDN, which presented a new way of internetworking technique for the reliable data transition between different networks.

From 1998 to 2002, he worked at LG Electronics R&D Center as an assistant researcher, building various hardware and software programs for mobile networking environments. In December 2002, he got married to Yun Gyung Cheong, who was a Ph.D. student in Computer Science at North Carolina State University at that time. In August 2003, he moved to the United States and entered the Master/Ph.D. program in Computer Science at North Carolina State University. Soon he joined the Liquid Narrative group led by Dr. R. Michael Young and performed research in the area of automated background music generation for narrative. In 2005, he earned his Master's degree in Computer Science and continued his study on emotion, cognitive science, and narrative. In March 2007, he became a father of a beautiful baby girl, Hyunji Iris Bae. In November 2008, he won the Best Paper Award at the first International Conference on Interactive Digital Storytelling. After graduation, he plans to pursue a career in research on interactive storytelling and emotions of intelligent agents.

ACKNOWLEDGEMENTS

Foremost, I thank my committee, Dr. James Lester, Dr. Brad Mehlenbacher, and Dr. Robert Rodman for their time and comments. I thank R. Michael Young, my thesis advisor for his warm but strict guidance through the process of finishing this dissertation. I wouldn't be here where I am without him. Thanks for spending his time, effort, and patience to keep me on the right track.

I thank Dr. Marie-Laure Ryan for her kind and encouraging words about my work. I thank Dr. Jon Doyle, Dr. Carla Savage, Dr. Robert St. Amant, and other Computer Science professors at NC State for their enthusiastic class. I learned invaluable lessons from them. I thank Dr. David Thuente, Ms. Margery Page, and other Computer Science staffs at NC State University. I thank students in Computer Science and at NC State who voluntarily participated in my experimental studies.

I thank my fellow students at NC State University, Pat Cash, David Christian, Mike Dickheiser, Michael Dominguez, Julius Goth, Joseph Grafsgaard, Oliver Gray, Eun-Young Ha, Justin Harris, Dr. Arnav Jhala, Seung Yong Lee, Dr. Sunyoung Lee, Sam Munilla, Dr. Brad Mott, Dr. James Niehaus, Dr. Mark Riedl, Stephen Roller, Jonathan Rowe, Brian Shiver, Jim Thomas, Tommy Vernieri, Kevin Vaughan, and Joe Winegarden for enjoyable discussion on many topics. I enjoyed the six years at NC State because of you guys.

I thank Korea University alumni attending (or attended) at NC State who gave me good support and strength for six years. Special thanks for Seung-Jun Shin for his statistical counseling regarding my study.

I thank Chang-Yeol Lee for his good friendship over 25 years. I thank Jeong-Im Yom for her timeless friendship over 20 years and her family for their hospitality. I thank Pat and Ron Leith for their warmness and inviting my family to their Thanksgiving Day party every year. I also thank Andy and Cheryl White for their kindness. I thank Mike, the owner of Global Village coffee house on Hillsborough Street, for his gentle manner and good coffee. With Yuna, my wife, I spent a lot of good time there reading numerous papers. I also thank the

crews at CupAJoe at Mission Valley. Thanks to the double-shot iced mocha, my all-time favorite, I could survive summer in Raleigh.

I thank my parents, Young-Sik Bae and Sin-Sook Kang for their bottomless support and sacrifice. I thank my sister, Youn-Mi Bae, and my brother, Byoung-Jun Bae for their sweetness and care. I also thank my brother-in-law, Dr. Jae-Ok Ahn, and my sister-in-law, Chang-Hee Lee.

I thank my beloved wife and friend, Yun-Gyung Cheong, who gives the most support during my study. Special thanks to my daughter, Hyunji Iris Bae, for giving me such a strong motivation to finish this dissertation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

Introduction

Life is lived looking forward, but it is told looking backward.

- *Marie Laure Ryan, from* ***Avatars of Story*** *(2006)*

Surprise is one of the fundamental emotions that we experience in everyday life. With surprise, regardless of how big or how small it is, we live a dramatic life. Sometimes it comes in a pleasant way along with a sense of happiness. Sometimes it is accompanied by sadness or disappointment. Surprise is also one of the important literary emotions that we frequently encounter while reading books or watching movies. Like surprise in real life, surprise in narrative focuses the reader's attention on the story, often making them feel surprised the same way the main character feels surprised in the story. Psychomedia analysts often view surprise, along with suspense and curiosity, as one of the crucial emotions that contribute to the reader's satisfaction while reading (Tan, 1996).

According to the narrative theorists focusing on the structural aspect of narrative, narrative can be viewed as having two parts – story and discourse (Chatman, 1978; Genette, 1988; Abbott, 2002; Prince, 2003; Ryan, 2006). Here story refers to a temporal sequence of the events in the narrative, while discourse refers to a verbal or written representation of the

story in which the story events are recounted by a storyteller or a narrator (Genette, 1988; Prince, 2003). For dramatic effect in a narrative discourse, some story events are omitted, shortened, lengthened, repeated, transposed, or described in detail by the storyteller. The hearer or reader experiences the discourse part of a narrative, which is told by the storyteller, and reconstructs a version of the story part of the narrative in his or her mind by building a mental representation of the discourse. In this dissertation I present a computational framework designed to generate discourse that effectively recounts story events in order to elicit a sense of surprise in the mind of a reader.

> **Concept 1.1 (Narrative).** *In this work, a narrative is viewed as consisting of two parts: its story and its discourse. A narrative's story is a temporal sequence of the events. A narrative's discourse is a representation of the story.*

1.1 Motivation

The reasoning process beyond chronological order of events is one of amazing human capabilities to understand a sequence of story events in narrative as a whole. In the real world, causality resides with us. The dynamics of the world around us are tightly linked to causality and the flow of time. A fire burns, and smoke rises as a result. Without fire, there is no smoke. With the help of causality, we often recognize an effect first and then identify its cause either by observation or by reasoning. In narrative, typical writers write their story with variance in temporal order, maintaining coherence as a whole, to evoke more interest to a reader: some story events are told ahead of time; some story events are told a while after they actually occurred. In particular, the reasoning process of 'how and why it happens' based on 'what happened' has been frequently used to elicit a sense of curiosity or surprise, both elements of the reading experience considered important to maintain the reader's cognitive engagement in the story.

Three temporal narrative devices particularly associated with cinematic narratives (Chatman, 1978; Prince, 2003; Bordwell, 1986) are often used by storytellers to manipulate

the presentation order of story events: flashforward, foreshadowing, and flashback. Flashforward shows to the reader ahead of time some story events that will occur later as the story unfolds. As a result, the viewer focuses his or her expectations on a specific story outcome and wonders how (or why) the outcome will happen. Flashforward is realized in various ways in literature and in film media. For instance, a narrator can directly tell the reader about an important story outcome at the beginning of the story[1]. A particular character in the story (e.g., a prophet or one who has a special ability to see the future) can foretell or show future events in the story[2]. Foreshadowing is also a narrative device that makes reference to later events in the story. Unlike flashforward, however, foreshadowing is implicit, so the underlying meaning of the foreshadowing becomes clear only when the target event occurs later in the story. In contrast to flashforward or foreshadowing, flashback is used for referring to past events which are related to current events in the story.

Since the 1970s, a number of research efforts have addressed the computational generation of narrative, but only a few have made an attempt to incorporate the notion of the temporal rearrangement of story events such as flashback or foreshadowing. For example, MINSTREL, a story generation program written by Turner (1994), used a foreshadowing technique to avoid a sense of contrivance for implausible events. In the project named Carmen's Bright IDEAS (Marsella et al., 2000; Marsella et al., 2003), flashback and flashforward were used, where flashback was used to represent a character's past events and flashforward was used to represent a character's imagination of future events. While those systems have addressed the importance of temporal aspects of storytelling, they have not provided a systematic framework for its manipulation that considers a reader's emotion as a cognitive response.

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[1] An example of this kind of flashforward can be found in the movie *American Beauty* (1999) in which Lester, the narrator and also a main character in the film, explicitly announces his death at the beginning of the film. A similar flashforward introducing a protagonist's death at the beginning of the film, without the help of a narrator, is cleverly used in the film *Pan's Labyrinth* (2006).

[2] Stephen King's famous novel '*The Dead Zone'* and the TV series with the same title based on this novel show an effective use of this kind of flashforward.

1.2 Applications

Surprise plays an important role in both entertainment and education. In terms of entertainment, surprise has a functional role of maintaining and focusing attention, which helps to keep the audience from distraction. Specifically, in stories with surprise endings, surprise is often connected with sudden reversals of fortunes. Thus in typical non-tragic narratives, an antagonist appears to succeed in achieving his or her goals, but a protagonist finally succeeds by surprise (Tan, 1996). For example, at the climax in the movie *21* (2008), Professor Micky Rosa, the antagonist, appears near the end of the film to achieve his final goal, but the film's conclusion comes with a surprising reversal[3]. These reversals and the reader's sense of surprise they foster contribute to maintaining the viewer's attention in the story.

We learn from our failure. For the same reason, surprise based on unexpectedness or expectation failure can play a central role in education and learning. According to Schank (1982), the events that are accompanied by unexpectedness are more readily recalled. Specifically, empirical studies have shown that surprise caused by unexpected important failures can motivate a causal search to find the cause of the unexpectedness in surprise (Gendolla and Koller, 2001). The experience of learning can be enhanced through this causal search process. Flashback in films, specifically in the detective/mystery genre, has often provided a functional role of explaining "what actually happened" to the viewer as a way of resolving unexpected surprise in the story.

1.3 Problem Statement

There are two main goals of this dissertation. The first is to develop a computational model of surprise arousal in narrative considering a reader's emotion as a cognitive response that is elicited by the surprising events. The second is to evaluate the computational model empirically. In this work, I define the concept of surprise in narrative as follows, borrowing from the definition of surprise in narrative defined by Prince (2003):

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[3] In the movie, Ben Campbell, the protagonist, also suffers reversal of fortunes several times.

Concept 1.2 (Surprise in Narrative). *Surprise in narrative refers to the emotion of a reader, which is obtained when expectations about what is going to happen are violated by what in fact does happen.*

In this dissertation I focus on the structural aspect of narrative based on the two-tier model of narrative described above. My approach to surprise arousal (or generation) in narrative is strongly motivated by Structural Affect Theory (Brewer and Lichtenstein, 1981; Brewer and Lichtenstein, 1982; Tan, 1996), which claims that different discourse structures in narratives can elicit different emotions as cognitive responses. As for surprise, specifically, Structural Affect Theory claims that surprise can be elicited by sudden presentation of an event that has an important story outcome without presenting crucial information related to the story outcome.

As an example of surprise arousal in Structural Affect Theory, consider a chronological sequence of four story events[4] as in Figure 1.1 (from Brewer and Lichtenstein, 1981). According to the Structural Affect Theory, a narrative to produce surprise has a discourse organization in which "a significant underlying event or expository information is omitted from the discourse structure without letting the reader know that something has been omitted (Brewer and Lichtenstein, 1981)." Thus a discourse structure for surprise arousal is: (2) The butler carried the wine to Lord Higginbotham. (3) Lord Higginbotham drank the wine. (4) Lord Higginbotham fell over dead. In this discourse structure, surprise is elicited because the

(1) BUTLER PUTS POISON IN WINE

(2) BUTLER CARRIES WINE TO LORD HIGGINBOTHAM

(3) LORD HIGGINBOTHAM DIRINKS WINE

(4) LORD HIGGINBOTHAM DIES

Figure 1.1: An example of chronological sequence of story events (from Brewer and Lichtenstein

[4] In their papers, Brewer and Lichtenstein (1981; 1982) use the terms *event structure* and *discourse structure*. The former refers to a chronological sequence of story events; the latter refers to a temporally rearranged discourse out of their chronological order.

omission of significant expository information (i.e., Event 1) without the reader's awareness. As a result Event 4, which is the consequence of the omitted Event 1, will be unexpected and surprising. While the emotion of surprise is often not clearly distinct from other emotions such as suspense or curiosity (e.g., the discourse structure for curiosity arousal may also elicit surprise or suspense to some extent), I distinguish them in this dissertation and focuses only on the discourse structure for surprise arousal[5].

Motivated by Structural Affect Theory, I propose a system that can elicit surprise by identifying surprising events, important outcomes in the story, and the initial and crucial information related to the surprising outcome. For the presentation of this kind of discourse structure, my system makes use of narrative models with flashback and foreshadowing. As a result, my system will produce a narrative with non-chronological time including a surprising event (which will result in an important story outcome), flashback as an explanation of the surprising events, and foreshadowing to mention the flashback in advance.

> **Concept 1.3 (Narrative with Non-chronological Time).** *A narrative with non-chronological time in this work refers to a narrative in which story events are presented out of chronological order on purpose. In this dissertation, a narrative with non-chronological time is generated for the purpose of surprise arousal.*

For the selection of surprising events in narrative, I also adopt a cognitive model of surprise based on expectation failures and use a reader model on the basis of a partial-order planning algorithm to simulate a reader's reasoning process.

1.4 My Approach

To generate narratives with non-chronological time, I start from an approach that is built on a narrative model with two parts – story and discourse. The story part of a narrative is generated by Longbow, a discourse planner employing a partial order causal link planning

[5] Section 5.1.2 briefly discusses a possible combination of suspense and surprise.

algorithm with hierarchical action decomposition[6] (Young, Pollack, and Moore, 1994). The story plan generated by Longbow has a partial-order plan structure, in which only the necessary chronological information between story events is specified. Figure 1.2 illustrates a representation of a partial-order story plan that corresponds to the sequence of story events as described in Figure 1.1. In the figure, a square box represents a plan step that corresponds to an event in the story. Specifically, a graded square box represents either the initial state or the goal state. A directed arc represents a causal relationship between steps. In the story plan in Figure 1.2, there are three initial conditions – *has(Butler, Wine)*, *has(Butler, Poison)*, *ofButler(Butler, Lord)* – and one goal condition – *dead(Lord)*. The story plan is dynamically generated by a story planner to achieve the specified goal condition from the initial state. The details of story plan structure are discussed in Section 3.1.1.

The discourse generated by my system is a non-chronological narrative for the purpose of surprise arousal. The discourse is generated by an algorithm motivated by Structural Affect Theory, in which important expository information is not presented until a surprising event occurs. For example, in Figure 1.2, *Fall-over-dead (Lord, Wine)* plan step is unexpected when the reader is unaware of the fact that the wine is poisoned, which is resulted from the omission of *Put-poison (Butler, Wine)* plan step. While the Structural Affect Theory does not differentiate surprise from unexpectedness, I draw a distinction between them. Section 3.2.2 describes this difference in detail.

My approach is also based on a cognitive model of surprise and empirical studies of the reader's emotions while reading. As a story plan has more plan steps, the number of surprising events and their relevant expository information in the story plan would increase exponentially. Therefore an effective evaluation methodology is necessary to select the best discourse structure to produce surprise. The surprise evaluation process in my system makes use of four factors: expectation failure based on a cognitive model of surprise causes, importance of events on the basis of causal relations between story events, emotional valence

[6] In this dissertation, I do not use the hierarchical decomposition capability of Longbow.

considering a reader's preference, and resolution of incongruities in surprise. This evaluation process is described in Section 3.2.2 in detail.

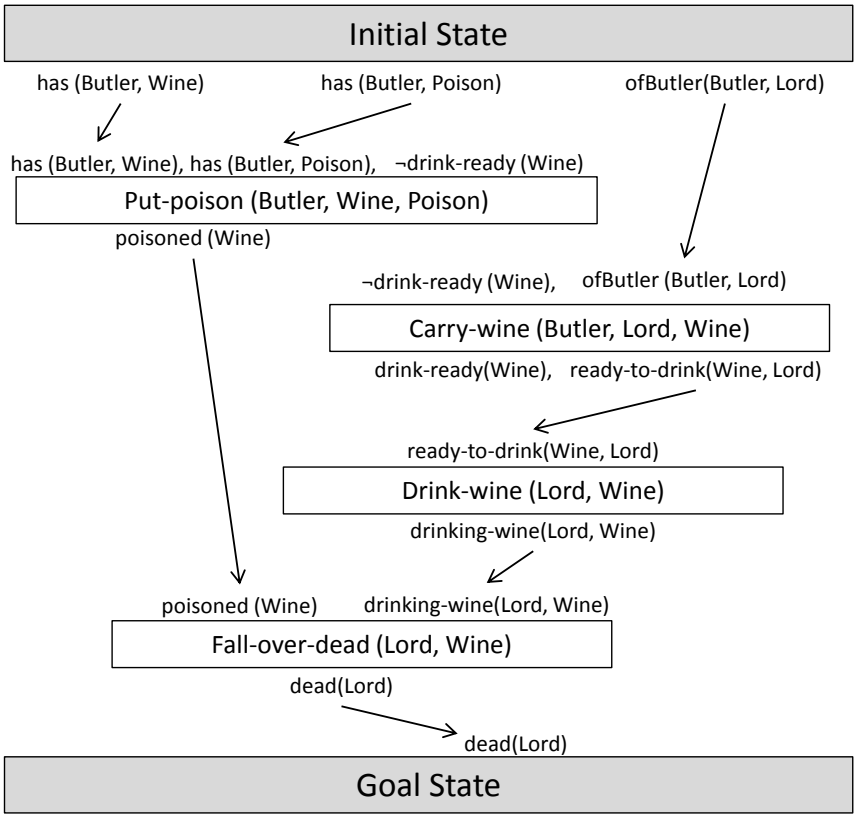

Figure 1.2: A story plan representation that corresponds to the sequence of story events shown in Figure 1.1

1.5 Contributions

There are two contributions made by this dissertation. First, I present a computational framework for narrative generation designed to elicit surprise. The approach makes use of a two-tier model of narrative and draws on Structural Affect Theory. While empirical studies have demonstrated the validity of this theory, few attempts have been made to specify a computational framework using it. The presented computational framework will generate a narrative with non-chronological discourse structure using two narrative devices - flashback and foreshadowing. Second, I present a methodology to evaluate surprise in narrative

generation using a planning-based approach based on the cognitive model of surprise causes put forward by Ortony and Partridge (1987). The results of the experiments that I conducted show strong support that my system effectively generates a discourse structure for surprise arousal in narrative.

1.6 Thesis Organization

This dissertation is organized as follows. Chapter 2 reviews related work in the area of narrative theory, cognitive models of surprise, and story generation systems. Next, Chapter 3 presents Prevoyant, a planning-based computational model of surprise arousal in narrative generation. Then, Chapter 4 presents an evaluation of Prevoyant and discusses the results of two experiments that I conducted. Lastly, Chapter 5 concludes with discussion of future work with consideration of limitations of my approach.

Chapter 2

Related Work

In 1976, James Meehan developed a storytelling system called *Tale-Spin,* one of the first attempts at automatic story generation. Since Tale-Spin, a number of story generators have introduced various ways to build (or to present) a better story in terms of creativeness, story comprehension, interest, etc. This chapter outlines major previous efforts closely related to my research. Section 2.1 draws on ideas of narrative structure associated with temporality and cognitive emotions of the reader, highlighting two narrative devices – flashback and foreshadowing. Section 2.2 discusses the use of situation models in narrative, i.e., the reader's mental model while reading a story. Various computer models of story generation are reviewed in Section 2.3.

2.1 Narrative Structure, Temporality, and Reader's Emotions

Story and discourse, according to narrative theorists, are two main elements that comprise a narrative (Chatman 1978; Prince 2003). Story includes characters, setting, and events, consisting of the content plane (i.e., *what* is told) of a narrative; discourse represents the expression, or presentation, plane (i.e. *how* it is told) of a narrative (Chatman 1978). Figure 2.1 depicts the story and discourse distinction model of a narrative text (Chatman 1978: 19).

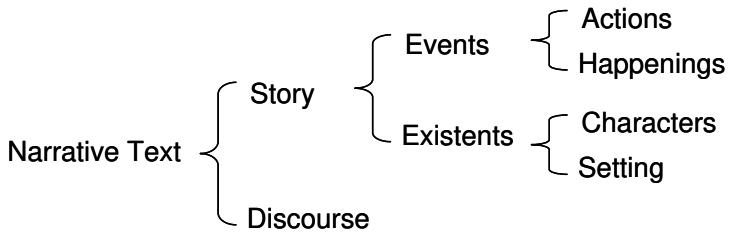

Figure 2.1: Story and Discourse as Essential Elements in Narrative Text [from Chatman 1978]

2.1.1 Time in Narrative

In the story-discourse model of a narrative, there exist two different levels of time. One is story time experienced by the characters in the story world. The other is discourse time experienced by readers. The events in the story level are related temporally and causally based on their natural order of occurrence, but they are often rearranged in the discourse level intentionally. In other words, authors can let the readers know about some facts in advance or hide some information until a certain point for a dramatic effect. The narrative theorist Genette (1980) explains this temporal disparity between story time and discourse time with respect to three major components of temporality: duration, frequency, and order.

First, duration of narrative refers to temporal features such as pace (or speed), summary, and pause in a narrative. As a rule of thumb, a span of trivial actions or events in the story time is shortened or skipped in the discourse time. Similarly, a span of important actions or events can be lengthened in the discourse time. By omitting details, a single story event can be described in a few sentences or in a few pages. While story time is unstoppable, discourse time can be frozen by description.

Second, narrative frequency explains that single story event can be repeated in the discourse time (or vice versa). In the German film *Run Lola Run* (1998), for example, the same story event, which has occurred only once in a story time, is cleverly repeated in the discourse time with different viewpoints (and with slight variations).

Third, Genette explains narrative order using the terms *analepsis* and *prolepsis*. Analepsis tells (or shows) what has happened in the past with respect to the present. Similarly, prolepsis presents what will happen in the future with respect to "now" in the story

(Bridgeman, 2005). The former is like rewinding the story, and the latter is like fastforwarding the story. In this dissertation, I use the terms *flashback* as an instance of analepsis and *foreshadowing* (or *flashforward*) as that of prolepsis, following the conventions in cinematic media (Bordwell 1985; Chatman 1978; Sijll 2005). The following section delineates flashback and foreshadowing (or flashforward).

2.1.2 Narrative Devices Relevant to Narrative Time

As explained in Chapter 1, both flashback and foreshadowing are narrative devices that present story events out of temporal order. Flashback describes some past events related to the present; foreshadowing gives allusion (possibly implicit) to some future events. Typically in film media, flashback often functions as a backstory to support a main story[7] (Sijll 2005), being presented either as a continuous sequence or as a series of cut scenes showing only the crux of the backstory.

By contrast, foreshadowing, as "hints of what is to come" (Chatman 1978), gives only implicit or partial information. If foreshadowing is completely implicit, the reader would realize its meaning later only in retrospect. If it is explicit with partial information, the reader is forced to fill in the information gap in her mental representation of the story. This kind of foreshadowing plays a role of focusing the reader's attention on a specific event.

While foreshadowing implicitly alludes to the future event so that the reader usually cannot recognize its meaning until the event actually happens, flashforward explicitly presents the future event so that the readers can be aware of it immediately[8]. The distinction between foreshadowing and flashforward, however, may not be clear in film narratives in which flashforward can be partially explicit with help of the camera (e.g., a shot in which a character's face is hidden by manipulation of the camera angle).

Narrative devices such as flashback and foreshadowing manipulate temporal order of story events at discourse level, influencing the reader's story comprehension. The following

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[7] Flashback can also be used to refer to an entire main story. For example, a narrator can tell a main story as a form of flashback in retrospect, often with the first person prospective. In this dissertation, I focus only on flashback that functions as a backstory.

[8] Based on Genette's terminology, foreshadowing is an example of *advance mention* and flashforward is an example of *advance notice*. The former is implicit; the latter is explicit.

section describes the relationships between the temporal discourse characteristics and the reader's emotions associated with the discourse structure.

2.1.3 Reader's Emotions and Narrative Structure

Emotions based on the reader's cognitive responses (e.g., suspense, curiosity, and surprise) provide the readers with attention, contributing to the readers' satisfaction with the story (Alwitt 2001; Tan 1996). These emotions, according to the Structural Affect Theory (Brewer and Lichtenstein 1981; 1982), can be aroused by manipulation of temporal characteristics in narrative structure. Empirical studies have shown that this temporal manipulation of discourse structure can produce different cognitive and emotional responses by influencing the reader's inferences and anticipation (Hoeken and van Vliet 2000; Levorato and Nemesio 2005). My study combines this empirical result of the Structural Affect Theory with the two narrative devices – flashback and foreshadowing – for surprise arousal in narrative generation.

We read books not just to acquire information but also to receive some kind of reward or to stimulate interest through reading (Kintsch 1980; Sijll 2005). According to Oatley (1994), a reader's emotions as literary response can be classified into two types – *external* and *internal*: *external* emotions are evoked as the reader confronts the pattern (i.e., schema or structure) of the narrative; *internal* emotions are aroused as the reader enters the story world described in the text. Cognitive responses such as curiosity or surprise epitomize external emotions that occur from narrative structure. Empathy with characters in the story is an example of internal emotions. This classification is in accord with Kintsch's distinction between *cognitive interest* and *emotional interest* (Kintsch 1980). The former is given from a well-organized discourse structure; the latter from emotional context in the story. In this dissertation I focus only on surprise as cognitive interest, separating from emotional interest or internal emotions.

Excluding emotional interest, Kintsch introduces the notion of *postdictability* that can contribute to the value of cognitive interest regardless of story types (Kintsch 1980). Postdictability characterizes a story structure in which every part makes sense for the reader

as a whole so that she can construct "a coherent macrostructure" with no conflict in retrospect. Without postdictability, unexpected events will produce no interest to the reader. For this reason, surprise associated with unexpected important story outcome should be postdictable ((Kintsch 1980; Tan 1996).

2.2 Reader Models for Narrative Comprehension

This section reviews the research on text comprehension and inferences of readers from the viewpoint of cognitive psychology. Section 2.2.1 outlines situation models in narrative comprehension to explain how the readers understand the narrative in text. Section 2.2.2 describes the three-pronged approach as an integrated effort to combine a discourse model, methodologies, and online measures for identifying readers' inferences in text comprehension.

2.2.1 Situation Models

When reading a text, readers bring up a mental representation, either obvious or blurred, based on several factors such as general world knowledge or contexts from the text. Discourse psychologists claim that a cluster of information is conveyed from the text to the reader's mind, capturing what the author wants to tell in the text (Graesser and Wiemer-Hastings, 1999). Readers continuously update their mental representations of the story through interpretation and logical inferences based on incoming information. Situation models refer to these mental representations of situations which are constructed in the readers' mind. Zwaan (1999a) explains situation models as "mental representations of the state of affairs described in a text rather than the text itself."

As for detailed processes of how the situation models work, there have been several distinct claims such as the constructionist theory (Graesser and Wiemer-Hastings, 1999) and the event-indexing model (Zwaan, Langston, and Graesser, 1995; Zwaan, 1999b). While both theories illustrate the readers' mental model while reading a story, they have different views. The constructionist theory puts more concentration on causation and motivation than the other factors.

2.2.1.1 The Constructionist Theory

The constructionist theory is a situation model that explains a reader's mental representation for the comprehension of a narrative text, taking two distinguished assumptions: coherence and explanation (Graesser, Singer, and Trabasso 1994; Graesser and Wiemer-Hastings 1999). In the coherence assumption, coherence among the actions, events, and states described in the text plays an important role to build a situation model. This coherence is built by establishing both local and global coherence. While the local coherence is established by linking incoming explicit statement to recent propositions in the reader's working memory, the global coherence is established when chunks of local information are grouped into a higher-level information. For example, the coherence for a high-level theme of a text can be established by linking several chunks of low-level episodes. The explanation assumption, on the other hand, posits that causal explanations for 'why' questions are essential to construct a situation model.

As an illustration of the inference process in the constructionist theory, consider a sample scenario in Figure 2.2 provided by Graesser and Wiemer-Hastings (1999).

> Two brothers were always in competition over money and success. George unfortunately went bankrupt the same year that Bill made his first million. Bill threw a New Year's Eve party that ended up being quite a festive occasion. But everyone sobered up very quickly when George was caught kissing Bill's wife.

Figure 2.2: A sample scenario [from Graesser and Wiemer-Hastings, 1999]

According to the constructionist theory, the reader makes a specific set of inferences, which are superodinate goal, causal antecedent, and causal explanation, in the process of constructing a situation model by answering the question 'why did George kiss Bill's wife?'. However, the reader fails to make another set of inferences, such as elaboration of subplans, causal consequence or expectation, and spatial setting, because these could not be the answers for 'why' questions. The constructionist theory models a reader's comprehension

and inferences by means of causal and motivational relations, which is independent of narrative genres or reading situation.

2.2.1.2 The Event-Indexing Model

The event-indexing model (Zwaan, *et al.* 1995) uses five types of event indices, which are temporality, spatiality, protagonist, causality, and intentionality, to explain a reader's continuous updating of her mental representation for text information while reading a story. Zwaan and Radvansky (1998) claim that a break of logical inference on any of these five dimensions can make a substantial influence on the reader's reading time.

The event-indexing model places equivalent emphasis on those five dimensions. Therefore, in addition to the inference based on 'why'-questions, other inferences associated with 'when' (time), 'where' (place), and 'who' (character) could be evaluated in the process of construction of a situation model. Regarding the time index, specifically, Zwaan et al. (2001) claim that story plots are often conveyed more effectively by shuffling the order of story events, stressing the importance of temporal reordering in narrative.

2.2.2 Effort of Convergence: Three-Pronged Approach

Situation models characterize a reader's mental representation of narrative comprehension, apart from discourse models or methodologies. The three-pronged approach (Suh and Trabasso 1993; Magliano 1999) presents a systematic approach to the analysis of the reader's narrative comprehension by integrating three procedures: theory, methodologies, and measures.

First, as a theory, the causal network model (Trabasso and Sperry 1985) is proposed as a narrative analysis model where a story is represented by a causal network comprising events and causal relations. Based on Warren *et al.* (1979)'s taxonomy of causalities (see Trabasso and Sperry 1985), six types of causal relations are analyzed: motivation, psychological causation, physical causation, enablement, temporal succession, and temporal coexistence, where 'enablement' indicates that some actions, or states, are necessary to cause other actions, or states, but are not sufficient; for example, a state of 'Donkey being at Bridge' is a necessary condition of a state of 'Donkey falling off Bridge' but not a sufficient condition.

Next, as methodologies to elicit verbal inferences, two protocols are suggested: think-aloud protocol and question-answering protocol. The think-aloud protocol allows respondents to speak any inferences occurred to them during the process of discourse comprehension, which is suitable for identifying the frequency of various types of inferences. On the other hand, the question-answering protocol encourages respondents to answer a specific kind of inference. In general, based on world knowledge, prior text, and inferences, three kinds of questions are evaluated: 'why'-questions for explanations, 'how'-questions for associations, and 'what-happens-next'-questions for predictions.

Last, as simple online response measures, sentence reading times and priming latencies are recommended to evaluate, where *Priming* denotes "a change in the response to a stimulus (i.e., the *target*) due to a recent exposure to it or a similar stimulus (i.e., the *prime*) (Neely 2003)."

2.3 The Emotion of Surprise

To a large extent, surprise is connected to different emotions with two opposite hedonic tones: surprise with pleasantness and surprise with unpleasantness. Pleasant surprise can be elicited when a desirable event confirms unexpectedly, or when an undesirable event disconfirms unexpectedly. Unpleasant surprise can be elicited when a desirable event disconfirms unexpectedly, or when an undesirable event confirms unexpectedly (cf. prospect-based emotions: Ortony, Clore, and Collins, 1987: p.110). The former experience can give rise to happiness and relief. Sadness (or disappointment) and shock can arise from the latter. Therefore, surprising events – strictly speaking, the *unexpectedness* in the surprising events – elicit surprise which is then followed by other emotions with differing valence, depending on the appraisal of the surprising events. Thus the more surprising events we have in our daily life, the more emotionally dramatic life we experience.

In narratives, surprise plays two important roles. One is to focus a reader's attention by the sudden presentation of an important event (Brewer and Lichtenstein, 1982), creating an inference gap that makes a reader pause at the moment. The other is to stimulate a reader's cognitive and emotional processes, which are prompted as an effort to resolve reader's

understanding of the unexpected situation. A proper resolution will satisfy the reader both intellectually and emotionally, which is of major importance for storytelling. In contrast, an improper or failed resolution will make a reader frustrated or disappointed.

2.3.1 Cognitive Models of Surprise

Many of the previous efforts to study surprise differ in their details, but are in agreement when considering the notion that expectation failure or expectancy disconfirmation elicits surprise (Meyer, Reisenzein, and Schützwohl, 1997; Ortony and Partridge, 1987; Stiensmeier-Pelster, Martini, and Reisenzein, 1995). In particular, Ortony and Partridge (1987), describe three causes for surprise: active expectation (or prediction) failure, passive expectation (or assumption) failure, and unanticipated incongruities. Active expectation failure occurs when input is in conflict with a situation that is actively inferred by an agent (e.g., one sits down to watch one's favorite TV show, but then finds out that the show is canceled and another show is running in its place). Passive assumption failure occurs when input, which is not actively entertained by an agent at the time, is in conflict with an agent's knowledge structure or belief (e.g., one finds out one's neighbor is on TV while watching one's favorite TV show). Unanticipated incongruity includes "deviation from normalcy" (e.g., one watches one's favorite TV show in which one's favorite character suddenly talks to the camera, addressing the audience directly). Although these distinctions are often blurred in both real life and in narratives, their analysis sheds some light on the cognitive models of surprise. More details about how my model adopts the expectation failure are explored in Section 3.2.2.1.1.

Like the Ortony and Partridge's threefold model of surprise causes, the expectancy-disconfirmation model of surprise (Meyer, Reisenzein, and Schützwohl, 1997; Stiensmeier-Pelster, Martini, and Reisenzein, 1995) is based on unexpectedness. According to the expectancy-disconfirmation model, surprise is elicited when the disconfirmation of expectancy is detected. This detection evokes an *attributional* search – a spontaneous and active causal search to resolve the discrepancy between expectancy and what actually happened. Factors such as valence and importance of events influence this *causal* search

(Gendolla and Koller, 2001). This expectancy-disconfirmation model is compatible with the computational model suggested by this dissertation, where the reader's effort to understand flashback corresponds to the causal search process.

2.3.2 Models of Surprise in Narrative

In narratives, one of the main functional roles of surprise is to stimulate a reader's cognitive interest, which can be drawn out from the narrative structure rather than the emotional impact of the story (Kintsch, 1980). The experience of surprise then contributes to the reader's story interest (Brewer and Lichtentein, 1982). Specifically, the evoked surprise should be resolved without any conflicts against other narrative elements in the story, that is, surprise should be *postdictable* (Kintsch, 1980). The notion of postdictability is compatible with the concept that achieving story coherence is essential in the assessment of surprise (Grimes-Maguire and Keane, 2005).

With regard to the generation of surprise in narrative, Structural Affect Theory (Brewer and Lichtenstein, 1982) suggests that surprise can be evoked in a reader's mind by the sudden presentation of a significant story event without the reader's awareness of the omission of its initiating events (that is, the critical information related to the significant event). Adopting this Structural Affect Theory, my system selects the *Significant Event* and its *Initiating Events*, and then generates a narrative structure that can elicit surprise by presenting the *Initiating Events* after the presentation of the *Significant Event*, using a planning-based approach. It also suggests the use of foreshadowing to enforce postdictability.

2.4 Computational Narratives with Nonlinearity

Storytelling is one of the finest artifacts created from humans. For entertainment and for education, storytelling has served to stimulate our intelligence and our emotions, which is refreshing and necessary to our everyday life. For this reason, a wide variety of story generation systems have focused on how storytelling can reflect human intelligence and emotions. This section reviews previous computational efforts about story generation and storytelling in terms of interactivity, narrative space, and narrative time.

2.4.1 Narrative Generation with Nonlinear Narrative Space

Traditionally narratives have been linear in terms of interactivity or narrative space. A linear story refers to a story that has a particular beginning and a particular ending. In the linear story, there is only one path from the story beginning to the story ending. The reader may pause in the middle of reading, but he or she will continue to read it after the break. The advent of digital media, such as hypertext, the World Wide Web, and virtual environments in the games, however, has greatly contributed to the development of interactive digital storytelling based on non-linearity. The interactive aspect of nonlinear narratives is closely associated with narrative space in which the reader (or the player) traverses a story world, influencing the story unfolding and the ending as well as characters and settings of the story.

2.4.1.1 Universe

The goal of Universe story generation system is to produce soap-opera type stories, which are characterized by similar plots with different character development (Lebowitz, 1984; Lebowitz, 1985). To generate theoretically never-ending stories, Universe extends the previous story plot repeatedly by interweaving various character backgrounds, such as family relations and interpersonal relationships, as most soap operas actually do.

Universe generates a story using a planning algorithm, keeping consistency and coherence in character development. Thus the extended story events, which are performed or experienced by the story characters with extended backgrounds, make sense without any conflict with existing story events in terms of causality. These coherent story events are combined with the character development information, making up a *plot fragment* which includes characters, constraints, goals, and subgoals. Story plans are generated by selecting appropriate plot fragments to achieve various author-specific goals.

Universe has a nonlinear narrative space structure because of its boundless extensibility using the concept of plot fragment and character development, which provides central ideas with later nonlinear interactive systems.

2.4.1.2 The Oz Project

The Oz project (Kelso, Weyhrauch, and Bates 1993) is a converged effort to generate a successful interactive drama, focusing on three major elements: believable characters, presentation technique, and drama theory. In order to simulate a user's response to an interactive drama in the virtual environments, they conducted "first live interactive improvisation" experiments with human actors and a drama director. The experiment has revealed two results: (1) the response to the interactive drama between observers (i.e., the audience who do not participate in the interactive drama) and the interactors (i.e., the users or the audience who participate in the interactive drama) is very different; (2) the interactors can immerse to the interactive drama more than the observers without disturbing the "suspension of disbelief" in spite of some obvious inconsistent behaviors of characters.

The interactive story model in the Oz project is represented by a simple plot graph, using DAG (Directed Acyclic Graph), as shown in Figure 2.3, where the nodes stand for major scenes (i.e., events and situations); directed arc decides partial and temporal ordering between nodes (i.e., scenes). A goal of the plot graph is to maintain balance between author's control and interactor's freedom, which is essential for the successful interactive drama. Specifically, hints and obstacles attached to the nodes are provided through monitoring the interactor's behavior, which enables to control the pace of the drama.

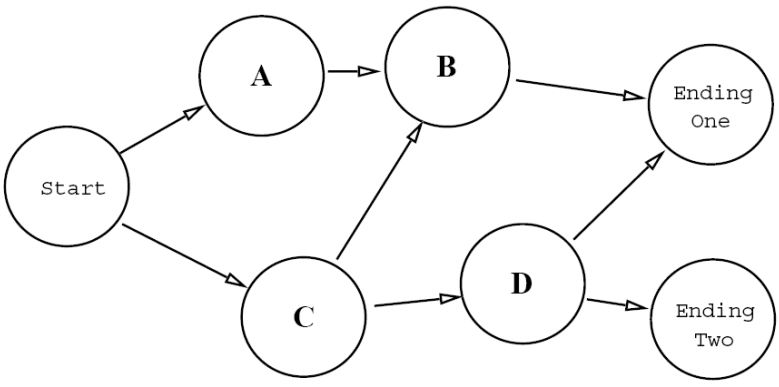

Figure 2.3: A simple plot graph for an interactive drama in the Oz project [from Kelso, Weyhrauch, and Bates 1993]

2.4.1.3 Façade

The experiment in the Oz project has shown a possibility of successful interactive drama while maintaining both character's free expression and author's coherent plot. Façade, a real-time animated virtual interactive drama (Mateas and Stern 2003), has moved the small stage of Studio Theater of Carnegie Mellon at the experiment to a much smaller computer monitor and replaced the human actors with computer-controlled non-player characters (NPCs) such as Grace and Trip, the believable agents equipped with natural language understanding unit.

In Façade, a user plays the role of a guest character visiting Grace and Trip, a couple who have some serious relationship problems. The player interacts with Grace and Trip, through typing appropriate sentences at each critical juncture, influencing on the drama unfolding and ending. The two believable agents, Grace and Trip, help the player explore the drama space without harming a coherent drama plot under the programmed guidance of a drama manager. For this programmed improvisation, the behaviors of Grace and Trip are determined by story units called "beats", a collection of behaviors for specific situation. Figure 2.4 shows an overall architecture of Façade.

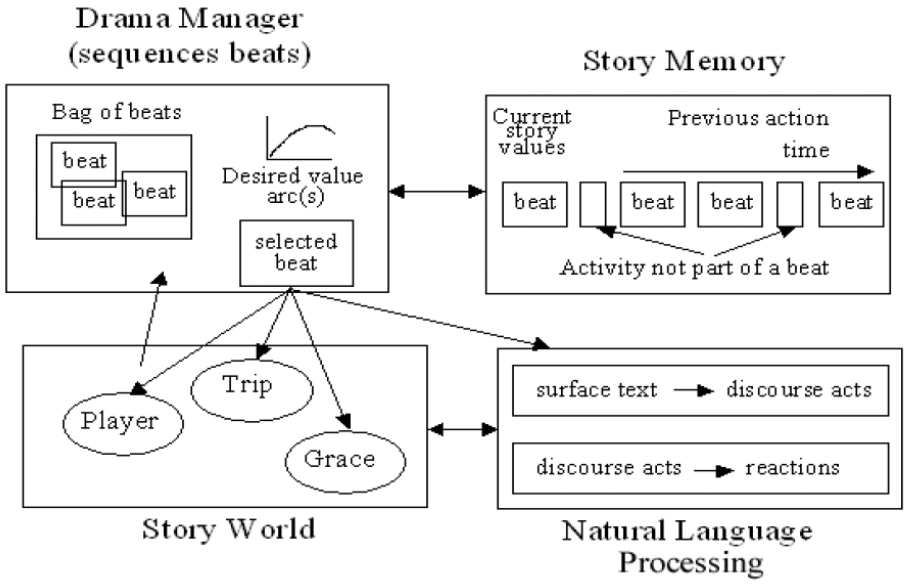

Figure 2.4: Façade architecture [from Mateas and Stern 2003]

2.4.2 Narrative Generation Using Nonlinear Narrative Time

Chronological narratives refer to the narratives in which stories are told in chronological order from the story's beginning to the story's end. In other words, the ordering of story events at discourse level is identical to that of story events at story level. In non-chronological narratives, by contrast, stories can be told out of chronological order, so they need to be reconstructed in chronological order in the reader's mind. As a result, the reader needs to make more efforts to comprehend the story when presented in non-chronological order.

2.4.2.1 MINSTREL

Creative thinking is one of the highest features of humans as well as a major goal to achieve in education. As a rule of thumb, creativity can be categorized in two ways: creation from scratch and adaptation from different domain. MINSTREL (Turner 1994) uses case-based reasoning to adopt the latter definition as a model for creativity. Considering storytelling as a problem-solving process, MINSTREL finds a solution with three steps using the creativity model: (1) slightly modify a given problem description; (2) recall a solution to similar past problems in another domain; (3) adapts the solution fitting to the original problem domain.

To solve this storytelling problem, MINSTREL looks for search space to accomplish three author-level goals – theme, consistency, and drama. Thematic goals denote moral or message in the story. Consistency goals characterize believable characters and reasonable actions without inconsistencies in terms of planning and emotion. Drama goals define four dramatic writing techniques such as tragedy, suspense, characterization, and foreshadowing, where characterization is similar to the character development in Universe (Lebowitz, 1984).

MINSTREL is one of the first story generation systems using foreshadowing, a narrative device for temporally nonlinear storytelling. To select what to foreshadow (i.e., the content of foreshadowing) and when to foreshadow (i.e., the location of foreshadowing), MINSTREL uses two domain-independent heuristics. One is a heuristic to choose foreshadowing content in order to avoid a sense of contrivance. To this end, MINSTREL searches for a combination of an action and its effect which is unique or uncommon. The combination of action and its effect is considered as unique if it is not found in the

The Mistaken Knight

It was the spring of 1089, and a knight named Lancelot returned to Camelot from elsewhere. Lancelot was hot tempored. Once, Lancelot lost a joust. Because he was hot tempered, Lancelot wanted to destroy his sword. Lancelot struck his sword. His sword was destroyed.

One day, a lady of the court named Andrea wanted to have some berries. Andrea wanted to be near the woods. Andrea moved to the woods. Andrea was at the woods. Andrea had some berries because Andrea picked some berries. At the same time, **Lancelot's horse moved Lancelot to the woods. This unexpectedly caused him to be near Andrea.** Because Lancelot was near Andrea, Lancelot loved Andrea.

Some time later, **Lancelot's horse moved Lancelot to the woods unintentionally, again causing him to be near Andrea.** Lancelot knew that Andrea kissed with a knight named Frederick because Lancelot saw that Andrea kissed with Frederick …

Figure 2.5: A foreshadowing example in the story *The Mistaken Knight* created by MINSTREL [from Turner, 1994]

MINSTREL's memory. If multiple combinations are found, one combination is randomly chosen. In Figure 2.5, for example, the action-effect combination "Lancelot's horse moved Lancelot to the woods unintentionally causing him to be near Andrea**.**" in the third paragraph is selected as a foreshadowing because of its uniqueness.

The other heuristic selects foreshadowing point (or location). To this end, MINSTREL searches through the story point that has an action or a state that is similar to that of the foreshadowing content. In the above example, the state "Lancelot is near Andrea" is located prior to the event "Lancelot loves Andrea" as a precondition. Thus the action and effect combination "Lancelot's horse moved Lancelot to the woods. This unexpectedly caused him to be near Andrea" is copied as foreshadowing before the event "Lancelot loves Andrea." As a result of this foreshadowing scene, the story appears more natural, avoiding a feeling of contrivance.

While MINSTREL's approach for foreshadowing is admittedly weak, it introduces two important characteristics of computational foreshadowing – what to foreshadow and when to foreshadow. Since MINSTREL copies the foreshadowing content from some later events in the story, it avoids a sense of contrivance and develops a sense of unity. In addition, this kind of foreshadowing does not mislead the reader unlikely *snares* or *red herrings* mentioned in Chapter 1, which may undermine a reader's focus on the story. Carefully designed snares, however, can enhance the story (see Barthes 1974: 32), serving as a way of delay of the truth. Twister (Platts, *et al.* 2002) in the next section addresses an interesting approach to generate a twisted ending for surprise.

2.4.2.2 Twister

Twister (Platts, Blandford, and Huyck 2002) is a story generation program aiming at creating a story with twist in its climax. As a result of the twisted story, unexpectedness and surprise is produced in the reader's mind.

Twister creates a story with twist ending by combining two parallel stories – an overt story and a concealed story. Specifically, some important expository information is omitted from the concealed story. When an overt story ends with its climax and another twisted story comes after it, the reader realizes that there was hidden expository information by backward reasoning. Taking a seed story as input, Twister generates a twist and a post-twist story (i.e.,

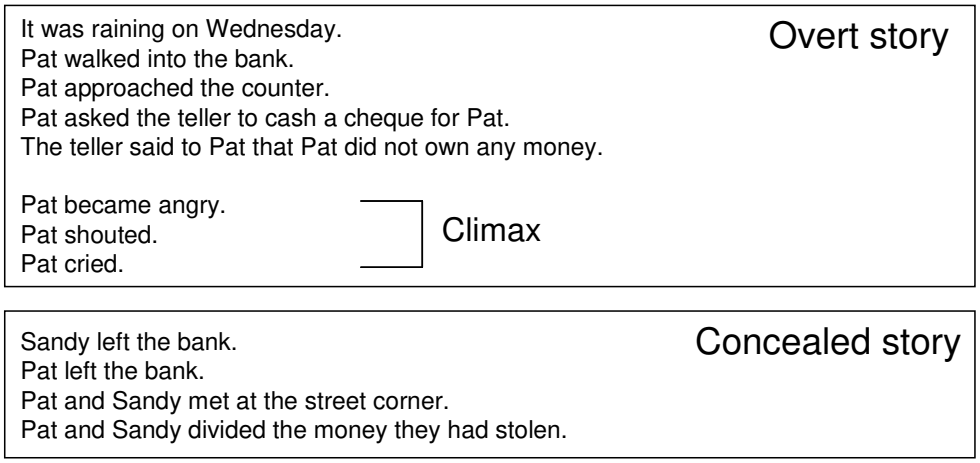

Figure 2.6: A twist-centered story example by Twister (from Platts, Blanddford, and Huyck 2002)

a covert story without some important expository information) in the following three steps. First, Twister builds an overt story on the basis of the seed story and locates its climax, as shown in Figure 2.6. Next, Twister builds a concealed story by slightly modifying the climax. Last, both overt and concealed stories are merged into one twist-centered story by resolving conflicts between the two stories. Overall, the overt story generated from the input seed story plays a role of setup to mislead the readers. The concealed story provides the readers with unexpected twist, contributing to the reader's surprise and interest.

While the process for building twisted stories might be similar to that of human authors, the detailed process to create a concealed story was not presented in the paper. Also, as the paper points out, the sudden introduction of the concealed story may undermine the story coherence.

2.4.2.3 Carmen's Bright IDEAS

Carmen's Bright IDEAS (CBI) is a multimedia title for an interactive pedagogical drama where a main character, Carmen, is a mother of two children – a nine-year old son suffering from pediatric leukemia and a six-year old daughter (Marsella, Johnson, and LaBore 2000; 2003). CBI is *interactive* in that a participant who plays a drama character named Carmen can choose Carmen's thoughts and emotions, helping her make some important choices at each critical juncture; *pedagogical* in that the participant playing Carmen can learn a problem solving skill with a positive (i.e., "Bright") viewpoint and a procedural method named IDEAS which stands for the five sequential procedures: "**I**dentify a problem", "**D**evelop possible solutions", "**E**valuate your options", "**A**ct on your plan", and "**S**ee if it worked". This multimedia drama is consisted of three acts in which the participant playing Carmen can learn a coping skill while discussing her problem with a virtual counselor named Gina. The story was scripted by a professional scriptwriter.

CBI explores both spatial and temporal nonlinearity. Through interaction with Carmen, the participant can traverse the drama story space in a nonlinear manner (i.e., branching at critical story moments). In addition, CBI suggests the use of two narrative devices – flashback for representing actions related to Carmen's recalling of the past events; flashforward for illustrating Carmen's imagination about possible future outcomes.

Figure 2.7: A Screenshot from Carmen's Bright IDEAS, where inner thoughts and emotions of a character named Carmen are represented by thought balloons. (from Marsella, Johnson, and LaBore 2000)

The candidate participants for CBI are people who are in similar situation to Carmen. For this reason, it is claimed that the participants may be able to feel immersive in the drama because of their empathetic emotion with Carmen. This claim is in accordance with the explanation about the emotional interest which can come from the reader's identification with story characters, as described in Section 2.1.3.

2.4.2.4 Suspenser

Suspenser (Cheong 2007) is a narrative generation system, focusing on the content-selection process from a *fabula* to a *sjužet*. According to Russian Formalist terminology, *fabula* refers to a chronological series of story events; *sjužet* represents reorganized story events in presentation order. The goal of Suspenser is to create a feeling of suspense, a combined cognitive emotion of anticipation and anxiety about an uncertain outcome of a significant event, in the reader's mind by selecting appropriate contents for the *sjužet* from the story events in the *fabula*. Suspenser does not consider the ordering of the story events at the discourse level during the *sjužet* construction process.

Suspenser selects important actions for inclusion in a story using a plan-based reader model that measures the suspense level of the reader at a certain point while reading a story. To achieve high suspense during the content selection process, Suspenser employs a way of

limiting the number of solutions available to a protagonist in the story. The concept that the number of available solutions influences a reader's suspense level has been proved by cognitive researchers such as Gerrig and Bernardo (Gerrig and Bernardo, 1994). While Suspenser concentrates on the selection of story content for suspense, my system stresses the presentation ordering of story content for surprise.

Chapter 3

Prevoyant: A Model of Surprise Arousal Using Flashback and Foreshadowing in Narrative

In this chapter I describe Prevoyant, a computational model of surprise arousal using flashback and foreshadowing in narrative generation. The name *Prevoyant* refers to the functionality of my system to see the whole story ahead of time and generate foreshadowing before some future events occur. Prevoyant produces as output a story containing structure intended to evoke surprise in the reader's mind. Given a source story described using a plan data structure, Prevoyant determines the content and insertion point in the story for flashback and foreshadowing events. Prevoyant makes use of a reader model which reflects the reader's conception of a story world constructed during reading. The story plan requires a specific medium to be realized. Prevoyant passes the output story plan to a module responsible for realization that could then generate text or other medium specific realization of the story. The output of Prevoyant is for telling the story events in a specific order, not for executing the story events dynamically in real time.

In Section 3.1, I outline the overall architecture of my system, also providing a description of the input story plan and the reader model used by Prevoyant. The three key

components of Prevoyant – the Generator, the Evaluator, and the Implementer – are explored in detail in Section 3.2 and Section 3.3.

3.1 Architecture

A functional role of surprise in narrative is to maintain and focus a reader's attention. Prevoyant aims to create surprise at an important story outcome, which can make the reader more engaged in the story (Alwitt, 2002). In order to create this sense of surprise in a reader, Prevoyant uses two narrative techniques: foreshadowing and flashback. Foreshadowing provides the reader with (possibly implicit) anticipation (Bal, 1997); flashback explains what caused the surprising event (i.e., the unexpected outcome) in retrospect. To meet this end, Prevoyant employs a generate-and-test design incorporating three major components – the Generator, the Evaluator, and the Implementer (see Figure 3.1).

Prevoyant takes a story, which is defined by a plan data structure, as input. Given a story with a partial order planning structure, Prevoyant rearranges the story's temporal order by selecting flashback and foreshadowing events, aiming at evoking surprise in the mind of a

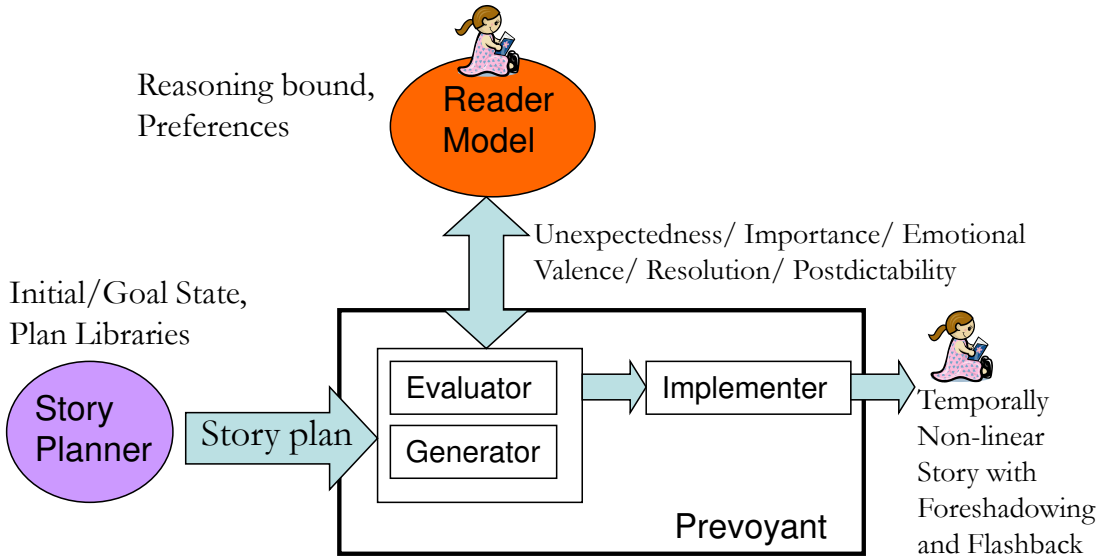

Figure 3.1: Prevoyant Architecture.

reader. During this temporal rearrangement process, the Generator and the Evaluator work together to reconstruct a given story based on the anticipated inferences made by the reader, as predicted by the reader model. The Generator selects candidate discourse structures that can elicit unexpectedness in the mind of a reader. Since unexpectedness alone is not sufficient to increase a reader's surprise in narrative, the Evaluator checks each candidate discourse structure based on four factors related to surprise arousal in narrative: unexpectedness, importance of the events, a reader's emotional valence, and resolution of the incongruities within the unexpectedness. After the reconstruction of story events is complete, the Implementer determines how to realize the story based on the specific medium in which the story is being told. The general architecture is shown in Figure 3.1.

When writing a story, writers typically make use of an imaginary ideal reader, known as the *implied reader* (Chatman, 1978; Rimmon-Kenan, 2002), to whom the writer tells the story. Without reference to the notion of the implied reader, an author may provide readers either with too much explanation or with sudden change of context (see Emmott, 1997: 7). Both can complicate the reader's comprehension process. Under a practical assumption of mutual 'cooperation' between author and reader, Prevoyant makes use of an explicit reader model to reflect three characteristics of a reader: the reader's plot-related inference process, the reader's plan-based reasoning capability, and the reader's story-related preferences (Young, 1999). The detailed structure and use of the reader model is described in Section 3.1.2.

On the whole, this generate-and-test architecture is motivated by the Cooperative Plan Identification (CPI) model (Young, 1999), which was originally developed as a method for creating an effective and concise textual description of a task plan based on notions of cooperative principles of communication first developed by Grice (1975). The next sections describe the input story plan and the reader model that is adapted from the hearer model in Young's CPI architecture.

3.1.1 Input: The Story Plan

As shown in Figure 3.1, Prevoyant takes a story as input which is defined by a plan data structure. This source story plan is represented as a plan structure created by Longbow, a discourse planner employing a partial order causal link planning algorithm with hierarchical action decomposition[9]. The causal relationships indicated between steps in the plan structure correspond closely with the characteristics of the causal network contained a mental model of a story built by readers (Trabasso and Sperry 1985).

To generate a story plan using the Longbow planner, a domain designer (i.e., the author) defines a planning problem and a plan library. A planning problem for a story plan is defined with a specification of the initial state and goal conditions. The initial state is a conjunction of the initial conditions that represent the initial story world state; goal conditions are a specification of the conditions required by the author to be true in the world after all story events have executed. I use the closed-world assumption when specifying the initial state in the planning system that I use. Under the closed-world assumption, any condition not explicitly marked as true in the initial state is considered to be false. The initial conditions and the goal conditions are represented using first-order terms (e.g., At (President, White House)).

A plan library defined by the domain designer describes a number of different action operators[10]. An action operator describes a single action in terms of a list of parameters, constraints, preconditions, and effects. A parameter of an action is an unbound variable used within Longbow' first-order action representation. A precondition of an action specifies a condition that must hold for the action to be executed. A constraint of an action is a condition that is satisfied only in the initial state, maintaining its value through the whole story plan. Constraints cannot appear in the representation of preconditions or effects of any plan actions. Preconditions must be either true in the initial state and maintained as true until the relevant

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[9] As mentioned in Chapter 1, the current Prevoyant does not make use of the decomposition capability of Longbow.

[10] Longbow is a hierarchical planner using two types of actions – abstract and primitive. A primitive action is an executable action, and an abstract action is one that characterizes or provides an abstraction for a sequence of more-primitive actions. Since the current implementation of Prevoyant does not make use of the hierarchical functionality of Longbow, only primitive action operators are considered in this dissertation.

```
Operator: Buy-Gun
    Parameters: ?user
    Constraints: (is-person ?user)
    Preconditions: (has-cash ?user)
    Effects: (has-gun ?user)
             (not (has-cash ?user)
```

Figure 3.2: Example of a schematic representation of a plan operator *Buy-Gun*

step or made true by some earlier step in the plan. An effect of an action describes a condition that will hold as a result of the execution of the action. Figure 3.2 shows a schematic representation of a plan operator *Buy-Gun*, where parameters, constraints, preconditions, and effects of an action are defined.

A story plan is a partial-order plan that is produced by Longbow planner as a solution to a given planning problem. The partial-order plan structure that Prevoyant uses includes a set of plan steps, a set of binding constraints over variables in the plan's steps, a set of temporal ordering constraints over the plan's steps, and a set of causal links between the effects of the plan's steps and the preconditions of other steps in the plan. A plan step is instantiated from the plan operators in the plan library. A binding constraint denotes a variable that is bound to a constant in a plan step. A temporal ordering constraint represents the ordering constraint between two plan steps. A causal link connects two plan steps where an effect of the first step (i.e., a source step) achieves a precondition of the second step (i.e., a destination step) (for details of the plan structure used in Longbow, see Young, Moore, and Pollack 1994; Young and Moore 1994; Young, Pollack, and Moore 1994).

> **Concept 3.1 (Story Plan).** *A story plan in this work refers to a tuple <S, B, O, C>, where S is a set of plan steps, B is a set of binding constraints over variables in S, O is a set of ordering constraints on the steps in S, and C is a set of causal links between steps in S.*

The story plan structure is represented as a graph in which nodes are steps and edges are ordering links between steps. The initial world state and goal conditions are given by a domain author. Given the initial world state and a set of goal conditions, a story plan is dynamically built to achieve the goal conditions.

An example story plan graph is shown in Figure 3.3. In this graph, plan steps in the story plan are represented by circles. The numbers inside the circles denote the plan step numbers that will be executed sequentially. Step 1 is the opening step, and step 20 is the closing step. The directed arcs between two steps denote causal links from their source step to destination step. Specifically, the dotted-line arcs denote the causal links starting from the initial state, distinguishing from the other causal links that start from the plan steps in the story plan[11]. The literals in the initial/goal state are represented by rectangles. This story plan employs seven

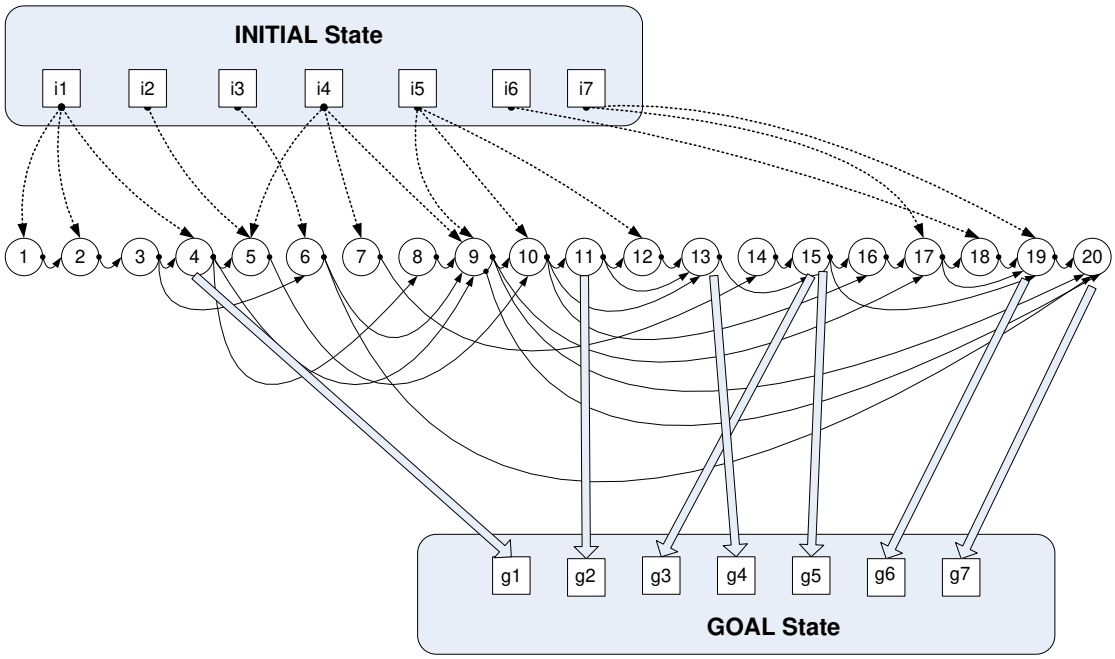


Figure 3.3: A Representation of Causal Relationships among Plan Steps, Initial Conditions, and Goal Conditions in a Story Plan

[11] This classification of causal links depending on their origin, either the initial conditions or plan steps, can be useful because the initial conditions may not be as explicit as the other plan steps in the story plan.

ground literals in the initial state, and satisfies seven ground literals in the goal state. The thick solid arrow represents that a goal literal is satisfied by an effect of a plan step (e.g., an effect of step 4 satisfies the goal literal g1). Figure 3.4 shows a text representation of the story plan in Figure 3.3.

Initial World State

i1	Erica has given an order from Jack
i2	Erica has the blueprints of Jack's fortress
i3	Erica has a boat
i4	Smith is on the land
i5	Smith is armed
i6	Dr. Cohen's lab is guarded
i7	Smith knows where Dr. Cohen's lab is located

Plan Steps

1	Erica installs a wiretap in Smith's home while he is away.
2	Erica eavesdrops on the phone conversation in which Smith is given the order to rescue Dr. Cohen.
3	Erica meets with Smith.
4	Erica tells Smith that her father was kidnapped by Jack and taken to Skeleton Island, and she asks Smith to save her father.
5	Erica gives Smith the blueprints of Jack's fortress, with her father's cell marked.
6	Erica provides Smith with a boat for transportation to Skeleton Island.
7	Before going to the island, Smith hides a diamond in his shoe.
8	Smith goes to the port containing Erica's boat.
9	Smith rides the boat to Skeleton Island.
10	Smith sneaks into the cell marked on the map containing Erica's father.
11	Jack and his guard capture Smith as he enters the cell.
12	The guard disarms Smith.
13	The guard locks Smith in the cell.
14	Smith bribes the guard with the diamond in his shoe.
15	The guard unlocks the door.
16	Smith leaves the cell.
17	Smith sneaks to the lab where Dr. Cohen is being held.
18	Smith fights the guards in the lab.
19	Smith takes Dr. Cohen from the lab.
20	Smith and Dr. Cohen ride the boat to shore.

Goal Conditions

g1	Erica asked Smith for help
g2	Smith got captured
g3	Smith is unlocked
g4	Smith was locked
g5	The guard helped Smith
g6	Smith accomplished his mission
g7	Smith is on the land

Figure 3.4: Text representation of the story plan in Figure 3.3

3.1.2 The Reader Model

As briefly mentioned above, the notion of cooperative communication between author and reader is central to Prevoyant's design. When constructing a story, an author needs to care about what her readers think as they read. From the reader's viewpoint, reading between the lines helps him or her grasp and focus on what the author wants to tell. Without his form of cooperation, storytelling and reading would be just a superficial conveyance of information.

Prevoyant's reader model simulates the reasoning process of an *implied reader* as a counterpart to an *implied author* (Chatman, 1978; Rimmon-Kenan, 2002). Prevoyant employs a plan-based reader model using the Longbow planning system, motivated, in part, by work that has shown that human planning process can be characterized by partial-order planners (Ratterman, 2001). In this dissertation, I use the Longbow planning system as a reader model to check whether or not a story event is unexpected on the basis of the current story world state. This unexpectedness decision process using the Longbow planner as a reader model is described in detail in Section 3.2.2.1.2.

The Longbow planning system is based on a domain-independent planning algorithm named DPOCL (Decompositional Partial Order Causal Link) (Young, Moore, and Pollack 1994), which performs refinement search (Kambhampati, et al., 1995) that views a planning process as a search process through a space of plans. The refinement search process is represented using a directed arc graph, where nodes denote (possibly partial) plans and arcs denote refinement of plans. The plan refinement process is characterized by fixing any flaws in a plan. The current Prevoyant considers two types of flaws[12]: open preconditions and threats. An open precondition refers to a precondition that is not achieved by actions in the plan. A threat occurs when there is an action whose effect conflicts with established causal links in the plan. A story plan that is produced by Longbow planner is a complete plan, that is, there are neither open preconditions nor threats in the story plan.

[12] In Longbow, there are three types of flaws: open preconditions threats, and abstract steps that can be decomposed into more primitive steps. As explained earlier, current Prevoyant does not use Longbow's decomposition capability, so the flaw of abstract steps does not considered.

The reader model simulates plot-related inferences performed by the reader. The (possibly partial) plans in the plan space represent completions of the story by the reader. The reasoning bound function defines the limits on the reader's ability to infer plans. The heuristic function characterizes the reader's preference for plans in the planning process such as the preference for content selection. The reader's current knowledge while reading a story is represented by a set of plan steps, which are instantiated from a reader's plan library. This reader's plan library characterizes world knowledge and text knowledge based on what she has read so far.

A partial order causal link planner has been employed as a human's reasoning process for generating a concise task-oriented text instruction (Young 1999) and creating a suspenseful story (Cheong 2007). In her story generation system, Cheong uses a variant of the Longbow planner to find the number of solutions available to a protagonist that the reader could construct from a given partial story.

3.2 Prevoyant: The Generator and the Evaluator

The Generator and the Evaluator are two main components in Prevoyant. Passed as input in chronological order (i.e., the order in which they occur in the story world), events in an input

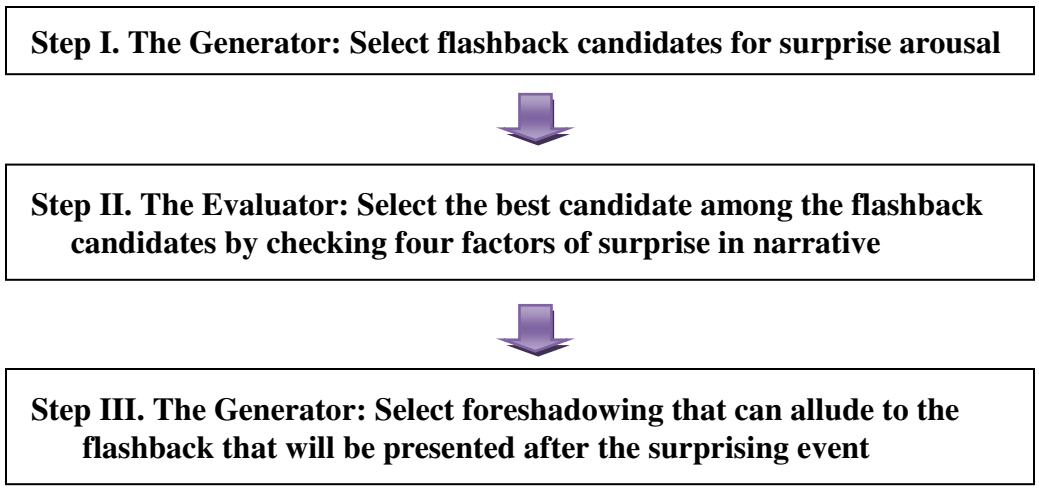


Figure 3.5: The Selection Procedure of Flashback and Foreshadowing

story plan are temporally re-ordered by the Generator and the Evaluator. The overall procedure consists of three steps as illustrated in Figure 3.5. First, the Generator creates potential candidates of flashback for surprise arousal. Second, the Evaluator decides the best candidate among the potential candidates by checking the factors that can contribute to surprise arousal. Finally, after the best candidate is determined, the Generator creates foreshadowing that alludes to the flashback events.

3.2.1 The Generator: Selection of Flashback Candidates

Flashback provides the reader with information relating to a backstory occurring in the past, typically associated with a relevant character, object, or event (Sijil, 2005). An effective use of flashback, however, should be carefully designed because frequent use of flashback, especially to explain some insignificant elements in the main story, may harm the story's momentum.

3.2.1.1 Modeling of Flashback for Surprise Arousal

A narrative structure that evokes surprise is characterized by "sudden presentation of an unexpected outcome", where expository or initiating events associated with the outcome are presented after the outcome or even omitted (Brewer and Lichtenstein, 1981; Tan, 1996). Here the outcome refers to a ramification of story events that the author wants to deliver. The initiating events refer to a critical cause for the outcome to occur in the story world. In this dissertation, specifically, a *story outcome* refers to one of goal conditions specified explicitly in the goal state, assuming that goal conditions in the story plan are important outcomes in the author-centric story generation system[13] (Alwitt, 2002).

The narrative structure for surprise arousal is similar to that used for curiosity arousal. Both of these structures present unexpected outcomes without their initiating events, but in the two cases the reader's knowledge about the initiating events is different. If the reader knows that the initiating events are missing or only partially depicted, curiosity occurs; if the

[13] In this thesis I assume that all goal literals have equal importance.

reader is not aware of the absence of the initiating events, surprise occurs (Alwitt, 2002; Brewer and Lichtenstein, 1982; Tan, 1996).

Based on this surprise model in the Structural Affect Theory, the Generator selects flashback events by identifying a *Significant Event* (SE) and its *Initiating Events* (IE) in the input story plan. A Significant Event is a plan step whose causal effect is a story outcome in the story. In other words, a Significant Event directly achieves one of the goal conditions in the goal state. An Initiating Events (IE) is characterized as a set of plan steps that serve as a causal antecedent of a relevant SE.

The process for flashback selection is outlined by the four phases as shown in Figure 3.6. During Phase 1 thorough Phase 3, the Generator identifies a set of separable Causal Chains, which includes flashback candidates, and passes it to the Evaluator. In Phase 4, after the best candidate of flashback is determined by the Evaluator, the Generator selects the temporal position of the flashback. These four phases are described in detail in the following text.

Phase 1: Selecting a set of Significant Events

Given an input plan representing a story, the Generator first identifies a set of *Significant Events*, a set of plan steps that directly connect to goal literals in the goal state. Define this set

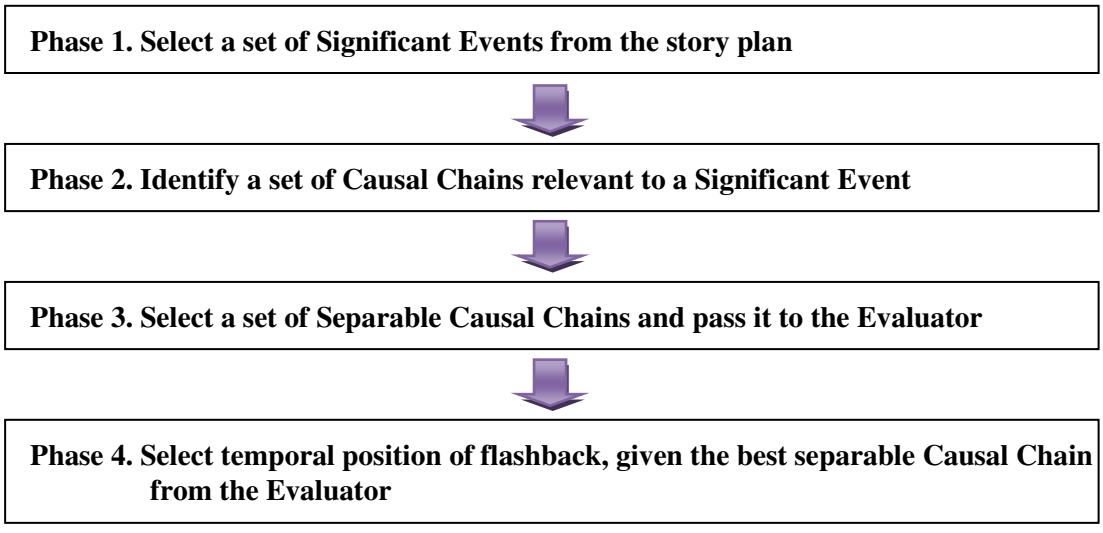


Figure 3.6: The Selection Procedure of Flashback in the Generator

of distinct Significant Events as *SE set*.

The size of an SE set can be greater than one. In Figure 3.3, for instance, the SE set in the story plan consists of the six steps – 4, 11, 13, 15, 19, and 20. When the size of SE set is larger than one, the importance of each significant event is rated in terms of causality and the participating characters and items in the story (Cheong, Jhala, Bae, and Young, 2008). The importance rating of each event is performed by the Evaluator and is described in Section 3.2.2.2.

Phase 2: Identify a set of Causal Chains

Consider each SE (Significant Event) in the candidate SE set. Let the IE (Initiating Events) for this set be just a series of events which are causally linked from the initial state to the SE, considering the closed-world assumption in which any condition not explicitly marked as true in the initial state is considered to be false. An SE will have possibly more than one relevant IE. For each IE of the relevant SE, create a pair consisting of the SE and an IE, where the IE originates from the initial state. Define this pair as a *Causal Chain*. There will be possibly more than one Causal Chain in the story plan. Create a set consisting of all the distinct Causal Chains in the story plan and define this set as a set of Causal Chains.

When the Generator identifies a Causal Chain that is associated with an SE, it traces all the incoming causal links until reaching the initial state. For example, in the story plan in Figure 3.3, step 4 is an SE and there are three distinct IEs originated from the initial state and is relevant to step 4: the initial step; a set consisting of the initial step, step 2, and step 3; a set consisting of the initial step, step 1, step 2, and step 3. So, there exist three distinct Causal Chains relevant to a Significant Event, step 4.

Phase 3: Selection of a set of *separable* Causal Chains

Once the set of Causal Chains in the story plan is determined, the Generator selects a set of *separable* Causal Chains among the elements in the set of Causal Chains. Here I say that a Causal Chain is *separable* just when the IE can be omitted from the story plan without causing any open preconditions for the steps that occur prior to the relevant SE; define this

Causal Chain as a separable Causal Chain. This *separability* of the IE ensures that the reader does not detect the absence of the IE from the rest of the story until the relevant SE occurs.

The main idea of *separability* here lies in how the temporal position of IE (Initiating Events), which are causally related to one another, can be moved as a separable group – from *before* the presentation of the relevant SE (Significant Event) to *after* the presentation of the SE – without affecting the causal relationships of the other events in a story. As a result, readers would not detect the omitted IE until the presentation of its Significant Event. This omitted IE is presented after the Significant Event as a form of flashback, explaining how the relevant SE could actually happen. To this end, the Generator checks two conditions that a separable Causal Chain should meet, which are specified in Figure 3.7 and describe in detail in the following text.

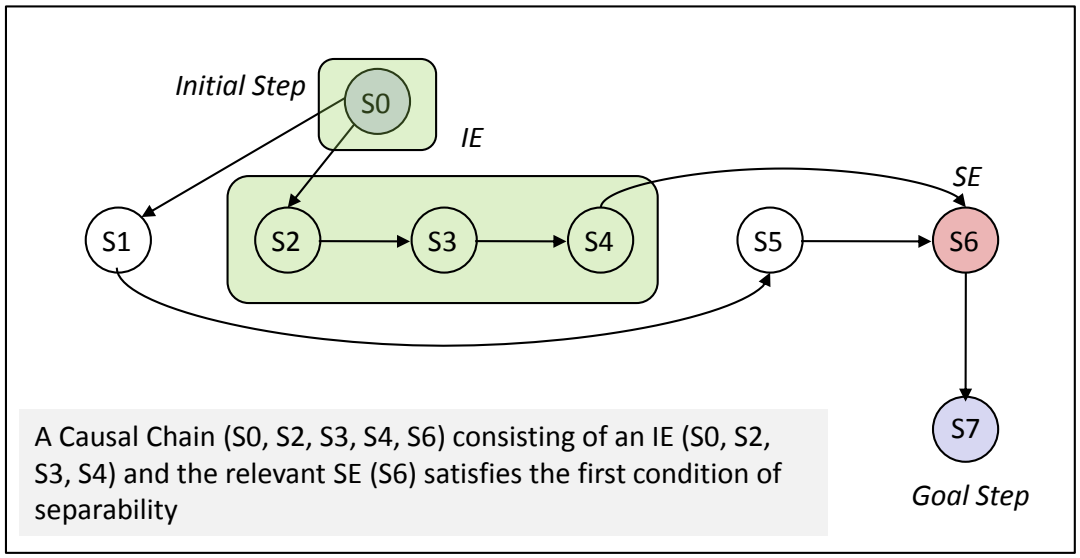
The first condition of separability helps to ensure that the omission of the steps in the IE of a separable Causal Chain is not detected by the reader until the presentation of its SE (Significant Event). This is possible because the plan steps of the IE in the separable Causal Chain do not causally contribute to the other story events prior to the SE. In Case 1 in Figure 3.8, for instance, a Causal Chain consisting of (S0, S2, S3, S4, S6), where S6 is an SE and (S0, S2, S3, S4) is a relevant IE to the SE, has no outgoing causal link initiating from a step in the IE of the Causal Chain to a step that does not belong to the IE and is temporally prior to the SE. As a result, the omission of the IE from the story plan would not be detected by the reader until the presentation of step 6, the SE. If there is an outgoing causal link initiating

Conditions of a separable Causal Chain

1. There is no outgoing causal links initiating from a step (except the initial step) in the IE of a Causal Chain prior to the SE.
2. There is no *dedicated* incoming causal links to a step in the IE of a Causal Chain, initiating from a step that is prior to the SE and does not belong to the IE of the Causal Chain.

Figure 3.7: Conditions of Separability

Case 1: There is no outgoing causal link from any step but S0 in an IE (S0, S2, S3, S4) to a step prior to the relevant SE (S6).



Case 2: There is an outgoing causal link from a step (S2) in an IE (S0, S2, S3, S4) to a step (S5) that is prior to the relevant SE (S6).

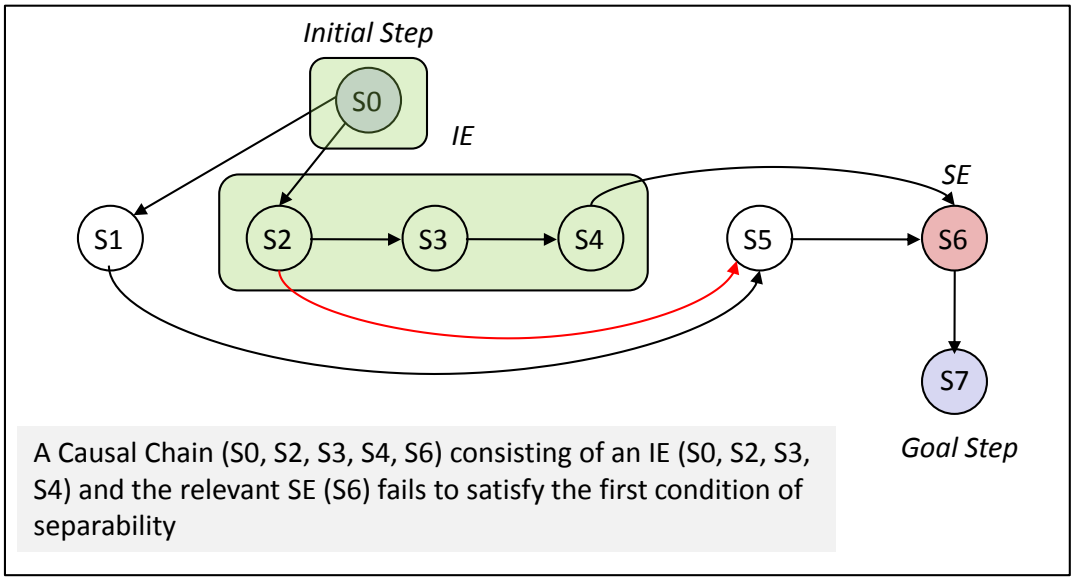
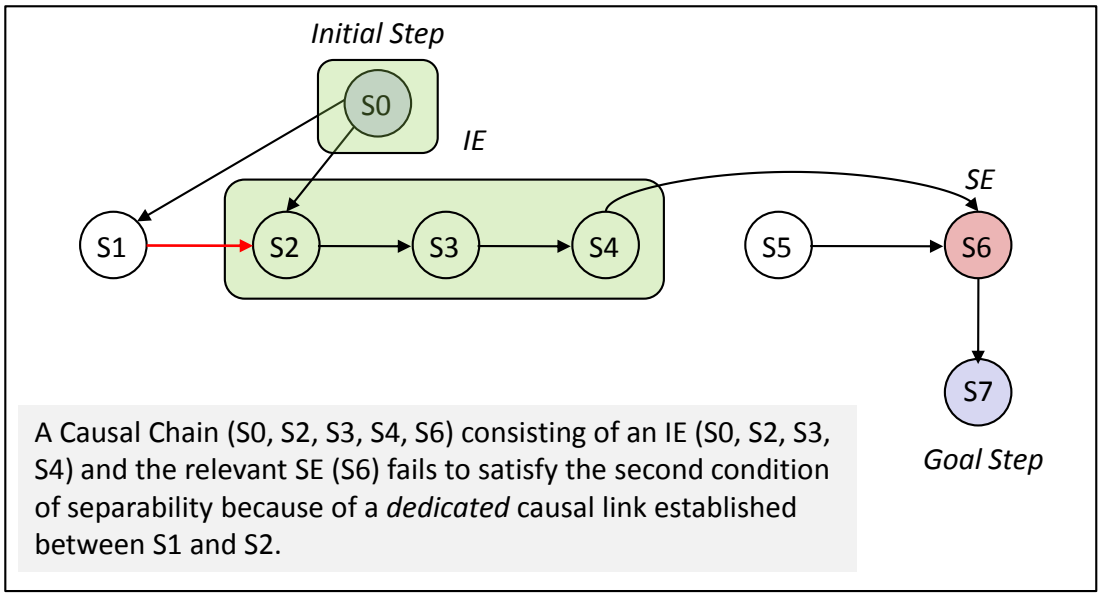


Figure 3.8: An Illustration of the first condition of separability. In the graph, nodes represent plan steps and edges represent causal links.

Case 1: A casual link initiating from S1 to S2 is a *dedicated* incoming causal link to S2 because this causal link is the only outgoing causal link of s1.



Case 2: A casual link initiating from S1 to S2 is not a dedicated incoming causal link to S2 because S1 has another outgoing causal link to a step in the story plan.

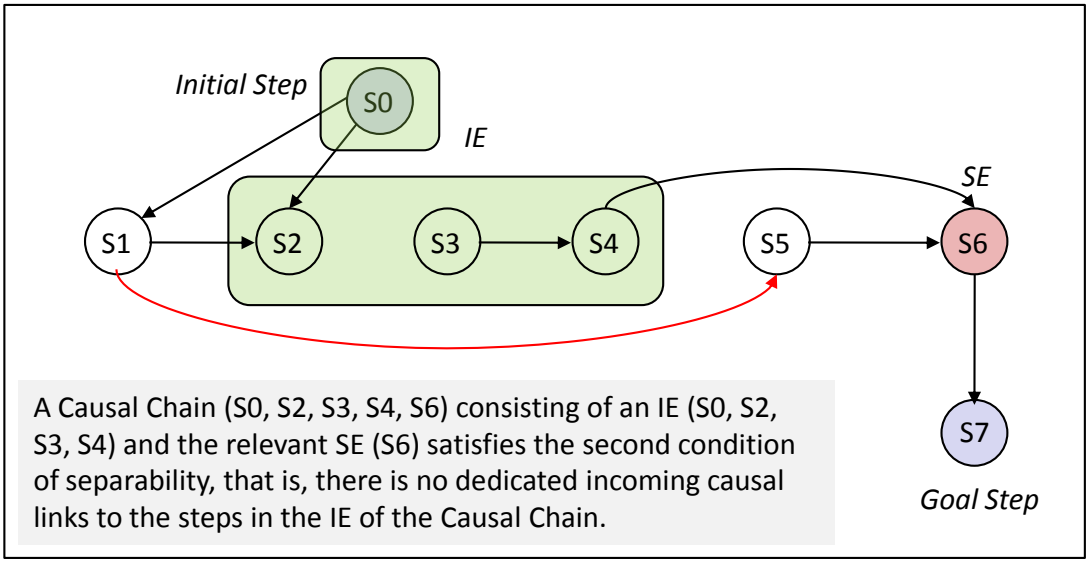


Figure 3.9: An Illustration of the second condition of separability. In the graph, nodes represent plan steps and edges represent causal links.

from a plan step of the IE in a Causal Chain to a plan step that is outside the chain and prior to the SE, however, the omission of the plan steps in the IE will make the plan step occur without its causal antecedent. As a result, the reader will detect the omission of the plan steps in the IE of the Causal Chain. Case 2 in Figure 3.8 illustrates this example.

The second condition of separability also helps to ensure that the omission of a separable Causal Chain does not affect the reader's awareness of its omission. Suppose there is a causal link that is established between two steps: s1 (a source step) and s2 (a destination step). Here I say that this causal link is a *dedicated* incoming causal link to s2 when this causal link is the only outgoing causal link of s1. In other words, when a dedicated causal link is established between a source step and a destination step, the source step causally contributes only to the destination step.

In Case 1 in Figure 3.9, for instance, a Causal Chain consisting of (S0, S2, S3, S4, S6), in which S6 is an SE and (S0, S2, S3, S4) is a relevant IE to the SE, has a dedicated incoming causal link initiating from S1 to S2, a step in the IE of the Causal Chain, Thus this Causal Chain fails to satisfy the second condition of separabilty. In Case 2 in Figure 3.9, however, the causal link established between s1 and s2 is not a dedicated causal link. Since there is no dedicated incoming causal link to the IE of the Causal Chain, this Causal Chain satisfies the second condition of separability.

Once a set of separable Causal Chains is determined, it is sent to the Evaluator. The Evaluator evaluates each separable Causal Chain in the set in terms of four surprise factors: expectation failure, importance of events, emotional valence, and resolution. Then, the Evaluator selects *the best separable Causal Chain* that can contribute to the reader's surprise. This decision process by the Evaluator is described in more detail in the next section.

Phase 4: Selection of temporal position of flashback

When the Generator receives the best separable Causal Chain from the Evaluator, the Generator defines an *Outcome Event (OE)* and *flashback* using the received Causal Chain. The Outcome Event is the SE in the best separable Causal Chain; flashback is the IE in the best separable Causal Chain.

After identifying the OE and a flashback, the Generator determines the temporal position of the flashback. In general, flashback is associated with a character in the story, so the character's memory or inner thoughts about some important past events can be revealed to the reader, explaining how a current situation is connected to the past events. I employ this notion of flashback to explain to the reader how the unexpected OE actually could happen. To simplify the process of determining where in the plan a flashback is placed and to make the relationship between the OE and flashback clear, the Generator always places the flashback immediately after the OE, as shown in Figure 3.10.

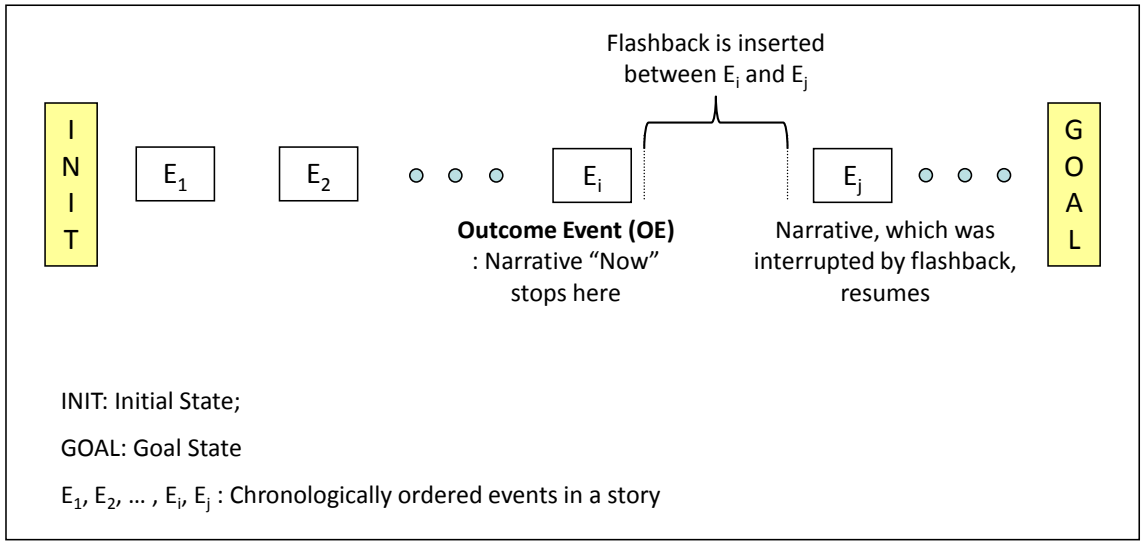


Figure 3.10: Selection of temporal position for flashback

3.2.2 The Evaluator: Checking Surprise Factors in Narrative

Once the Generator creates a set of separable Causal Chains, the Evaluator selects the best separable Causal Chain from the set to elicit surprise in the mind of a reader. As criteria, the Evaluator checks four factors for surprise arousal: expectation failure, importance of events, the reader's emotional valence, and resolution of incongruities in surprise. The Evaluator first filters out the separable Causal Chains that do not meet the criteria for surprise arousal using

three factors – expectation failure, the reader's emotional valence, and resolution of incongruities in surprise. And then the Evaluator selects the best separable Causal Chain using the importance factor. In this section, I first describe the four factors in detail and then explain how these four factors are combined to serve as criteria for surprise arousal in narrative.

3.2.2.1 Expectation Failure

3.2.2.1.1 Expectation Failure as Surprise Sources

Expectation failure (or expectation violation) is central for surprise. Either in real life or in a fictional story world, the emotion of surprise comes from a situation that we are not aware of until it occurs. As an effort to clarify the relations between unexpectedness and surprise, Ortony and Partridge (1987) claim that surprise and expectation failure are not the same, differentiating three types of surprise sources – active expectation failure, passive assumption failure, and unanticipated incongruities. Specifically, Ortony and Partridge explain these three surprise sources using a simple propositional logic and two factors: *practical deducibility* of a proposition; *conflict* between an input proposition and an agent's expectation.

Practically deducible propositions refer to those propositions that are either explicitly represented in the data base or implicitly inferred from the data base with help of simple inference rules. Ortony and Partridge did not provide any detailed information about the inference rules in their paper, leaving them to implementation details. *Conflict* refers to a situation in which an agent either actively predicts or passively assumes a practically deducible proposition P when the negation of the proposition (i.e., ¬P, which is not practically deducible) is given as an input proposition[14].

There are possibly two types of conflicts based on the practical deducibility of a proposition. One type of conflict occurs when an agent actively predicts a proposition *P* (which is practically deducible from the agent's data base), a proposition ¬*P* (which is not

[14] Since the notion of conflict was not clearly defined in Ortony and Partridge (1987), Prevoyant views the negation of a proposition as a simple instance of conflicts.

practically deducible from the agent's data base) is given as input. The other type of conflict occurs when an input proposition $\neg P$ (which is not practically deducible from the agent's data base) is given, an agent is not consciously entertaining P (which is the negation of the input proposition) but the agent can practically deduce P from the data base. The former is referred to as *active expectation (or prediction) failure*, and the latter is referred to as *passive expectation (or assumption) failure*.

The difference between active expectation failure and passive assumption failure is whether an agent expects actively a proposition (which is in conflict with an input proposition) or not. A proposition that is actively predicted by an agent is referred to as an *activated* proposition, which is "consciously entertained" by an agent. Ortony and Partridge did not specify how a proposition can be activated. Instead, they assumed that "At any point in time, the current task results in some parts of the data base being activated." So, given an input proposition $\neg P$, an active expectation failure occurs when P is activated; a passive assumption failure occurs when P is not activated.

Examples of active expectation failure and passive expectation failure are described in the followings (from Ortony and Partridge, 1987), where [A] denotes active expectation failure and [P] denotes passive assumption failure.

- **Example 3.1.** One chooses to go to a French restaurant because one feels like eating French food. On receiving the menu, one discovers that all the entrees are Greek. [A]

- **Example 3.2.** One comes across a green dog[15] on the street. [P]

- **Example 3.3.** One has chosen a French restaurant because one wanted to eat frog's legs, but the waiter explains that frog's legs are not a menu item in this particular restaurant. [A]

---

[15] It is assumed that the color property of DOG is specified in the initial world state, so dogs can have only colors that are classified as the colors of a dog. Then, a dog that has any color that is not classified as a dog color in the initial state is not practically deducible.

Both active expectation failure and passive assumption failure include a practically deducible proposition and a conflict. In the active expectation failure, an agent predicts a proposition that is practically deducible from the data base when a proposition in conflict is given as input. In the passive assumption failure, an agent assumes a proposition that is in conflict and practically deducible from the data base when an input proposition is given. Thus there is a conflict between an agent's expectation (either active or passive) and an input proposition that violates the agent's expectation. In active expectation failure, a proposition in conflict with an input proposition is activated already for some reason; in passive assumption failure, the proposition in conflict with an input proposition is not activated until an input proposition is given.

The third case of surprise sources, unanticipated incongruities, is different from active or passive expectation failure in that there is no conflict between an input proposition and an agent's expectation. When a proposition is given as input, neither the input proposition nor the proposition in conflict with the input is practically deducible from the agent's data base. Unanticipated incongruities are passive cognitive activity in that the agent does not actively expect any propositions in conflict with an input proposition. Unlike passive expectation failure, however, the agent cannot assume the propositions in conflict with the input proposition. Ortony and Partridge view this third category of surprise source as a violation or deviation from norms. Examples of unanticipated incongruities include the followings (from Ortony and Partridge, 1987):

- **Example 3.4.** When one sits in one's office, a rock flies through the office window.

- **Example 3.5.** One suddenly sees a person take off and fly with no apparent mechanical aids.

In Example 3.4, according to Ortony and Partridge, the proposition "A rock does not fly through the office window" is not practically deducible. Likewise, in Example 3.5, the

proposition "A person does not take off and fly with no apparent mechanical aids." is not practically deducible, either. As Ortony and Partridge pointed out, these propositions are more related to the violation of norms rather than the violation of expectations. Figure 3.11 illustrates the relationships of the different surprise sources based on expectation violation and norm violation. In Figure 3.11, symbol P represents a practically deducible proposition. Symbols Q and X represent practically non-deducible propositions. If P is activated for some reason when Q is given as an input proposition, active expectation failure occurs. Otherwise, passive expectation failure occurs. The practically non-deducible proposition X violates a norm. Neither X nor ¬X is practically deducible.

While Ortony and Partridge shed some light on the formalization of different surprise sources, their arguments have some limitations. For example, the definition of 'conflict' between an input proposition and an agent's expectation is not clearly defined. The criteria for differentiating passive assumption failure from unanticipated incongruities are also not clear, depending on the definition and range of norms. Their research on the relationships between unexpectedness and surprise, however, has been built upon by a number of AI researchers and cognitive scientists (Macedo and Cardoso, 2001; Castelfranchi, 2005). In the following section, I cast these notions of expectation failures in terms of a a planning-based

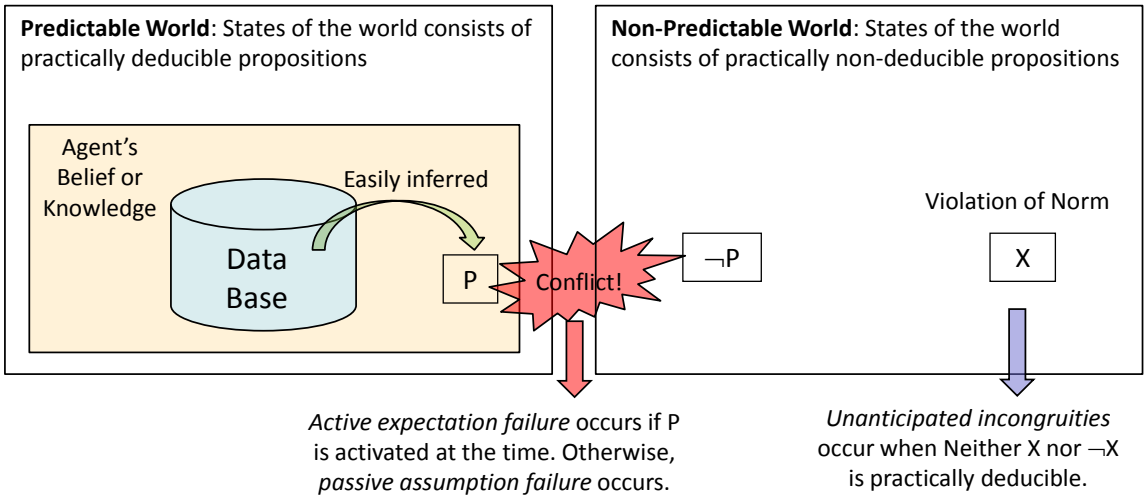


Figure 3.11. Three types of surprise sources, where P is a practically deducible proposition, where Q and X are practically non-deducible propositions.

approach to surprise.

3.2.2.1.2 Modeling of Expectation Failure Using a Planning-Based Approach

In Prevoyant, potential candidates for surprise are evaluated by a simple unexpectedness check using a planning-based reader model, where an event is characterized as *unexpected* if the reader model cannot find a complete plan to achieve the preconditions of the event in the context of the current story and its place in it. In other words, an event in the story is *expected* if the reader model can find a complete plan to achieve all the preconditions of the event using its knowledge about the world and the current state of the story world. The world knowledge of a reader is encoded using the reader's plan library (which defines a set of plan operators) and the initial world state. Figure 3.12 illustrates the reasoning process using this planning-based approach.

Expectation failure based on the concept of conflict, in the planning-based approach,

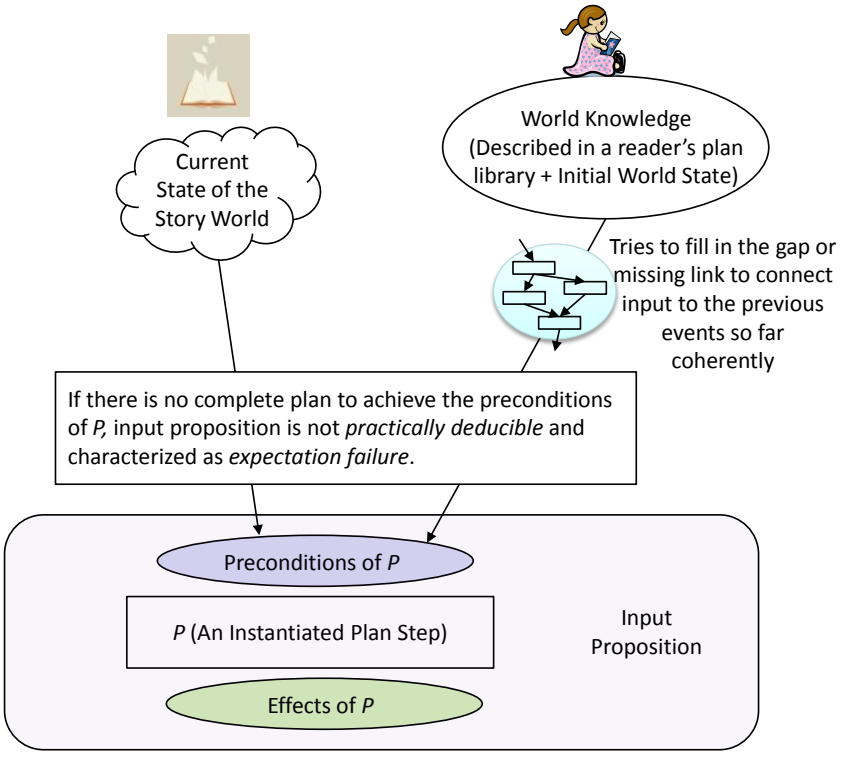


Figure 3.12: Illustration of Expectation Failures Using a Planning-Based Approach

comes from the different viewpoints between the reader model and a story generator. As mentioned in the previous section, both active expectation failure and passive assumption failure are based on the conflict between practically deducible propositions and an input proposition. From the perspective of the story generator and the reader model, this input proposition (i.e., a possibly unexpected or surprising event) is practically deducible from the story generator's viewpoint and is not practically deducible from the reader model's viewpoint.

Within Prevoyant, this different viewpoints between the reader model and the story generator arise in a variety of ways: (1) differences in the reader model's and story generator's plan operator sets (resulting in the reader model's inability to generate a story plan similar to that); (2) differences in the heuristic functions (resulting in the reader model building a complete plan that differs significantly from the one built by the story generator); (3) differences in reasoning bound (resulting in the reader model's failing to complete the construction of a story plan within the computational resource limit); (4) differences in initial conditions (resulting in the reader model failing to construct the needed story plan due to inconsistencies arising from the differences in the model of the initial state); and so forth. The Evaluator considers these cases using the notions of *practical deducibility* and *conflict*.

The Evaluator characterizes a target event (i.e., an input proposition) as *practically deducible* if all the preconditions of the target event are achieved *practically* – that is, achieved by the initial state conditions, by newly updated conditions made by the previous events, or by filling in the missing gap (i.e., building a complete plan to achieve the rest of the preconditions of the target events successfully). When the reader model decides the practical deducibility of an input proposition, it uses a reader's plan library to find a complete plan. In search of a complete plan, the Evaluator defines a new planning problem by setting up initial conditions and goal conditions. Here (i.e., at the t_0 point in the Figure 3.13) the goal conditions are specified as the preconditions of the target event; the initial conditions are specified as the updated conditions of the initial state, reflecting changes made by the previous story events. Figure 3.13 illustrates an example of this unexpectedness evaluation process, where the preconditions of a target event (that is, ¬p, q, r, and s) are set as the goal

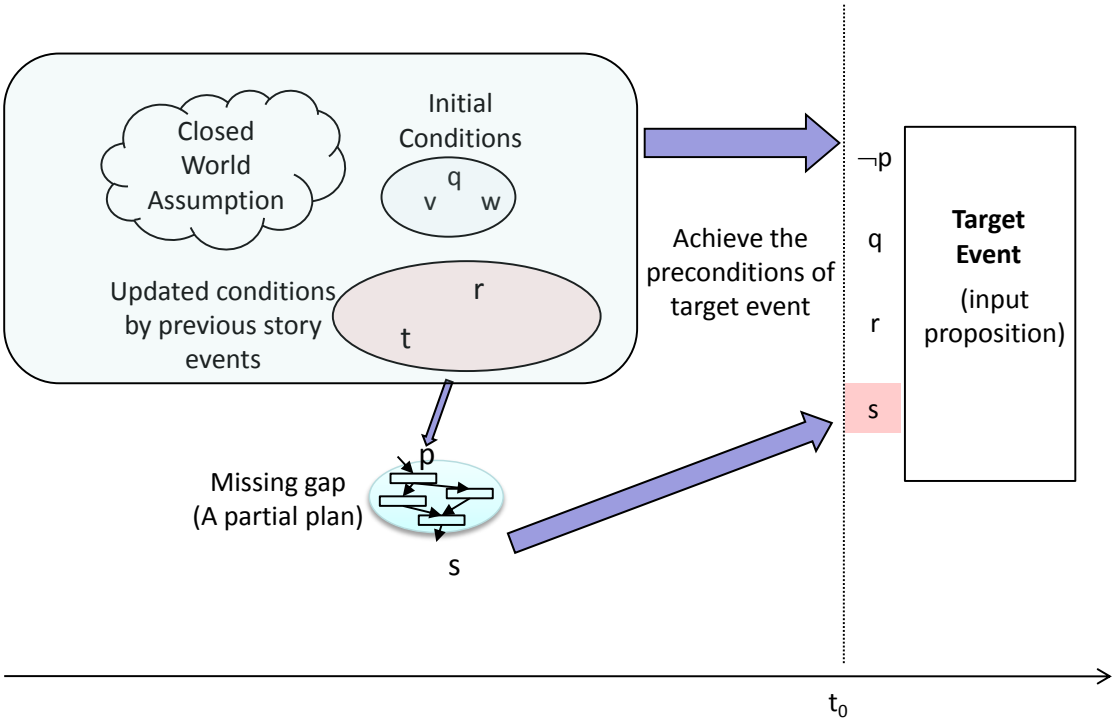


Figure 3.13: Illustration of the notion of *practical deducibility* of a target event, where all the preconditions of the target event are achieved *practically*.

conditions. In the figure, the goal conditions are achieved by a complete plan. Thus, this target event is practically deducible, and there is no expectation failure.

Expectation failure occurs when the reader model fails to build a complete plan to achieve the preconditions of the target event. Specifically, the Evaluator views the newly updated story world conditions by previous events as *activated* conditions. Thus, when the reader model fails to find a complete plan, *active expectation failure* occurs if an activated condition is in conflict with a precondition of the target event (e.g., in Figure 3.14, the two conditions $\neg s$ and s are in conflict with each other, where $\neg s$ is activated). Likewise, *passive assumption failure* occurs, when the reader model fails to find a complete plan, if the reader model can find a complete plan to achieve a condition that is in conflict with the target condition (e.g., in Figure 3.14, the two conditions $\neg t$ and t are in conflict with each other, where $\neg t$ is not activated but is practically deducible). In a similar vein, given the passive

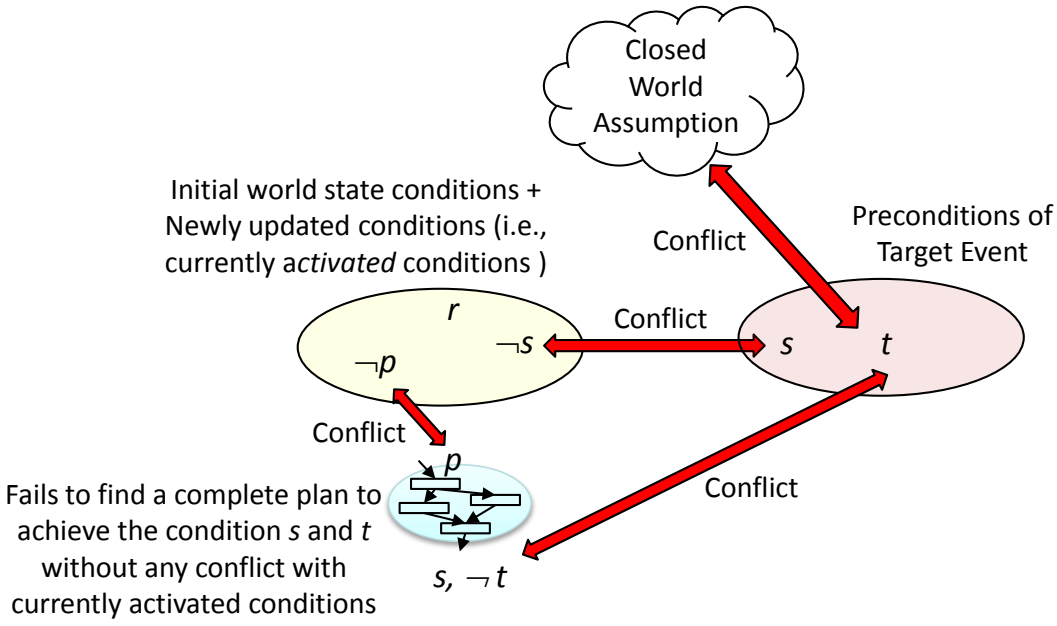


Figure 3.14: Illustration of the conflicts, which result in unexpectedness

assumption failure, *unanticipated incongruity* occurs if the reader model even fails to find a complete plan to achieve a condition that is in conflict with the target condition. (e.g., in Figure 3.14, the reader model cannot even find a complete plan to achieve the condition $\neg t$ that is in conflict with a target condition and not activated at the time – in other words, neither t nor $\neg t$ is practically deducible.).

3.2.2.2 Importance of Events

The importance of an unexpected event can influence the intensity of surprise experienced by a reader upon learning of the event's occurrence: the more important an unexpected event is, the more surprising it will seem (Gendolla and Koller, 2001). This is consistent with Structural Affect Theory. As explained earlier, the Structural Affect Theory claims that the emotions such as surprise and suspense can be achieved by manipulation of the temporal structure of narrative. According to the Structural Affect Theory, surprise can be aroused by the sudden presentation of a *significant* story outcome (Brewer and Lichtenstein, 1982). This

section describes how the Evaluator determines importance of story events in terms of causal relatedness, story goals, and other factors such as character importance and item importance.

3.2.2.2.1 Story Recall, Importance of Story Events, and Causal Relatedness

Prevoyant's analysis of the causal relationships among story events is based on the Causal Chain network model of story recall, devised by Trabasso, et al. (1984; 1985). In this work, Trabasso and his colleagues maintain that the number of direct causal connections between story events is closely related to a reader's ability to recall the events and the reader's judgment of the events as significant within the story. In other words, the greater the number of direct causal connections a story event has, the more readily it is recalled; the more readily an event is recalled, the more significant it is considered. Figure 3.15 shows the causal network representation for *The Father, His Son and Their Donkey* story, one of the stories used by Trabasso and his collaborators. In this graph, nodes represent events in the story and arrowed arcs denote causal relations between the story events. The plan-based representation of story plans used by Prevoyant and discussed earlier in this chapter (cf. Figure 3.3) is motivated by and consistent with this causal network representation. Earlier work by Christian and Young (2004) provides strong support for the use of the plan-based model as a proxy for the causal network mental model of a story used by a reader. Warren et al. (1979) identified six kinds of causal relations based on a taxonomy of relations between statements in a story's text: motivation, psychological causation, physical causation, enablement, temporal succession, and temporal coexistence.

3.2.2.2.2 Importance Rating of Events in a Story Plan

The Evaluator rates the importance of story events on the basis of the causal relations in the story plan, adopting the causal network model. The Evaluator employs three types of elements that characterize the events in a story plan: the opening act, the closing act, and the motivating act (Trabasso and Sperry, 1985; Cheong, 2007). Opening acts are the first actions in the story – those that connect propositions from the initial state to later events; closing acts are the last actions that occur in the story; motivated acts are plan steps that directly connect to the goal state.

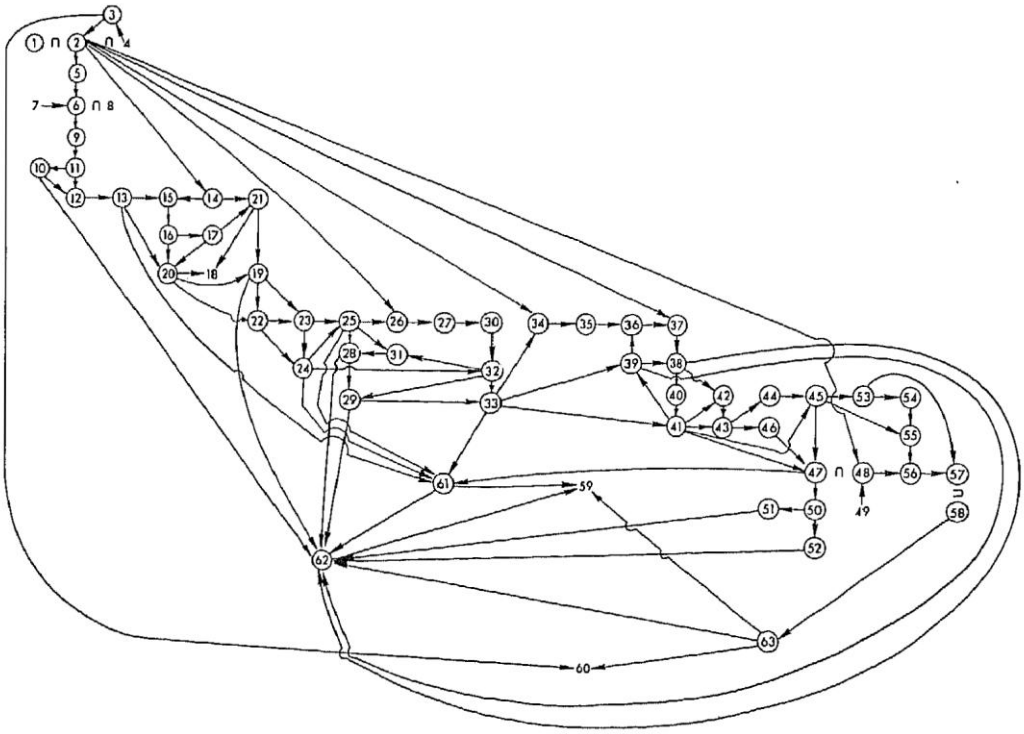


Figure 3.15: Causal Network Representation for a Story [from Trabasso and Sperry, 1985]

To compute the causal importance of a story event (i.e., a plan step), two factors are considered. One is the number of incoming and outgoing causal links of the step. This number reflects both the number of steps added to the story that establish conditions needed for this step to execute correctly and the number of steps in the story dependent upon this step for their successful execution. The other factor is the number of goal conditions that are directly achieved by the step. The greater the number of a step's effects that are causally linked directly to story goals, the more important the step is rated.

Determining the significance of a story event based on the event's causal connections is an efficiently computable method that is supported by existing empirical studies of narrative comprehension. However, this technique above is not sufficient to capture all elements within a story that express an author's weighting of significance. For instance, the author may want to put more importance on specific characters or items irrespective of their causal

importance, particularly in narrative-oriented computer games environments. To this end, the Evaluator also weighs the significance of an event based on the characters and items that play a role in the event. Here I say that the characters and items that play a role in an event are just those characters and items that are referred within the event's corresponding plan step data structure (i.e., via a binding constraint that links a step's variable to a character or item or via the appearance of the character's or item's name constant in the step's definition). (Cheong et al., 2008). The Evaluator calculates the importance of characters and items on the basis of the frequency with which the character or items play a role in the story action relative to the overall set of events in the story. Thus the total importance of an event (i.e., a plan step) is calculated by the following equation:

$$w(a) = k_c^{\,CC(a)} \cdot \left(k_i IN(a) + k_{in} INIT(a) + k_o OUT(a)\right) + k_{ch} CH(a) + k_{it} IT(a) \quad : Eq.(1)$$

Here *IN(a)* returns the number of incoming causal links to step *a* except the links that originate from the initial state[16]; *INIT(a)* returns the number of incoming causal links from the initial state to step *a*; *OUT(a)* returns the number of step *a*'s outgoing causal links; *CC(a)* represents the Causal Chain value of an event that is determined by the event's Causal Chain type – opening, closing, and motivated. Since CC(a) gets to be exponential to k_c, it contributes exponentially when k_c (the coefficient for causal importance) is assigned greater than 1; k_c, k_i, k_{in}, and k_o are assigned for causal relationships; k_{ch} and k_{it} are coefficients for character importance and item importance respectively; *CH(a)* and *IT(a)* return the character importance and the item importance respectively.

The particular values for the coefficients in the formula can be determined empirically. For instance, to increase the contribution of causal relationships to the importance of an event, the coefficients k_i, k_{in}, k_o, and k_c can be set to any positive real numbers greater than 1. In

[16] In this dissertation, I draw a distinction between the incoming links that originate from the initial state and those that originate from the plan steps in the story plan. This distinction is efficiently expressive when a realization of the initial state is different from that of the plan steps.

contrast, setting these coefficients to real numbers between 0 and 1 will reduce their effects on the importance.

When an input story plan is given, the Evaluator maintains a character table consisting of participating characters in each action of the story. As an example, Table 3.1 shows analysis

Table 3.1: Example of Character Importance and a Character Value Table Based on the Character's Occurrence Frequency

Character Importance

step-id	Step (Event)	Participating Characters		Character Importance
1	Trade ring	Tom	Dr. Evil	.68
2	Put Xmas gift	Tom	Iris	.32
3	Withdraw from bank	Dr. Evil		.45
4	Buy a gun	Dr. Evil		.45
5	Travel	Mr. Greenpeace		.18
6	Give a speech	Mr. Greenpeace		.18
7	Announce fund-raising	Mr. President		.41
8	Travel to WH	Mr. Greenpeace		.18
9	Watch TV	Dr. Evil		.45
10	Donate million dollars	Dr. Evil		.45
11	Invite	Mr. President	Dr. Evil	.86
12	Arrive at White House	Dr. Evil		.45
13	Put the agents to sleep	Dr. Evil		.45
14	Send warning e-mail	Tom	Mr. President	.64
15	Receive warning e-mail	Mr. President	Tom	.64
16	Put on bulletproof vest	Mr. President		.41
17	Fire the gun	Dr. Evil	Mr. President	.86
18	Get shot	Mr. President		.41
19	Fight and arrest	Mr. Greenpeace	Dr. Evil	.63
20	Stand up	Mr. President		.41
21	Get Xmas gift	Iris	Tom	.32
22	Create foundation	Mr. President		.41

Character Value Table

Characters	Proportions of occurrences as a participating character relative to the overall set of story events	Character's Value
Tom	5/22	.23
Dr. Evil	10/22	.45
Mr. Greenpeace	4/22	.18
Mr. President	9/22	.41
Iris	2/22	.09

of character significance for a story plan consisting of 22 plan steps. The character importance of a plan step is determined by the sum of each character's value that is calculated in the character value table on the basis of the relative frequency of occurrence of participating characters. The more frequently a character appears in the story, the higher the character value that is assigned to the character. The computation of item importance is done in the same way. The use of these character importance and item importance allows Prevoyant to select important events based on additional factors beyond just the weights derived from causal relations between story events. The process has also proven useful for generating effective story summaries (Cheong et al., 2008).

3.2.2.3 A Reader's Emotional Valence

A variety of emotions can be explained using two emotional dimensions – arousal and valence. For this reason, the circumplex model of emotions (Russel, 1980), as shown in Figure 3.16, has been adapted for use in different research areas. The claim that surprise should be included in the basic emotion group is controversial because of its lack of emotional valence. In particular, surprise as a cognitive response is difficult to recognize in

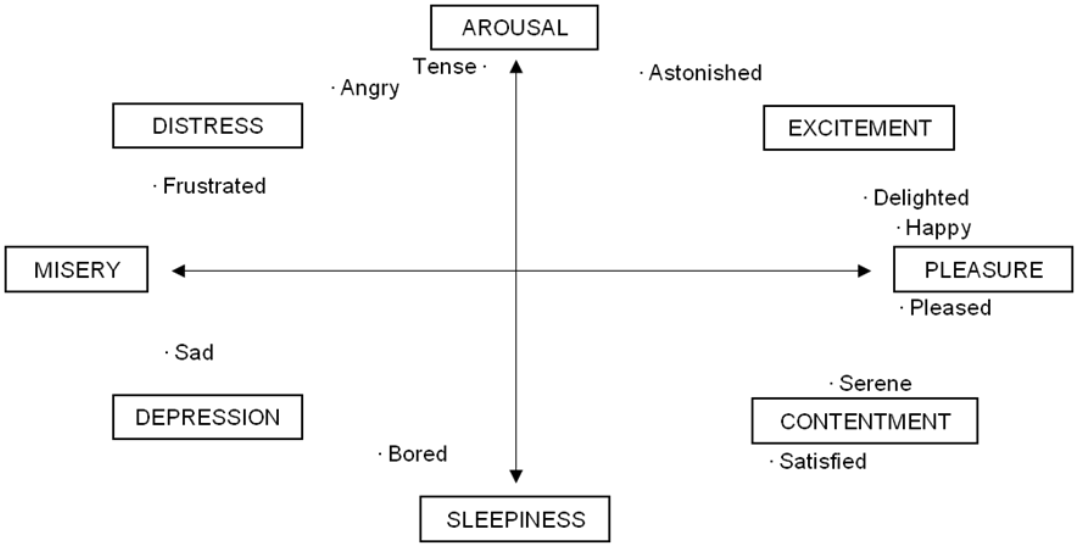


Figure 3.16: The Circumplex Model of Emotions Using Affect Words (from Russel, 1980)

terms of facial expressions or physiological changes. Thus, surprise is often viewed either purely as an aroused mental state without any emotional valence or as a short-lived, transitional emotion that is followed by some emotional valence. According to Ortony et al. (1988), pure unexpectedness – regardless of its importance – is emotionally neutral, and it requires a valenced reaction to the unexpected event in order for surprise to occur. In this view, surprise arises as a direct result of valenced appraisal, transforming an unexpected event into either pleasant surprise or unpleasant surprise (Ortony, Clore, and Collins, 1988).

In narrative, a reader's emotional valence to a story outcome contributes to his or her assessment of surprise. Depending on the reader's emotional valence, a purely aroused emotional state can become either pleasant or unpleasant. Specifically, according to Gendolla and Koller (2001), surprise intensity elicited by an important outcome with negative valence is higher than that elicited by an important event with positive valence in the context of a character's achieving his or her goals (see Table 3.2). In other words, the intensity of surprise is heightened when an outcome that the reader considers both important and undesirable occurs. For example, assuming that a reader is concerned about a protagonist's goal achievement and expects the protagonist to succeed, the intensity of the reader's surprise is greater than it otherwise would be when he or she sees that the protagonist unexpectedly fails to achieve the relevant goal.

Plan-based approaches have been used to decide whether an event is positively valenced (i.e., desirable) or negatively valenced (i.e., undesirable) (Oatley and Johnson-Laird, 1987;

Table 3.2: Example: Predicted Effects of Outcome Valence and Importance on Surprise Intensity (from Gendolla and Koller, 2001)

Outcome importance	Outcome valence	Surprise intensity
Unimportant	Positive	High
	Negative	Low
Important	Positive	Low
	Negative	Very high

Table 3.3: Five Basic Emotion Together Their Elicitors (from Oatley and Johson-Laird, 1987)

Emotion	Juncture of Current Plan
Happiness	Subgoals being achieved
Sadness	Failure of major plan or loss of active goal
Anxiety	Self-preservation goal threatened
Anger	Active plan frustrated
Disgust	Gustatory goal violated

Slobada and Juslin, 2001). For example, positive emotions (such as happiness) can be triggered when subgoals are being achieved; negative emotions (such as sadness or anger) can be elicited by a frustrated action or loss of an active goal (see Table 3.3). Extending this idea to characterize surprise, Prevoyant characterizes a surprise as positive when it involves the unexpected achievement of a goal. Likewise, Prevoyant labels a surprise as unpleasant when it involves goals that are threatened or when active plan are frustrated unexpectedly. In the present work I assume that a protagonist's valence is the same as the reader's valence. In other words, a protagonist's goal achievement (i.e., a happy ending) corresponds to a reader's positive valence[17].

The Evaluator checks whether the goal condition achieved by an unexpected Significant Event (SE) corresponds with a protagonist's goal (or subgoal) achievement. In the current version of Prevoyant, specific goal conditions are predefined as the protagonist's subgoals. For example, in the Bond story example (Cheong, 2007; Bae and Young, 2008), the plan step *Unlock (Guard, Smith)* is a Significant Event because it achieves the condition *Unlocked (Smith)*, one of the goal conditions in the story. Given *Smith* as a protagonist, the Evaluator considers the condition *Unlocked (Smith)* as the juncture of the plan in which the

[17] According to the claim of Gendolla (1997) and the expectancy-disconfirmation model of surprise, the intensity of surprise caused by a protagonist's success would be lower than that caused by the protagonist's failure because the protagonist's success is predominantly expected by the reader.

protagonist's subgoal is achieved. Thus the Evaluator considers this Significant Event as a potential candidate for surprise with positive valence.

3.2.2.4 Resolution

The final factor that Prevoyant uses to evaluate a surprise is the notion of *incongruity* resolution (that is, resolution of the discrepancy between expectation and what actually happened) resolution in surprise, which is closely related to the story interest (Iran-Nejad, 1987; Kintsch, 1980). As explained earlier in Section 3.2.2.1.2, Prevoyant views this incongruity as the conflict between an agent's practically deducible proposition and the conditions made by an unexpected event.

In Prevoyant, flashback serves the functional role of incongruity resolution in surprise. Since flashback in Prevoyant is generated by rearranging the temporal order of story events rather than by creating new events from scratch, flashback events can be fitted into the whole story coherently as long as a coherent story plan is given initially as input. As a result, from the viewpoint of coherence, the flashback can resolve the incongruity in surprise, but may not be sufficient to contribute to story interestingness or reader's satisfaction. Other factors such as plausibility or novelty will be attributed to the flashback that functions as a resolution of the incongruity to increase the story interestingness. Although both plausibility and novelty are important factors to story interestingness, the current version of the Evaluator does not take them into account, leaving them to the story author's responsibility.

While the Evaluator does not consider plausibility or novelty of the flashback, it considers the flashback's importance and length relative to the overall set of story events. As described in Section 3.2.2.2, the importance of story events is calculated in terms of three types of importance – causal importance, character importance, and item importance. The selection of the flashback with high causal importance contributes to the story interestingness, increasing the postdictability in retrospect. Either character importance or item importance can be used to make up for the causal importance for stories that have a weak causal structure. With regard to the flashback length, the current Evaluator takes a simple approach. To avoid a trivial one, the minimum length of the plan steps in the flashback events is greater than one. To serve as a backstory rather than a main story, the proportion of flashback events relative

to the entire set of story events is less than .5[18]. The closing step, which is executed last in the story plan, is excluded from the candidates of surprising event for a proper ending.

An excellent example of incongruity resolution using flashback would be the flashback scene at the ending in *The Usual Suspects* (1995), where the detective interrogating "Verbal" Kint realizes the truth – who *Keyser Söze* actually is – right after releasing Kint. In this famous flashback scene, seemingly unimportant items, such as a simple mug cup in the office, play important roles to reveal the hidden truth, fitting every detail into a united whole.

3.2.2.5 A Pipeline Evaluation Process Using Four Factors

As explained earlier in the beginning of Section 3.2.2, the Evaluator's functional role is to select the best separable Causal Chain for surprise arousal, given a set of separable Causal Chains as input. The Initiating Events (IE) of the best separable Causal Chain will be presented as a flashback in the resulting story after presentation of the Outcome Event (i.e., the Significant Event of the best separable Causal Chain). To this end, the Evaluator carries out a pipeline evaluation process using the four factors as shown in Figure 3.17, which is explained in the following text.

The overall pipeline evaluation process consists of four phases. The first three phases filter out the separable Causal Chains that do not meet the evaluation criteria in terms of three factors: emotional valence, expectation failures, and resolution. First, the Evaluator selects the resulting set just those separable Causal Chains having the SE that will result in either active or passive expectation failure. Then, the Evaluator selects the separable Causal Chains having the SE that enables a protagonist's goal achievement[19]. Next, the Evaluator selects from the working set the separable Causal Chains having the IE that meets the minimum length condition of the flashback events. As the last phase, after carrying out these three filtering phases, the Evaluator selects one separable causal chain by computing the importance of the plan steps in each separable Causal Chain and picking the one with the

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[18] This approach is a rule of thumb. More refined approach will be necessary as future work.

[19] According to Gendolla and Koller (2001), the intensity of surprise will be highest when the outcome valence is negative and important (cf. Table 3.2). The current Evaluator, however, considers only the important outcome with positive valence.

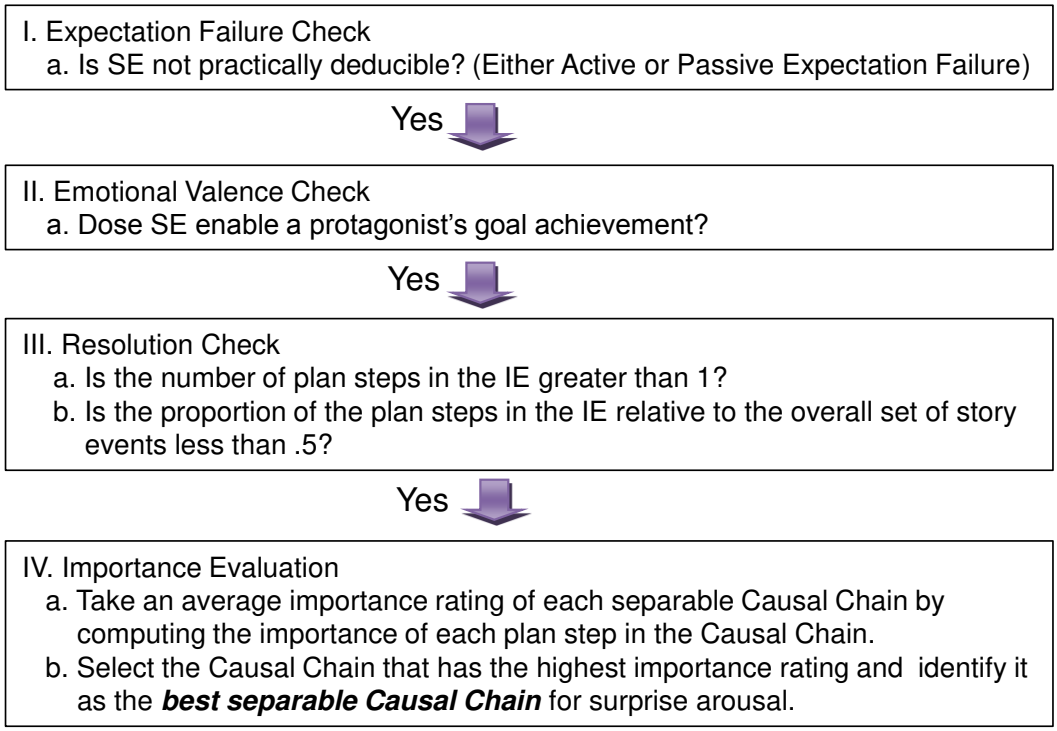


Figure 3.17: Pipeline process for the selection of the best separable Causal Chain, given as input a set of separable Causal Chains.

highest average importance value (breaking ties arbitrarily). The finally selected separable Causal Chain is the output of the Evaluator, the *best separable Causal Chain*.

3.2.3 The Generator: Selection of Foreshadowing

Foreshadowing is a narrative device that provides hints about events that will happen later in the story. The hint given by foreshadowing can be manifested in various ways. Simple introduction of characters or items, which will become of importance later in the story, can be an instance of foreshadowing. Subtle description using metaphor or analogy (e.g., presentation of a dead bird implying a character's death) can also serve as foreshadowing. The current version of Prevoyant employs the former, inspired by the narrative technique known as *Chekhov's Gun*.

3.2.3.1 Chekhov's Gun as an Instance of Foreshadowing

Chekhov's Gun is an instance of literary foreshadowing[20], which is based on a quote from a letter written by the author Anton Chekhov to his friend. In the letter, Chekhov writes "One must not put a loaded rifle on the stage if no one is thinking of firing it." According to Chekhov, everything on the stage is intentionally introduced for its unique use in the play. In other words, narrative elements (such as characters, objects, and locations) that are supposed to be used importantly later in the story are introduced earlier. This kind of foreshadowing does not seem bear any importance at the time of introduction and is of importance only when the relative important events occur later in the story (Mar and Oatley, 2008).

In Prevoyant, the Generator takes a simple approach motivated by Chekhov's Gun. Once the best separable Causal Chain is passed from the Evaluator, the Generator looks at the plan steps in the IE of the best separable Causal Chain. Among the plan steps in the IE, the Generator identifies the first plan step in the IE, starting from a step that is chronologically the closest from the initial state, as a target foreshadowing step. A foreshadowing event is a copied plan step of the target foreshadowing step in which some crucial information is hidden. The detailed realization of foreshadowing is left to the Implementer.

3.2.3.2 Temporal Position for Foreshadowing

In Prevoyant, foreshadowing gives a hint about a plan step in the Initiating Events (IE) that will be presented after the presentation of the Outcome Event (OE) as a form of flashback (see Figure 3.18). Theoretically, foreshadowing can be temporally located at any temporal positions between the initial position of the target plan step in the IE and its causal antecedent step. In Figure 3.18, for example, when the target plan step (E_3) in the IE has a dedicated incoming causal link originated from E_1, there are two potential temporal positions for a foreshadowing event serving as a hint about the target plan step, E_3: between E_1 and E_2; and after E_2. Among those potential positions, the current Prevoyant selects the temporal position

[20] A similar device in filmmaking is named *leave-behind*, in which the camera lingers on a specific object, implying its importance for later use (Mar and Oatley, 2008).

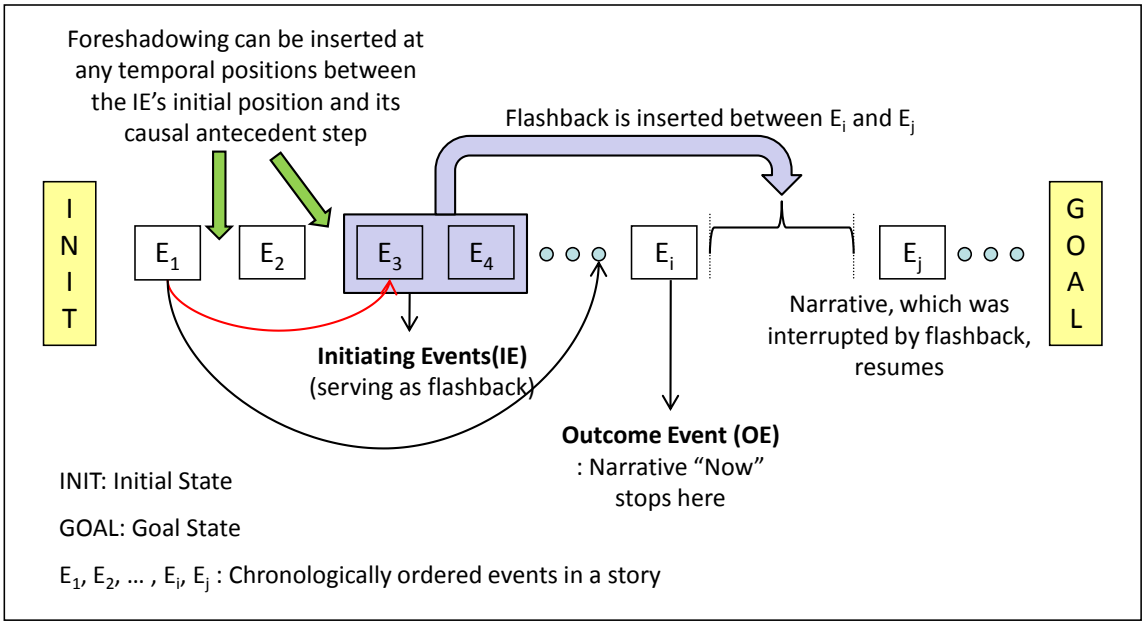


Figure 3.18: Selection of temporal position for foreshadowing and flashback

right after the causal antecedent step of the target foreshadowing step (that is, after E_1 in Figure 3.18).

3.2.3.3 Postdictability and Coherence

After the selection of foreshadowing and flashback is complete, the Evaluator checks postdictability. Surprise is *postdictable* if every narrative part makes sense as a whole when the reader reconstructs the whole story in retrospect. Since the flashback and foreshadowing in Prevoyant are based on a complete story plan that is created from a sound discourse planner, the temporally reconstructed story satisfies this postdictability.

While the foreshadowing and flashback used in Prevoyant helps to ensure the postdictability because of its backward causality (that is, foreshadowing does not bear importance until the relevant flashback is presented), it may also distract the reader's attention from the main story because of its ambiguity and surplus in nature (Morson, 1994) as well as the interruption of the story flow. As a result, the coherence of the entire story may be harmed. The current Prevoyant does not address this issue about how the story coherence

can be maintained without the reader's distraction, but more work will be needed as future work.

3.3 Prevoyant: The Implementer

The Implementer's functional role is to *tell* the story events in a non-chronological way. Given flashback and foreshadowing events, the Implementer manifests the temporally rearranged story plan with flashback and foreshadowing in a specific medium such as text or visual media. Currently, Prevoyant considers text realization in which a plan step is mapped into a sentence in text. The realization of visualized stories is discussed in Section 5.1 as future work.

For the textual realization of flashback events, specific discourse markers can be used to specify the temporal rearrangements caused by flashback in the discourse. In the flashback discourse the Implementer uses the discourse marker "actually" and past tense verbs to let the reader know that these sentences were flashback, while representing other events in the present tense. For example, an instantiated plan step *PutOn*(President, BulletProofVest) can be realized as a sentence "President puts on a bullet-proof vest", which will be rephrased in the flashback sentence as "Actually, President put on a bullet-proof vest."

As for the textual realization of foreshadowing events, some crucial information can be replaced with particular pronouns such as *someone*, *somebody*, or *something*. For example, a realized plan step "Smith hides diamond in his shoe" can be rephrased in the foreshadowing sentence as "Someone hides diamond in his or her shoe."

Chapter 4

Evaluation

This chapter describes the two experiments that I conducted to evaluate the effectiveness of Prevoyant in terms of generating a discourse structure that can elicit surprise in the reader's mind. The first experiment was conducted as a pilot study using printed texts with a small number of subjects. The second experiment was conducted as a main study using Web-based texts with a larger number of subjects.

To measure participants' surprise levels, I chose verbal self-reports. In general, manifestations of surprise can be identified by three types – subjective verbal reporting about a subject's surprise experience, physiological reactions, and behavior including facial expression (e.g., raised eyebrows and open mouth) (Meyer and Niepel, 1994). Since the surprise to be measured in my experiments is surprise that is elicited as a reaction to text materials rather than surprise as a physiological response, the measurement of surprise based on either physiological change or specific behavior was excluded. Instead, participants read stories and were asked to indicate specific story elements that contributed to or give rise to feelings of surprise.

As story materials, I picked two stories which are named the Bond story and the Xmas story, respectively. These stories were previously used in experimental studies measuring suspense in narrative generation (Cheong, 2007). The story plans corresponding to these

stories were originally created by Crossbow, a C# implementation of Longbow, and share the same plan structure characteristics. A minor change has been made to the design of the story plans – involving the specification of an associated plan library, initial state and goal state specifications. The final story materials contain an initial background setting, which is written by hand on the basis of the initial conditions, and a main story consisting of sentences based on 20~23 plan steps. The plan steps that comprise a complete story plan were created by the Longbow planner to satisfy the goal literals in the goal state.

4.1 Experimental Study 1: Pilot Study

I conducted a pilot study to examine how factors such as unexpectedness, the importance of events, a reader's valence, and resolution can be employed within a planning-based framework to evaluate surprise within a narrative using flashback and/or foreshadowing. The dependent variables were a rating of emotions as a subject's cognitive responses (that is, surprise, suspense, and curiosity) and a rating of interestingness. The independent variables were the texts that were produced by Longbow and Prevoyant with three variants (or levels): *Chronological* (where story events are ordered chronologically), *Flashback* (where an Outcome Event is presented without its relevant IE which is presented as a form of flashback), and *Flashback with Foreshadowing* (where foreshadowing gives a hint about the target foreshadowing step in the flashback).

This evaluation methodology corresponds to that used in Grimes-Maguire and Keane's study (Grimes-Maguire and Keane, 2005). In the study, three different versions of a short story (Predictable, Neutral, and Unpredictable), consisting of 4~5 sentences, were used as story materials to measure the relationship between early expectation and a story's ending. In my study I adopted a longer story (consisting of 20 sentences) that included more than two characters.

I hypothesized that the surprise and interestingness ratings of the *Flashback* and *Flashback with Foreshadowing* subject groups would be higher than that of the *Chronological* subject group. Although I did not predict beforehand the level of curiosity or

suspense, I measured both as references to cognitive interests. Table 4.1 compares the null hypotheses and the alternative hypotheses in the Experiment 1.

Table 4.1: Hypotheses in Experiment 1

Hypothesis 1: Surprise Rating

Null Hypothesis

When a story is represented using three different text types that were produced by Prevoyant, there is no difference among the means of surprise rating in the three text types. [$\mathbf{H_0}$: $\mu_1 = \mu_2 = \mu_3$, where μ_1 : the mean surprise rating in *Chronological* text type; μ_2 : the mean surprise rating in *Flashback* text type; μ_3 : the mean surprise rating in *Flashback with Foreshadowing* text type]

Alternative Hypothesis

When a story is represented using three different text types that were produced by Prevoyant, there is difference among the means of surprise rating in the three text types: the mean surprise rating of *Flashback* text type will be greater than that of the *Chronological* text type; or the mean surprise rating of *Flashback with Foreshadowing* text type will be greater than that of the *Chronological* text type; or the mean surprise rating of *Flashback* and *Flashback with Foreshadowing* text type will be greater than that of the *Chronological* text type. That is, [$\mathbf{H_1}$: $\mu_1 < \mu_2$ or $\mu_1 < \mu_3$ or $\mu_1 < (\mu_2 + \mu_3)/2$)]

Hypothesis 2: Interestingness Rating

Null Hypothesis

When a story is represented using three different text types that were produced by Prevoyant, there is no difference among the means of interestingness rating in the three text types. [$\mathbf{H_0}$: $\mu_1 = \mu_2 = \mu_3$, where μ_1 : the mean interestingness rating in *Chronological* text type; μ_2 : the mean interestingness rating in *Flashback* text type; μ_3 : the mean interestingness rating in *Flashback with Foreshadowing* text type]

Alternative Hypothesis

When a story is represented using three different text types that were produced by Prevoyant, there is difference among the means of interestingness rating in the three text types. the mean interestingness rating of *Flashback* text type will be greater than that of the *Chronological* text type; or the mean interestingness rating of *Flashback with Foreshadowing* text type will be greater than that of the *Chronological* text type; or the mean interestingness rating of *Flashback* and *Flashback with Foreshadowing* text type will be greater than that of the *Chronological* text type. That is, [$\mathbf{H_1}$: $\mu_1 < \mu_2$ or $\mu_1 < \mu_3$ or $\mu_1 < (\mu_2 + \mu_3)/2$)]

4.1.1 Configuring the Experimental System

As described in Section 3.2.2.5, Prevoyant makes use of four factors to evaluate surprise in narrative – expectation failure, importance of events, a reader's emotional valence, and resolution. Among the four factors, the constant values in Eq.(1) to determine the importance of event (see Section 3.2.2.2.2) were set as the same values that were used in the experimental study for suspense (see Cheong, 2007: p.73). Table 4.2 shows the constant values that were used in the study in which only the causal importance (that is, k_i, k_{in}, k_o, and k_c) was used to compute the overall importance and character/item importance (that is, k_{ch} ,and k_{it}) were not used. The constant value CC in the equation was assigned 2.0 when an event is a motivated act (i.e., a Significant Event that achieves a goal condition directly) as in the studies for suspense.

Table 4.2: Experimental values for weighting constants (from Cheong, 2007: p.73)

Constants	Description	Value
k_i	Incoming Causal Links	1.0
k_{in}	Incoming Causal Links from the Initial State	0.3
k_o	Outgoing Causal Links	5.0
k_c	Category	2.5
k_{ch}	Character Importance	0.0
k_{it}	Item Importance	0.0

4.1.2 Method

4.1.2.1 Participants and Experiment Design

A total of 18 subjects, undergraduate and graduate students majoring in Computer Science at North Carolina State University (4 women, 14 men), were volunteer participants in the pilot study. Their ages ranged from 20 to 40 years old. I used a repeated measures design, where each participant was randomly assigned to one of six subject groups and viewed two story materials with distinct text types. Table 4.3 show two story materials with three distinct text types (i.e., three levels) and six subject groups. Among the two story materials, only the data

Table 4.3: Experimental design of the pilot study, where two story materials with three distinct text types were used.

Text Types / Stories	Chronological	Flashback	Flashback with Foreshadowing
Story (Bond)	BondB	BondFB	BondFF
Story (Xmas)	XmasB	XmasFB	XmasFF

Subject Group	First Story	Second Story
S1	BondB	XmasFB
S2	BondB	XmasFF
S3	BondFB	XmasB
S4	BondFB	XmasFF
S5	BondFF	XmasFB
S6	BondFF	XmasB

from the first story (i.e., the Bond story) was analyzed because the counterbalanced design was not considered in the pilot study. Since every subject was asked to read the Bond story first, according to the scheme shown in Table 4.3, the data from the Bond story was free from the error that might stem from the lack of the counterbalanced design. The experiment was conducted over two weeks from February 23, 2009 to March 4, 2009.

4.1.2.2 Materials

Two story materials were used, which were the Bond story and the Xmas story. Only the data from the Bond story, however, were collected because of the potential error pointed out in the previous section. Each story had three distinct text types: Chronological, Flashback, and Flashback with Foreshadowing. The Chronological text type was created using Longbow planner by defining a planning problem and a plan library, which were designed by a domain

engineer who was not involved in this research. The other two text types (Flashback and Flashback with Foreshadowing) were created using Prevoyant by applying the same planning problem.

Each story material contained an initial background setting and a main story. The initial background setting was necessary to provide the subjects with background information (e.g., each character's goals) of the story. The background setting was a handwritten text on the basis of the initial conditions of the story plan. The main story consisted of sentences that have direct one-to-one mappings to the steps of the story plan. For example, a plan step *Leave (Smith, Cell)* in the Bond story was translated into a sentence *Smith leaves the cell*. The number of plan steps in the Bond story plan was 20, so there were 20 sentences in the main story of the Bond story. For this experiment, the mapping was done manually.

Since the planning problem and the plan library was the same as those used in the evaluation of Suspenser, the Chronological text of the Bond story was almost the same[21] as a material that was used for the evaluation of Suspenser (cf. Cheong, 2007: A.3 Evaluation Materials for Pilot Study 3, p. 119). Table 4.4 represents the Chronological text of the Bond story that was used in the experiment.

With regard to the Flashback text, where the flashback events (which were E7 and E14 in Table 4.4) were reordered to present after E15 (which was the Outcome Event), the discourse marker "actually" and past tense verbs were used to let the reader know that these sentences were flashback. So, the flashback events E7 and E14 in Table 4.4 were translated as "Actually, before going to the island, Smith hid a diamond in his shoe" and "Smith bribed the guard with the diamond in his shoe," respectively. In the Flashback with Foreshadowing text, a foreshadowing sentence was given between E2 and E3 as "Someone hides a diamond in his or her shoe." In both treatments, the sentence numbers were given sequentially so that the subjects could not recognize the manipulation of the ordering of story events.

[21]Two minor changes have been made. First, each sentence in the material for Cheong's study was sequentially numbered so that the participants could select the appropriate sentence numbers as they were asked questions in the questionnaire. Second, Smith the FBI agent, was changed as Smith the CIA agent.

Table 4.4: Story material (The Bond story) in the pilot study (adapted from Cheong, 2007: A.3 Evaluation Materials for Pilot Study 3, p.119)

Background Setting	
I1	The lunatic villain known as Jack has been developing biological weapons of devastating proportions.
I2	To accomplish the final stages of weapon development, he kidnapped the famous scientist, Dr. Cohen, and brought him to his private fortress on Skeleton Island.
I3	Jack expected that the CIA would soon send Smith, their top agent, to rescue Dr. Cohen.
I4	To keep the troublesome Smith out of his hair, Jack ordered his own agent, Erica, to monitor Smith and capture him if he is assigned to Dr. Cohen's rescue operation.

Main Story	
E1	Erica installs a wiretap in Smith's home while he is away.
E2	Erica eavesdrops on the phone conversation in which Smith is given the order to rescue Dr. Cohen.
E3	Erica meets with Smith.
E4	Erica tells Smith that her father was kidnapped by Jack and taken to Skeleton Island, and she asks Smith to save her father.
E5	Erica gives Smith the blueprints of Jack's fortress, with her father's cell marked.
E6	Erica provides Smith with a boat for transportation to Skeleton Island.
E7	Before going to the island, Smith hides a diamond in his shoe.
E8	Smith goes to the port containing Erica's boat.
E9	Smith rides the boat to Skeleton Island.
E10	Smith sneaks into the cell marked on the map containing Erica's father.
E11	Jack and his guard capture Smith as he enters the cell.
E12	The guard disarms Smith.
E13	The guard locks Smith in the cell.
E14	Smith bribes the guard with the diamond in his shoe.
E15	The guard unlocks the door.
E16	Smith leaves the cell.
E17	Smith sneaks to the lab where Dr. Cohen is being held.
E18	Smith fights the guards in the lab.
E19	Smith takes Dr. Cohen from the lab.
E20	Smith and Dr. Cohen ride the boat to shore.

4.1.2.3 Procedure

Each subject individually participated in the study. After being randomly assigned to one of six subject groups as in Table 4.3, each subject was given a printed material which included experimental instructions, a demographic survey questionnaire, the first story material (the Bond story) and a questionnaire, the second story material (the Xmas story) and a questionnaire, and the post-experiment comments. According to the assigned subject group, each participant was given different text type as shown in Table 4.3. While the printed material included experimental instructions, each subject was given a brief verbal instruction from the study investigator before the study begins.

In the story questionnaire, the relevant story events were grouped together for the corresponding questions. (Specifically, it was stressed that subjects were not supposed to read the next page before they finish the current page through both the written instruction and the verbal instruction.) For example, a question about expectation like "Would you expect that Smith can get out of the cell?" was asked after event E13 (The guard locks Smith in the cell); a question about the importance of flashback events (E14/ E15) was given after the presentation of E15; questions about the ratings of the reader's external emotions (that is, surprise, curiosity, and suspense), overall interestingness, important events in the story, and favorite characters were asked after the story's last sentence was given. Subjects were asked to provide ratings on a 5-point scale ranging from *not at all* (1) to *extremely* (5). The definitions of surprise, suspense, and curiosity were provided to all subjects (see Table 4.5).

4.1.3 Results

As mentioned before, a procedural error in the second story (i.e., the Xmas story) caused me to disregard data collected for it. As a result, all analysis was applied only to data for the first story (i.e., the Bond story)[22].

[22] Even though subjects read two stories, all the subjects read the Bond story first. Therefore, data collected from the first story was free from the procedural error and could be analyzed as if they were collected separately.

Table 4.5: The Definitions of Surprise, Suspense, and Curiosity Used in the Experiments (based on Price, 2003)

Surprise The emotion felt when expectations about what is going to happen are violated by what in fact does happen.
Suspense An emotion or state of mind arising from a partial and anxious uncertainty about the progression or outcome of an action, especially one involving a positive Character.
Curiosity An intrinsically motivated desire for information or knowledge which is partially described or has some missing gaps at the time.

A one-way ANOVA confirmed that at least two discourse types had significant effects on the ratings of surprise, $F(2, 15\ df) = 9.61$, $p = .002$, and on the ratings of interestingness, $F(2, 15\ df) = 5.24$, $p = .019$. There was no significant effect on the ratings of suspense and curiosity at the 95 percent confidence level. *A priori* pair-wise comparisons using a one-tailed t-test confirmed that there were significant increases of the surprise ratings between *Chronology* and *Flashback* text types, $t(15\ df) = -3.998$, $p < .001$ as well as between *Chronology* and *Flashback with Foreshadowing* text types, $t(15\ df) = -3.554$, $p < .002$. With regard to the interestingness ratings, there were also significant increases between *Chronology* and *Flashback* text types, $t(15\ df) = -2.566$, $p < .011$ as well as between *Chronology* and *Flashback with Foreshadowing* text types, $t(15\ df) = -2.994$, $p < .005$. For both surprise and interestingness, there was no significant difference between *Flashback* and *Flashback with foreshadowing* text types. Table 4.6 and Figure 4.1 show the mean ratings of the three text types. Figure 4.2 illustrates the proportions of the subjects who marked surprising events, where E15 is the surprising event (i.e., the Outcome Event); E7 and E14 are the flashback events (i.e., the Initiating Events).

Table 4.6: Mean and standard deviation of cogntive interests (i.e., surprise, suspense, and curiosity) and interestingness in the Bond story

	Chronological	Flashback	Flashback with Foreshadowing
	M (SD)	M (SD)	M (SD)
Surprise	**1.5 (0.50)**	**3 (0.82)**	**2.83 (0.37)**
Suspense	2.5 (0.96)	2 (1.15)	3 (0.58)
Curiosity	2.67 (0.94)	2.83 (1.07)	3.83 (0.37)
Interestingness	**2 (0.82)**	**3 (0.58)**	**3.17 (0.37)**

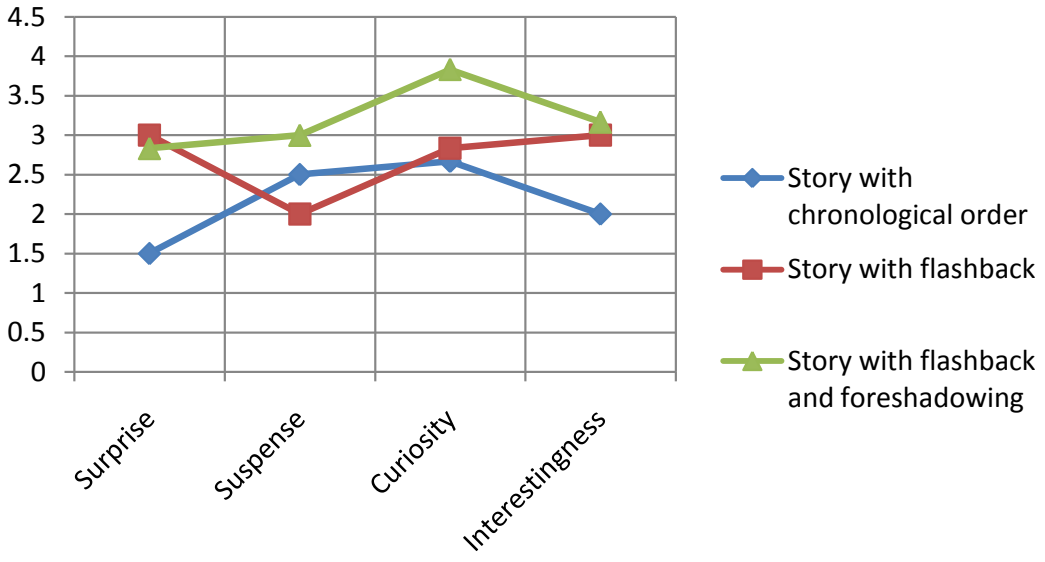


Figure 4.1: Mean ratings of cognitive interests (i.e., surprise, suspense, and curiosity) and overall interestingness depending on the three text types in the Bond story

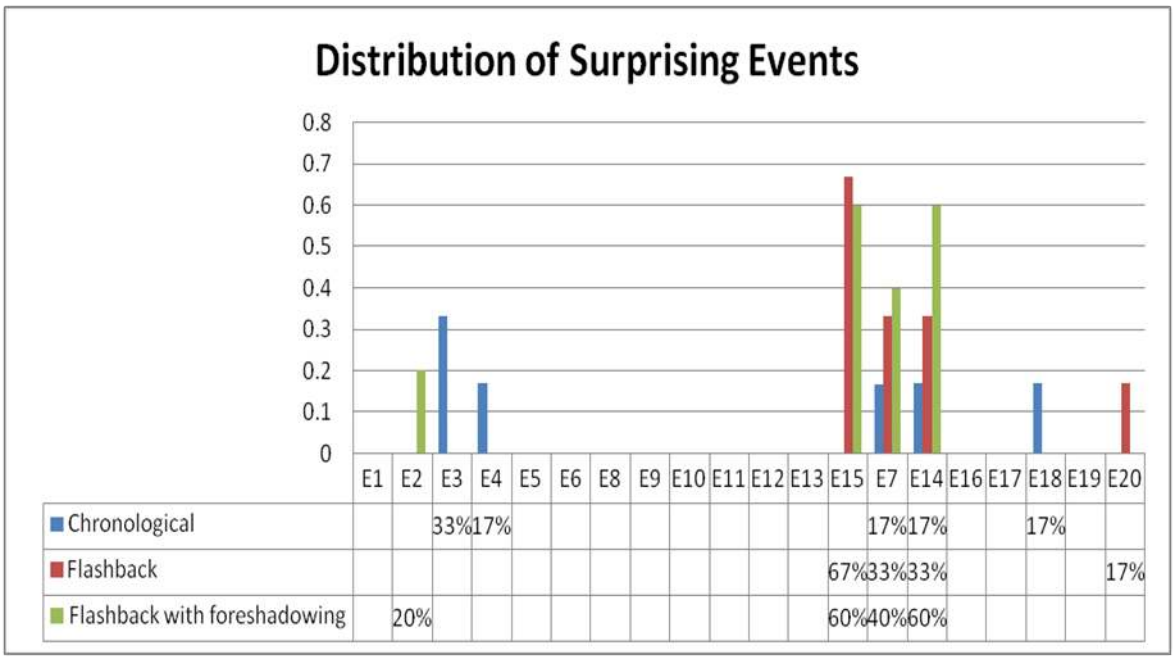


Figure 4.2: The Proportions of participants who marked surprising events in the Bond story (e.g., 67% of the *Flashback* subject group answered that E15 (the Outcome Event) had contributed to eliciting surprise)

4.1.4 Discussion

4.1.4.1 Expectation Failures

In the survey questionnaire, a question about expectation "Would you expect that Smith can get out of the cell?" was asked after the presentation of event E13 (The guard locks Smith in the cell). 72% of the total participants answered *Yes* to this question. The reason that subjects reported for the formation of this expectation varied depending on the treatment. In the *Chronological* subject group (where 5/6 of the subjects answered *Yes*), all the subjects who answered *Yes* picked event E7 (Smith hides a diamond in his shoe) as a reason for their expectation. In the *Flashback with Foreshadowing* subject group (where 4/6 of the subjects answered *Yes*), all the subjects who answered *Yes* picked the foreshadowing event (Someone hides a diamond in his or her shoe) as a reason for their expectation. In the *Flashback* subject group (where 4/6 subjects answered *Yes*), the subjects who answered *Yes* picked event I3 (a

top agent Smith) or E4 (Erica asks Smith to rescue her father) as a reason. These *active* expectations were mostly at an abstract level (e.g., Smith, the top agent and the protagonist in the story, would manage to escape from the cell *somehow* in order to achieve his goal). In contrast, the *passive* assumption failures after the presentation of E14 and E15 were at a primitive level (e.g., the diamond was actually a secret tool or weapon; Erica was actually a double agent).

4.1.4.2 Importance of Events

After reading the whole story, subjects were asked to select six important events in the story. On average, the Outcome Event (E15) and its Initiating Events (i.e., the flashback events; E7 and E14) were ranked high (see Figure 4.3). Interestingly, E18 (Smith fights the guard in the lab) was rated highly important (83%) in the *Chronological* subject group, but it was rated very low in *Flashback* (17%) and *Flashback with Foreshadowing* (0%) subject group.

4.1.4.3 Emotional Valence

The favorite characters in the story were Smith (52%) and Erica (28%), followed by Jack

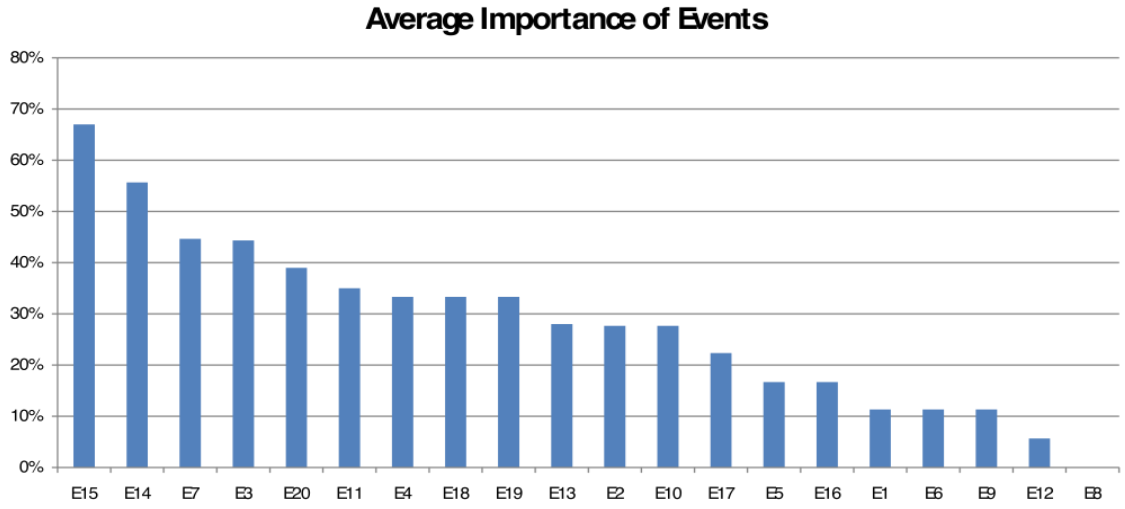


Figure 4.3: Average importance of events (e.g., 67% of the subjects chose E15 as one of the six important events in the story)

(10%), Dr. Cohen (5%) and the Guard (5%). The most common reason noted for choosing Smith was because he was the protagonist in the story. Both Erica's rather ambiguous identity and the lack of Jack's activity as the antagonist in the story were pointed out as reasons for excluding these characters from subjects' favorites.

4.1.4.4 Resolution and Story Interest

At the end of the study, subjects were asked to give comments about the stories. Both story resolution and incongruity resolution in surprise were addressed in the post-experiment comments. As for story resolution, lack of description of Jack and Erica's outcome was pointed out by subjects in free-form comments as harmful to a reader's interest in the story. As for incongruity resolution, the implausibility of the resolution event (e.g., getting out of the cell by *bribing* the guard) was pointed out by subjects. To the subjects who considered this story as a typical spy-genre action-thriller, this kind of resolution, which was supposed to be a resolution of the story's climax, seemed inappropriate.

4.2 Experimental Study 2: Main Study

I conducted the second experimental study to examine how factors such as unexpectedness, the importance of events, a reader's valence, and resolution can be employed within a planning-based framework to evaluate surprise within a narrative using flashback and/or foreshadowing. The independent variables were the texts that were produced by Prevoyant with three variants (or levels): *Chronological* (where story events are ordered chronologically), *Flashback* (where an Outcome Event is presented without its relevant IE which is presented as a form of flashback, and *Flashback with Foreshadowing* (where foreshadowing gives a hint about the target foreshadowing step in the flashback). As in the first experiment, suspense and curiosity were measured as references. The hypotheses were also the same as those in the first experiment: the surprise and interestingness ratings of the *Flashback* and *Flashback with Foreshadowing* subject groups would be higher than that of the *Chronological* subject group. The same weighting constant values were assigned.

The main experiment had several differences from the pilot experiment. First, the second experiment was conducted online using the Web. Thus the online participants viewed the

story materials through their computer monitors by accessing a specified Web site rather than viewing the printed materials. Second, the story sentences were displayed one by one rather than displayed as a group of sentences at a time. Third, the data were gathered using a repeated measures design with counterbalancing, that is, each participant read two stories with different text types. Finally, a question about the story coherence was added to the questionnaire in the main experiment.

4.2.1 Method

4.2.1.1 Participants and Experiment Design

A total of 54 subjects, undergraduate and graduate students at North Carolina State University (19 women, 35 men), including their family members and friends, were volunteer participants in the main experimental study. Their ages ranged from 20 to more than 50 years old. For reliability, I only counted the participants who specified their name, discarding the data from seven anonymous participants from the sample. This experiment was conducted over three weeks from April 26th, 2009 to May 16th, 2009. During the period, each participant individually accessed the specified Web site, which is designed using PHP scripts, randomly in his or her free time and assigned to one of the 12 subject groups. Each subject group is given two story materials with two different text types (see Table 4.8). For the assignment of a participant to a subject group, the accumulated number of participants was counted automatically whenever each participant accessed the Web site and completed his or her demographic data before participating in the main study, and then a subject group number was assigned using a modulo 12 (i.e., "the accumulated number of participants mod 12"). According to the assigned subject group, each participant was given two stories with

Table 4.7: Experiment design – two story materials with three levels

Text Types / Stories	Chronological	Flashback	Flashback with Foreshadowing
Story (Bond)	BondB	BondFB	BondFF
Story (Xmas)	XmasB	XmasFB	XmasFF

Table 4.8: Experiment design - 12 subject groups according to the three levels of the story material

Subject Group	First Story	Second Story
S1	BondB	XmasFB
S2	BondFB	XmasFF
S3	BondFF	XmasB
S4	XmasFB	BondFF
S5	XmasFF	BondB
S6	XmasB	BondFB
S7	BondFF	XmasFB
S8	BondB	XmasFF
S9	BondFB	XmasB
S10	XmasFB	BondB
S11	XmasFF	BondFB
S12	XmasB	BondFF

two distinct text types as shown in Table 4.8.

4.2.1.2 Material

Two story materials were used, which were originally created for measuring suspense in narrative generation (Cheong, 2007). Among the two story materials, the Bond story is the same as that in the pilot experiment (see Table 4.4). Another story (the Xmas story) was slightly modified in the main experiment to have similar story structure to the Bond story by adding new operators and new initial conditions. The character names and background setting also had a minor change. The plan steps that comprise a complete story plan were created by Longbow to satisfy the goal conditions specified in the goal state. Table 4.10 shows the background setting and the main story of the Xmas story.

Both the *Flashback* text and the *Flashback with Foreshadowing* text were created using Prevoyant. The chronological ordering of events in the discourse was done by Longbow, where each plan step in the story plan was mapped into one sentence. In the *Flashback* text,

where the flashback events (e.g., E14, E15, and E16 in Table 4.9) were reordered to present after E21 (the Outcome Event), the discourse marker "actually" and past tense verbs were used to let the reader know that these sentences were flashback. So, the flashback events E14, E15, and E16 were described as "Actually, Tom, suspecting Dr. Evil's evil plan, sent a warning email to the White House," "The President received Tom's email and read it on his smart phone," and "As a precaution, the President put on a bullet-proof vest before going to the fundraising party", respectively. A foreshadowing sentence was given between E2 and E3 as "Someone sends an email message". The sentence numbers were given sequentially so that the readers could not recognize the manipulation of the ordering of story events while reading.

Table 4.9: Story material (the Xmas Story) in the Main Experiment (based on Cheong, 2007)

Background Setting	
I1	In 2012, mankind faces severe environmental problems. The process of deforestation has spread to North America. The sea level has been raised significantly by shrinking glaciers.
I2	An environmentalist named Mr. Greenpeace, head of the World Environmental Foundation and an ex staff sergeant in the British special force, is aware of these urgent problems, planning to persuade the U.S. President to take prompt actions to prevent the coming disaster. Mr. Greenpeace is at his office in London, about to fly to Washington D.C.
I3	Meanwhile, Dr. Evil, a billionaire psychopath, plans to assassinate the U.S. President. His plans are complicated by the security at the White House, where only invited people can enter.
I4	In a nearby suburb of Washington D.C., a man named Tom, who is a single father of a three-year-old girl named Iris, is hoping to give his daughter a Christmas present. Tom, a computer programmer, has been unemployed for six months.
I5	**T**om has a shiny silver ring that was given to him by his wife long time ago. Unknown to Tom, the ring is magical; when worn, whispering a special spell 'etaudarg anna wi' will cause the ring to send out a magical pulse that will put anyone within a ten foot radius to sleep. Dr. Evil knows about the secret of this ring.
I6	Tom's goal is to get a limited special edition *Dora The Explorer* doll for Iris's Christmas present. The limited special edition *Dora The Explorer* doll is very popular but rare and expensive. Tom tries to sell or trade his ring for the special edition *Dora The Explorer* doll through craigslist. One day before Christmas, Tom receives an email from Dr. Evil that he has the limited special edition *Dora The Explorer* doll and he is willing to trade it for Tom's ring. Tom is invited to Dr. Evil's billionaire castle.

Table 4.9 Continued

Main Story	
E1	Tom visits Dr. Evil's castle and trades his ring for the limited special edition Dora The Explorer doll. As a result, Tom obtains the special edition *Dora The Explorer* doll that Iris wants; Dr. Evil obtains the ring. After meeting Dr. Evil, Tom suspects that Dr. Evil is planning something evil against the President.
E2	Tom puts the special edition *Dora The Explorer* doll under the Christmas tree.
E3	Dr. Evil withdraws some cash from an ATM in his bank.
E4	Dr. Evil buys a gun from an arm dealer. The gun is made out of composite materials designed to avoid detection by metal detectors.
E5	Mr. Greenpeace travels from London to Washington D.C., the U.S. capitol.
E6	Mr. Greenpeace gives a speech about the importance of taking prompt actions to save the Earth.
E7	Being impressed by Mr. Greenpeace's speech, the U.S. President announces that he will raise funds to support Mr. Greenpeace's environmental foundation and whoever donates more than one million dollars will be invited to the White House for a fundraising party. The president also invites Mr. Greenpeace to the fund-raising party at the White House.
E8	Mr. Greenpeace travels to the White House.
E9	Dr. Evil watches the TV and finds out that a donation will get him invited to the White House.
E10	Dr. Evil donates one million dollars to the White House.
E11	The President invites Dr. Evil to the fundraising party.
E12	Dr. Evil travels to the White House with the ring and the gun.
E13	Dr. Evil uses the ring of power to put all the secret service agents to sleep. As a result, there is no one guarding the president.
E14	Tom, suspecting Dr. Evil's evil plan, sends a warning email to the White House.
E15	The President receives Tom's email and reads it on his smart phone.
E16	As a precaution, the President puts on a bullet-proof vest before going to the fundraising party.
E17	Dr. Evil aims his gun and fires it at the President.
E18	The President is shot in the chest and falls to the floor.
E19	Mr. Greenpeace arrives and seizes Dr. Evil.
E20	After being seized, Dr. Evil looks at the President collapsed on the floor and laughs hysterically.
E21	The President slowly stands up.
E22	The President gives his press conference, committing considerable support to the World Environment Foundation in order to save the Earth.
E23	The next day on Christmas, Iris finds a Christmas present for her, the special edition *Dora The Explorer* doll that she wants to have. Iris holds the *Dora The Explore* doll preciously. Tom is happy watching Iris holding the doll.

4.2.1.3 Procedure

Each subject individually participated in the study by accessing the designated Web site randomly. All interaction for all subjects was done within their Web browsers. After completing a demographic survey, each subject assigned in to one of twelve subject groups using a modulo 12 arithmetic described in Section 4.2.1.1, and two different texts were given as shown in Table 4.9. Then, the brief instructions for the experiment were given before reading of the first story started. The story events were grouped together for the corresponding questions. In the Xmas story, for example, a question about expectation like "Would you expect that Dr. Evil could achieve his goal to assassinate the President?" was asked after event E18 (The President is shot in the chest and falls to the floor); a question about the importance of flashback events (E14/ E15/ E16) was given after the presentation of E21; questions about the ratings of cognitive interest (surprise, curiosity, and suspense), overall interestingness, important events in the story, and favorite characters were asked after the last sentence (E23) was given. Each sentence was displayed sentence by sentence, where the next sentence was displayed by clicking the *Next* button on the screen. Subjects were asked to provide ratings on a 5-point scale ranging from *not at all* (1) to *extremely* (5). The definitions of surprise, suspense, and curiosity were provided to all subjects (see Table 4.5).

4.2.2 Results

The mean ratings of surprise and the mean ratings of coherency in the collected data were compared, and the results showed possible interaction between two factors: texts with three levels and stories with two levels (see Table 4.10 for the means of surprise ratings and Table 4.11 for the means of coherency ratings). As shown in Figure 4.4 and Figure 4.5, the curves in the line graphs are not parallel, which implies that there could be interaction between the two factors.

A 2 X 3 factorial analysis of ANOVA confirmed that the interaction between factors in the means of surprise ratings was not significant, where $F_{Text*Story}(2\ df) = 1.595$, $p = .2049$, at the 99 percent confidence level (see Table 4.12), so the main effect could be interpreted using a one-way ANOVA analysis. The interaction between factors in the means of coherency ratings, however, was significant, where $F_{Text*Story}(2\ df) = 4.211$, $p = .018$, at the

Table 4.10: Mean ratings of surprise in the main experiment

Text Type / Story	Chronological	Flashback	Flashback with Foreshadowing	**Means of Story Types**
Bond	1.89	3.11	2.78	**2.59**
Xmas	2.11	2.50	2.63	**2.41**
Means of Discourse Types	**2.00**	**2.81**	**2.70**	
			Grand Mean	**2.50**

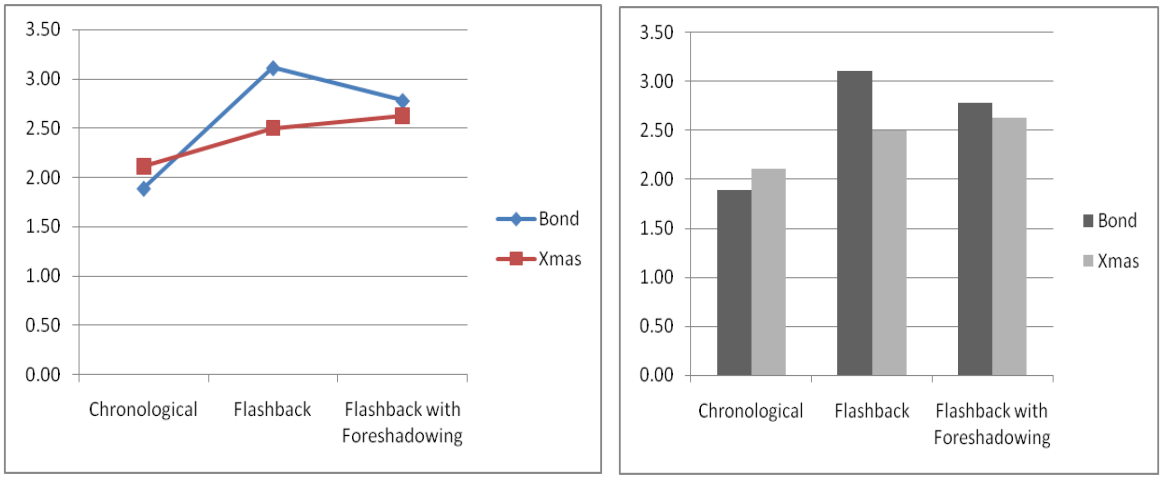


Figure 4.4: Line graph and bar graph of surprise ratings in Table 4.13 (shows possible interaction between story types and discourse types, which is not significant)

95 percent confidence level (see Table 4.12), so the main effect could not be interpreted using a one-way ANOVA analysis.

Because the interaction in the surprise ratings was not significant, the Tukey HSD (Honestly Significant Difference) test was conducted to compare the three levels within the text factor in the means of surprise ratings. The Tukey HSD confirmed that there were significant increases of the surprise ratings between the mean for the *Chronology* text and the mean for the *Flashback* text, where HSD=8.323, $p<.01$. There was also significant increase in the surprise ratings between the mean of the *Chronology* text and the mean of *Flashback*

Table 4.11: Mean ratings of coherency in the main experiment

Text Type / Story	Chronological	Flashback	Flashback with Foreshadowing	**Means of Story Types**
Bond	3.72	3.22	2.56	**3.17**
Xmas	3.06	3.42	3.06	**3.18**
Means of Discourse Types	**3.39**	**3.32**	**2.81**	
			Grand Mean	**3.17**

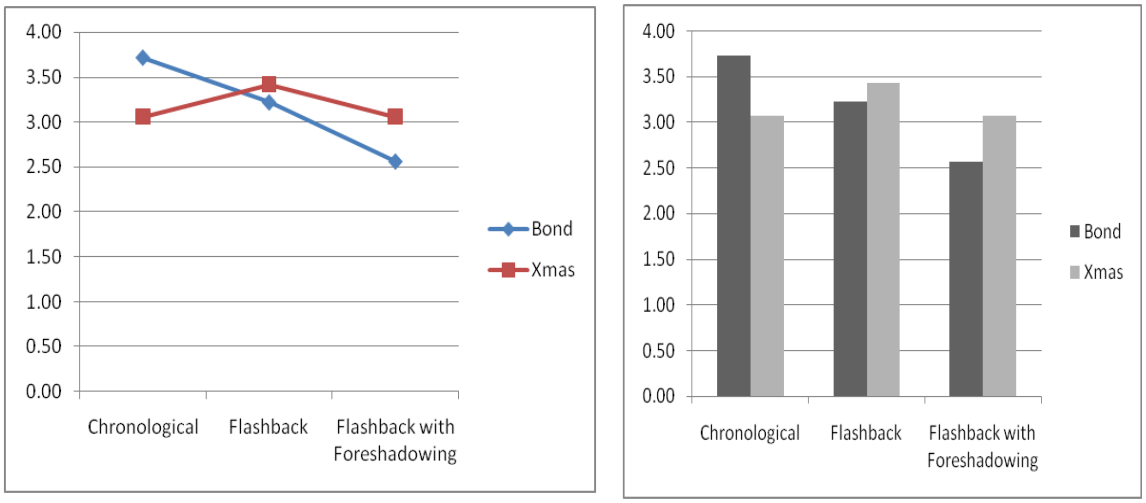


Figure 4.5: Line graph and bar graph of coherency ratings in Table 4.13 (shows possible interaction between story types and discourse types, which is statistically significant)

with Foreshadowing text, where HSD=7.247, $p<.01$. There was no significant difference between the mean of *Flashback* text and the mean of *Flashback with Foreshadowing* text, where HSD=1.076, $p>.05$.

As shown in Figure 4.6, the Outcome Event (E21) and the flashback events (i.e., the Initiating Events, which are E14, E15, and E16) were marked as surprising events. Although E18 (The President is shot in the chest and falls to the floor) was neither the Significant Event nor the Initiating Events, it was also marked as surprising.

Table 4.12: ANOVA Summary tables for the surprise ratings and coherency ratings in the main experiment

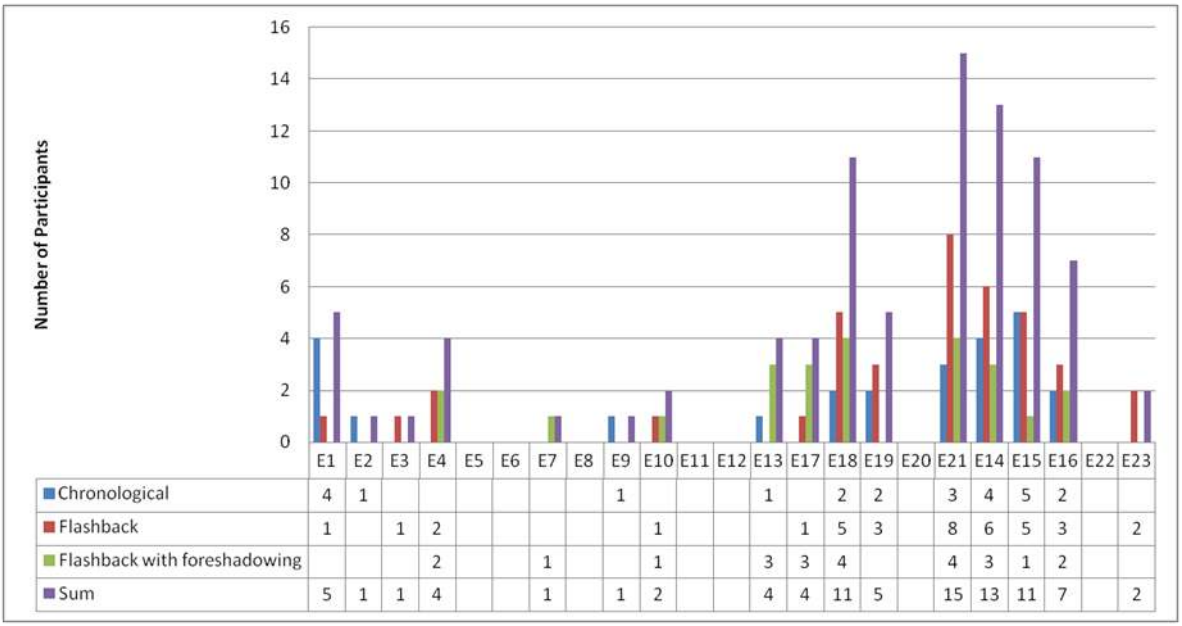
Surprise

Source	*SS*	*df*	*MS*	***F***	***p***
Text	13.63	2	6.813	**6.734**	**.002**
Story	.93	1	.926	**.915**	**.340**
Text*Story	3.25	2	1.614	**1.595**	**.205**
Error	103.19	102	1.012		
Total	121.0	107			

Coherence

Source	*SS*	*df*	*MS*	***F***	***P***
Text	7.394	2	3.697	**4.732**	**.011**
Story	.009	1	.009	**.011**	**.921**
Text*Story	6.580	2	3.290	**4.211**	**.018**
Error	79.68	102	.781		
Total	93.66	107			

The interpretation of interaction and main effects in the means of coherency ratings, which could not be interpreted using a one-way ANOVA because of the significant interaction, is not straightforward. In this experiment, I took into account a single independent variable, that is, text, assuming that there would be no difference between the two stories. Based on the data, it is not clear what factors of the story caused the interaction. The factors could be either at the story syntax level (e.g., the number of story plan steps, the number of causal links, and so on) or at the story semantics level (e.g., novelty or plausibility of events). The line graph and the bar graph in Figure 4.5 show that coherency of non-chronological discourses is rated lower than that of chronological discourse in the Bond story,



	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E17	E18	E19	E20	E21	E14	E15	E16	E22	E23
Chronological	4	1							1				1		2	2		3	4	5	2		
Flashback	1		1	2						1				1	5	3		8	6	5	3		2
Flashback with foreshadowing				2			1			1			3	3	4			4	3	1	2		
Sum	5	1	1	4			1		1	2			4	4	11	5		15	13	11	7		2

Figure 4.6: The proportions of participants who marked surprising events in the Xmas story, where E21 is the Outcome Event (i.e., the surprising event); E14, E15, and E16 are flashback events.

but not in the Xmas story. The coherency mean rating of foreshadowing discourse, however, was the lowest among three discourses in both stories. I posit that the low coherency ratings in the foreshadowing discourse come from the foreshadowing sentences (e.g. "Someone sends an email" in the Xmas story), which interrupts the story flow and undermines the reader's comprehension of the story.

With regard to interestingness, suspense, and curiosity, there was no significant difference among texts or between stories (see Table 4.13 for details).

4.2.3 Discussion

The results from the analysis of the collected data have shown that Prevoyant is effectively generating texts that can arouse surprise in the mind of a reader. In this section, I discuss how the four evaluation factors were affected the reader's surprise.

4.2.3.1 Expectation Failures

In the survey questionnaire, an expectation question "Would you expect that Dr. Evil achieve his goal to assassinate the President?" was asked after the presentation of event E18 (The

Table 4.13: Mean ratings of interestingness, suspense, and curiosity in the main experiment

Interestingness

Text Types / Story Types	Chronological	Flashback	Flashback with Foreshadowing	Means of Story Types
Bond	2.22	2.61	2.50	**2.44**
Xmas	2.44	2.89	2.53	**2.62**
Means of Text Types	**2.33**	**2.75**	**2.52**	
			Grand Mean	**2.53**

Suspense

Text Types / Story Types	Chronological	Flashback	Flashback with Foreshadowing	Means of Story Types
Bond	2.18	2.24	2.44	**2.29**
Xmas	2.22	2.88	2.29	**2.46**
Means of Text Types	**2.20**	**2.56**	**2.37**	
			Grand Mean	**2.38**

Curiosity

Text Types / Story Types	Chronological	Flashback	Flashback with Foreshadowing	Means of Story Types
Bond	2.65	2.53	2.80	**2.66**
Xmas	2.29	2.50	2.50	**2.43**
Means of Text Types	**2.47**	**2.52**	**2.65**	
			Grand Mean	**2.55**

President is shot in the chest and falls to the floor). 70% of the total participants answered *No* to this question. The proportions of the subjects reported for the formation of this expectation varied depending on the texts. In the *Chronological* and the *Flashback with Foreshadowing* texts, 83% and 88% of the subjects answered *No*, respectively. In the *Flashback* text, by contrast, only the 42% of the subjects answered *No*. As reasons for their expectation, the subjects specified some specific facts (such as Mr. President's wearing a bullet-proof vest), context-based guesses (such as Tom or Mr. Greenpeace would help), or general assumptions (such as "the bad guys never win").

4.2.3.2 Importance of Events

After reading the whole story, subjects were asked to select six important events in the story. As shown in Figure 4.7, the three surprising events (E16, E21, and E14) were ranked high. E16 was the Significant Event; E16 and E14 are two of the three flashback events (i.e., the Initiating Events) in the story. This corresponds to the Evaluator's surprise criterion that selects important events as surprising events.

Besides the three surprising events, the events E1 and E18 were also ranked high. E1 is

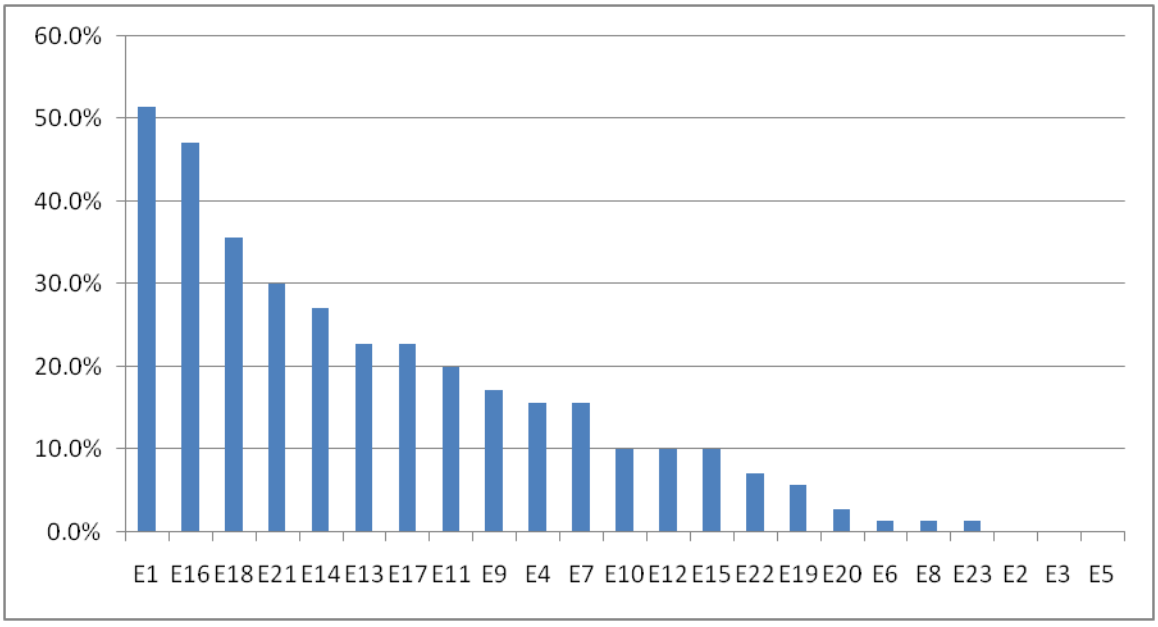


Figure 4.7: Average importance of events in the Xmas story (e.g., 51% of the subjects chose E1 as one of the six important events in the story)

causally linked to E14, that is, the sentence "After meeting Dr. Evil, Tom suspects that Dr. Evil is planning something evil against the President" is an effect of the plan step E1, which satisfies a precondition of E14 (Tom, suspecting Dr. Evil's evil plan, sends a warning email to the White House). E18 (The President is shot in the chest and falls to the floor) is important in terms of the antagonist (i.e., Dr. Evil)'s goal achievement.

4.2.3.3 Emotional Valence

The favorite characters in the Xmas story were Dr. Evil (35.2%) and Tom (33.3%), followed by Mr. President (16.7%), Mr. Greenpeace (3.7%) and Iris (1.9%). It is interesting that Dr. Evil was ranked highly, even though he had a role of antagonist. Presumably, it is because Dr. Evil is the main character leading the story by occurring most frequently over the whole story. According to the post-questionnaire, his name also appeared to contribute to his high emotional valence rating, reminding some subjects of a favorite character in the movie *Austin Powers*. Figure 4.8 shows the proportions of the favorite characters in both stories.

4.2.3.4 Resolution and Story Interest

The relations between incongruity resolution in surprise and story interest were not directly measured, but the post-questionnaire comments point toward the importance of plausibility for incongruity resolution in surprise. In the Xmas story, for example, it seemed implausible

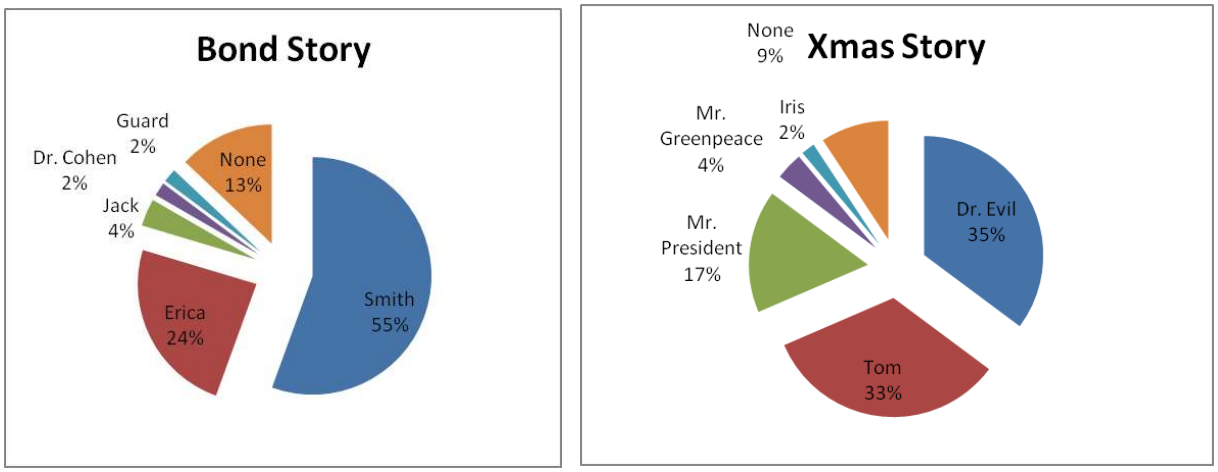


Figure 4.8: Reader's favorite characters of the two stories in the main experiment

for Tom, an ordinary person, to send an e-mail to the President directly, which could have failed to maintain the willing suspension of disbelief of the reader. As for story resolution, the subjects pointed out the lack of explanation about characters' background (including motivation) or the lack of uniqueness (i.e., cliché) as factors that could have harmed the story interestingness.

Chapter 5

Conclusions

This dissertation presents Prevoyant, a planning-based computational model of surprise arousal in narrative generation, and analyzes the effectiveness of Prevoyant. The design of Prevoyant is strongly motivated by the Structural Affect Theory (Brewer and Lichtenstein, 1982), which claims that a reader's emotions such as surprise or suspense are closely related to narrative structure, and a two-tier model of narrative in which a narrative is described using two parts – story (i.e., "content") and discourse (i.e., "expression" or "presentation"). To produce a discourse structure for surprise, Prevoyant manipulates temporal ordering of story events using prolepsis (or flashforward) and analepsis (or flashback) in narrative (Genette, 1988). In this work, flashback provides a backstory to explain what causes a surprising outcome, while foreshadowing gives hints about the surprise before it occurs.

Prevoyant consists of three main components – the Generator, the Evaluator, and the Implementer. The Generator takes as input a story – defined by a partial-order plan data structure – and produces a discourse structure with foreshadowing and flashback. Flashback content is selected based on causal relationships between events in the story plan. Foreshadowing content is selected to give a hint about the flashback. The Evaluator tests each potential flashback produced by the Generator to determine if it will contribute to evoking surprise in the reader's mind. To this end, the Evaluator makes use of four factors

for surprise evaluation: expectation failure using a planning-based approach, importance of events, a reader's emotional valence, and resolution. Given a temporally reconstructed story plan with flashback and foreshadowing, the Implementer manifests it in a specific medium. The current version of Prevoyant focuses only on the Generator and the Evaluator.

The results of the experiments that I conducted show strong support that Prevoyant effectively generates a discourse structure for surprise arousal in narrative. A one-way ANOVA and a *post hoc* test using the Tukey HSD comparisons between means confirm that there was a statistically significant increase in the surprise ratings between the mean for the input story text (which is presented in chronological order) and the mean for the output of Prevoyant (which is presented with flashback and/or foreshadowing out of chronological order) at the 99% confidence level.

5.1 Future Work

As future work, I consider three potential extensions of Prevoyant: a story plan's cinematic realization; combination of surprise and suspense; and interactive storytelling. The following sections explain these three areas for future work.

5.1.1 Cinematic Realization

Stories can be visualized in a cinematic form in virtual environments with the help of automatic camera control and the graphic engines provided by game engines (Cheong et al., 2008; Jhala, 2008). In order to translate the story plan to a visualized story in a virtual environment, Prevoyant can use Zocalo, a web-based service-oriented architecture for intelligent control of 3D virtual worlds (Vernieri, 2006; Jhala, 2008). Zocalo is developed by Liquid Narrative group at North Carolina State University, integrating a variety of planning-related software components such as Bowman (a Graphic User Interface for plan construction; Thomas and Young, 2006), Fletcher (Web Services), Crossbow (a Hierarchical Partial-Order Causal-link Planner based on Longbow), and the Execution Manager (Intelligent controller of commercial game engine environments and Web services for planning). Based on previous efforts developing the Mimesis system (Young 2001), Zocalo provides interface services to translate plan steps in the story plan into executable actions in

the 3D virtual environments. By incorporating the service-oriented capabilities of Zocalo, Prevoyant will be able to realize story plans in cinematic form.

For the visualization of flashback, Prevoyant can take advantage of patterns of camera usage typically seen in film. When flashback is connected to a character in film, associated visual cues often precede the flashback itself: the camera tends to show the character in close up as a signal to the viewer, and then follow with flashback scenes. Using a different color filter for shots (e.g., sepia) can also be an indication of flashback.

Unlike flashback, foreshadowing is given without a visual cue since it is implicit in nature. In a cinematic narrative, the camera serves as an implicit narrator by virtue of controlling what is seen in a scene (or a shot). Specifically, *hidden* information in the foreshadowing can be efficiently handled by the camera. For example, consider a foreshadowing with a primitive action *Gunshot* (?*shooter*, ?*victim*), where ?*shooter* and ?*victim* are variables that can be bound at run-time to specific characters in the story world. If the variable ?*shooter* is marked as hidden, the face or identity of the shooter can be concealed through the manipulation of camera angle. If both variables are supposed to be hidden, the sound of gunfire and the close-up of the gun can be shown without revealing the shooter or the victim.

5.1.2 Combination of Surprise and Suspense

Surprise and suspense can be effectively combined to increase story interest, complementing each other (Chatman, 1978). Foreshadowing can be used to produce suspense or to mislead the reader for a surprising outcome later in the story (Prince, 2003). In particular, stories with surprise endings can make a strong impression on the viewers. In stories that lead to surprise endings in their plot structure, the viewer's suspense is often first controlled by the manipulation of the reader's expectation about a protagonist's success in the story (Cheong, 2007). Then, as the story reaches its climax, a reversed story outcome can be revealed with a presentation of surprising events, making the reader feel surprised the same way that a main character feels surprised in the story. In the movie *Sixth Sense* (1999), for example, when Malcolm realizes the real truth about his condition in the world, the audience feels surprise to

the same extent. This surprising experience increases story interest greatly as the earlier story events make sense with the revealed hidden truth as a whole.

5.1.3 Interactive Storytelling

Interactive digital storytelling in virtual media has been an effective tool for entertainment, education, and training (Cavazza et al. 2002; Marsella et al. 2003; Young et al., 2004; Mott and Lester, 2006; Szilas, 2007). In interactive narrative environments, foreshadowing and flashback are more directly associated with the emotions of a story character which a user plays. The content and timing for flashback will be dynamically chosen to reveal the cause of the character's surprise. Moreover, the flashback can show only partial information of the backstory in order to evoke curiosity in the user's mind, which can motivate the user to uncover the whole concealed backstory. Since foreshadowing should be presented prior to the coupled flashback, the system's mediation may occur. In other words, once a foreshadowing is given by predicting a character's surprise, the system will guide the character (that is played by a user) to execute some actions which will lead to the surprise situation. Then the flashback will be given to support the backstory. This kind of flashback can be used to bridge the gap between a main story and its backstories.

5.2 Limitations

There are two central limitations to this work that should be addressed in follow-on research. First is the critical relation between pleasant surprise and story interestingness. Second is the relation between cognitive interest resulting from narrative structure and narrative comprehension.

First, surprise in narrative needs to be a pleasant surprise. The emotion of surprise is distinct from other emotions in that it can be viewed as a purely aroused emotion having neutral valence – neither positive nor negative. As a result, depending on the cognitive appraisal of a given situation, surprise can be either pleasant or unpleasant. Pleasant surprise will contribute to stimulating our narrative experiences while reading books, watching films, or playing games; unpleasant surprise will harm the experiences, doing the opposite. In this dissertation I focus only on the arousal of surprise. As briefly mentioned in Section 3.2.2.4

(Resolution) and in Section 4.2.3.4 (Resolution and Story Interest), novel and plausible resolution of incongruities in surprise will be necessary to increase the story interestingness.

Second, narratives out of chronological order can be challenging to the reader because it is required to reconstruct the whole story in chronological order in the reader's mind. Therefore, it is important to strike a balance between cognitive interest evoked by discourse structure and the reader's comprehension of the story[23]. Too straightforward story unfolding may cause the reader's boredom; too complicated story unfolding may cause the reader's frustration. In this dissertation, I focus only on one flashback and one foreshadowing in a relatively short story. As narrative space and narrative time extend, more careful consideration about the reader's story comprehension will be necessary.

[23] Films such as *Memento* (2000) or *The Prestige* (2006) will be examples of this issue. In the movies, story events are presented in reverse chronological order or out of chronological order, stimulating the viewer's cognitive interest such as curiosity and surprise. At the same time, however, it makes the viewer keep reconstructing the whole story in chronological order to understand the plot, causing the reader to make extra effort.

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Appendices

Appendix A

Evaluation Materials

This appendix describes the evaluation materials that I used for the pilot study and the main study. The survey questionnaire consists of Instruction, Pre-Experiment Questionnaire, 1st story, 2nd story, and Post-Experiment Questionnaire. In the main study, each subject was assigned one of 12 subject groups and was given story materials as assigned in Table 4.8. The two story materials were named *The Bond story* and *The Xmas story*, respectively. The Bond story material has three distinct discourse types: Chronological (Story 1A); Flashback (Story 1B); Flashback with Foreshadowing (Story 1C). In the same way, the Xmas story material has three distinct discourse types: Chronological (Story 2A); Flashback (Story 2B); Flashback with Foreshadowing (Story 2C).

The pilot study was conducted on the basis of a pen-and-paper questionnaire, and the main study was conducted based on a Web-based survey. In the printed materials, the relevant story events were grouped together for the corresponding questions. The story materials in the Web-based survey, however, were presented sentence by sentence.

Instruction

- The purpose of this survey is to understand how a reader comprehends a short story while reading it.
- You will be asked to read two short stories consisting of 20 ~ 25 sentences, respectively.
- Your reading time will not be recorded, so you should progress through each page at your own pace.
- You will be asked questions at several points through the story.
- Please read the story carefully and complete the questions as they are presented.
- You can refer to *the previous pages* any time, but please **do not look ahead**.

Pre-Experiment Questionnaire

Please complete the following list of questions.

You may choose to NOT answer any of the following questions by selecting No response.

1. Name in full:

2. Gender

□ Female □ Male □ No response

3. Age Group

□ 18-19 □ 20-24 □ 25-29 □ 30-34

□ 35-39 □ 40-49 □ 50+ □ No response

4. How would you describe your origin? (This is for identifying your cultural background, not country of birth or nationality):

□ African American □ Asian □ Hispanic or Latino

□ Mixed □ White □ Other □ No response

5. If you're a student or have a degree,

Major:

Year in School (if you are a full-time student):

□ Freshman □ Sophomore □ Junior □ Senior

□ Master □ Ph. D. □ Other □ No response

Degree (if you are not a full-time student):

□ Bachelor □ Master □ Ph. D. □ Other □ No response

6. Language

□ English as a native language □ English as an official language in your country

□ English as a foreign language □ No response

7. How often do you watch a movie, either at home or at a movie theater?

□ More than once a week

□ More than once a month

□ Seldom

□ No response

Story 1A:

Background Setting

I1	The lunatic villain known as Jack has been developing biological weapons of devastating proportions.
I2	To accomplish the final stages of weapon development, he kidnapped the famous scientist, Dr. Cohen, and brought him to his private fortress on Skeleton Island.
I3	Jack expected that the CIA would soon send Smith, their top agent, to rescue Dr. Cohen.
I4	To keep the troublesome Smith out of his hair, Jack ordered his own agent, Erica, to monitor Smith and capture him if he is assigned to Dr. Cohen's rescue operation.

Main story

E1	Erica installs a wiretap in Smith's home while he is away.
E2	Erica eavesdrops on the phone conversation in which Smith is given the order to rescue Dr. Cohen.
E3	Erica meets with Smith.
E4	Erica tells Smith that her father was kidnapped by Jack and taken to Skeleton Island, and she asks Smith to save her father.
E5	Erica gives Smith the blueprints of Jack's fortress, with her father's cell marked.
E6	Erica provides Smith with a boat for transportation to Skeleton Island.
E7	Before going to the island, Smith hides a diamond in his shoe.
E8	Smith goes to the port containing Erica's boat.
E9	Smith rides the boat to Skeleton Island.
E10	Smith sneaks into the cell marked on the map containing Erica's father.
E11	Jack and his guard capture Smith as he enters the cell.
E12	The guard disarms Smith.
E13	The guard locks Smith in the cell.

Questions:

1. Would you expect that Smith can get out of the cell and save Dr. Cohen safely?

   1.1 Your answer: □ Yes □ No

   If your answer is 'Yes', how (or why, describe briefly):

   1.2 What information in the story most strongly shaped those expectations (circle all that apply)?

   I1 I2 I3 I4 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 E12 E13 None

   1.3 How much would you expect that your answer will actually occur after **E13**?

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

   In the next page, you will see what **E14** and **E15** events are.

Main story (Continued from the previous page)

E14	Smith bribes the guard with the diamond in his shoe.
E15	The guard unlocks the door.

Questions:

2. Are **E14** and **E15** what you expected?

   2.1 Your answer:

   a. Yes, this is just what I expected.

   b. Not exactly what I expected, but close to it

   c. Different from what I expected, but plausible

   d. No, this is not at all what I expected.

   If your answer is not 'a', what did you expect? Describe briefly:

   2.2 What information in the story most strongly shaped those expectations (circle all that apply)?
   I1 I2 I3 I4 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 E12 E13 None

3. Based on your experiences reading stories and watching movies in this genre, how typical (or common) are situations like those in **E14/E15** to occur in fictional stories or movies?

E7	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always
E14	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always
E15	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always

4. How much would you rate the importance of the following events contributing to the story overall?

E7 (Hide the diamond)	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely
E14 (Bribe the guard)	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely
E15 (Unlock the door)	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely

Main story (Continued)

E16	Smith leaves the cell.
E17	Smith sneaks to the lab where Dr. Cohen is being held.
E18	Smith fights the guards in the lab.
E19	Smith takes Dr. Cohen from the lab.
E20	Smith and Dr. Cohen ride the boat to shore.

Questions:

5. While reading from E1 through E20, if any, choose the appropriate level of emotions that you felt. Please refer to the definitions of surprise, suspense, and curiosity.

Surprise	The emotion felt when expectations about what is going to happen are violated by what in fact does happen

5.1 Rate the degree of surprise that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel surprise (circle all that apply)?

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20

Suspense	An emotion or state of mind arising from a partial and anxious uncertainty about the progression or outcome of an action, especially one involving a positive character

5.2 Rate the degree of suspense that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel suspense (circle all that apply)?

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20

Curiosity	An intrinsically motivated desire for information or knowledge which is partially described or has some missing gaps at the time

5.3 Rate the degree of curiosity that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel curiosity (circle all that apply)?

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20

6. After reading from E1 through E20, select what you think were the *six* important events (or situations) contributing to the story plot overall:

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20

7-1. Choose your *most* favorite character in the story:

Jack Dr. Cohen Smith Erica the guard none

Why (describe briefly):

7-2. If you could play a character in the story, which character would you pick?

Jack Dr. Cohen Smith Erica the guard none

8. How would you rate this story in terms of its coherence? In other words, how well do all the actions fit together?

1: Not at all coherent

2: A little coherent

3: Moderately coherent

4: Very coherent

5: Extremely coherent

9. How would you rate this story in terms of its interestingness?

1: Not interesting at all

2: A little interesting

3: Somewhat interesting

4: Very interesting

5: Extremely interesting

Thank you so much for your time!

Story 1B:

Background Setting

I1	The lunatic villain known as Jack has been developing biological weapons of devastating proportions.
I2	To accomplish the final stages of weapon development, he kidnapped the famous scientist, Dr. Cohen, and brought him to his private fortress on Skeleton Island.
I3	Jack expected that the CIA would soon send Smith, their top agent, to rescue Dr. Cohen.
I4	To keep the troublesome Smith out of his hair, Jack ordered his own agent, Erica, to monitor Smith and capture him if he is assigned to Dr. Cohen's rescue operation.

Main story

E1	Erica installs a wiretap in Smith's home while he is away.
E2	Erica eavesdrops on the phone conversation in which Smith is given the order to rescue Dr. Cohen.
E3	Erica meets with Smith.
E4	Erica tells Smith that her father was kidnapped by Jack and taken to Skeleton Island, and she asks Smith to save her father.
E5	Erica gives Smith the blueprints of Jack's fortress, with her father's cell marked.
E6	Erica provides Smith with a boat for transportation to Skeleton Island.
E7	Smith goes to the port containing Erica's boat.
E8	Smith rides the boat to Skeleton Island.
E9	Smith sneaks into the cell marked on the map containing Erica's father.
E10	Jack and his guard capture Smith as he enters the cell.
E11	The guard disarms Smith.
E12	The guard locks Smith in the cell.

Questions:

1. Would you expect that Smith can get out of the cell and save Dr. Cohen safely?

   1.1 Your answer: □ Yes □ No

   If your answer is 'Yes', how (describe briefly):

   1.2 What information in the story most strongly shaped those expectations (circle all that apply)? I1
   I2 I3 I4 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 E12 None

   1.3 How much would you expect that your answer will actually occur after **E12**?

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

In the next page, you will see what **E13** event is.

Main story (Continued from the previous page)

E13	The guard unlocks the door.

Questions:

2. Is **E13** what you expected?

2.1 Your answer:

a. Yes, this is just what I expected.

b. Not exactly what I expected, but close to it

c. Different from what I expected, but plausible

d. No, this is not at all what I expected.

If your answer is not 'a', what did you expect? Describe briefly:

2.2 What information in the story most strongly shaped those expectations (circle all that apply)?
I1 I2 I3 I4 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 E12 None

In the next page, you will see the events **E14** and **E15**.

Main story (Continued from the previous page)

E14	Actually, before going to the island, Smith hid a diamond in his shoe.
E15	Smith bribed the guard with the diamond in his shoe.

Questions:

2. Is **E14/E15** what you expected?

   2.3 Your answer:

   a. Yes, this is just what I expected.

   b. Not exactly what I expected, but close to it

   c. Different from what I expected, but plausible

   d. No, this is not at all what I expected.

   If your answer is not 'a', what did you expect? Describe briefly:

   2.4 What information in the story most strongly shaped those expectations (circle all that apply)?
   I1 I2 I3 I4 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 E12 E13 None

3. Based on your experiences reading stories and watching movies in this genre, how typical (or common) are situations like those in **E13/ E14/E15** to occur in fictional stories or movies?

E13	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always
E14	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always
E15	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always

4. How much would you rate the importance of the following events contributing to the story overall?

E13 (Unlock the door)	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely
E14 (Hide the diamond)	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely
E15 (Bribe the guard)	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely

In the next page, you will see the rest of the story.

Main story (Continued)

E16	Smith leaves the cell.
E17	Smith sneaks to the lab where Dr. Cohen is captured.
E18	Smith fights the guards in the lab.
E19	Smith takes Dr. Cohen from the lab.
E20	Smith and Dr. Cohen ride the boat to shore.

5. While reading from E1 through E20, if any, choose the appropriate level of emotions that you felt. Please refer to the definitions of surprise, suspense, and curiosity.

Surprise	The emotion felt when expectations about what is going to happen are violated by what in fact does happen

5.1 Rate the degree of surprise that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel surprise (circle all that apply)?

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20

Suspense	An emotion or state of mind arising from a partial and anxious uncertainty about the progression or outcome of an action, especially one involving a positive character

5.2 Rate the degree of suspense that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel suspense (circle all that apply)?

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20

Curiosity	An intrinsically motivated desire for information or knowledge which is partially described or has some missing gaps at the time

5.3 Rate the degree of curiosity that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel curiosity (circle all that apply)?

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20

6. After reading from E1 through E20, select what you think were the six important events (or situations) contributing to the story plot overall:

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20

7-1. Choose your *most* favorite character in the story:

Jack Dr. Cohen Smith Erica the guard none

Why (describe briefly):

7-2. If you could play a character in the story, which character would you pick?

Jack Dr. Cohen Smith Erica the guard none

8. How would you rate this story in terms of its coherence? In other words, how well do all the actions fit together?

1: Not at all coherent

2: A little coherent

3: Moderately coherent

4: Very coherent

5: Extremely coherent

9. How would you rate this story in terms of its interestingness?

1: Not interesting at all

2: A little interesting

3: Somewhat interesting

4: Very interesting

5: Extremely interesting

Thank you so much for your time!

Story 1C:

Background Setting

I1	The lunatic villain known as Jack has been developing biological weapons of devastating proportions.
I2	To accomplish the final stages of weapon development, he kidnapped the famous scientist, Dr. Cohen, and brought him to his private fortress on Skeleton Island.
I3	Jack expected that the CIA would soon send Smith, their top agent, to rescue Dr. Cohen.
I4	To keep the troublesome Smith out of his hair, Jack ordered his own agent, Erica, to monitor Smith and capture him if he is assigned to Dr. Cohen's rescue operation.

Main story

E0	Erica installs a wiretap in Smith's home while he is away.
E1	Erica eavesdrops on the phone conversation in which Smith is given the order to rescue Dr. Cohen.
E2	Someone hides a diamond in his or her shoe.
E3	Erica meets with Smith.
E4	Erica tells Smith that her father was kidnapped by Jack and taken to Skeleton Island, and she asks Smith to save her father.
E5	Erica gives Smith the blueprints of Jack's fortress, with her father's cell marked.
E6	Erica provides Smith with a boat for transportation to Skeleton Island.
E7	Smith goes to the port containing Erica's boat.
E8	Smith rides the boat to Skeleton Island.
E9	Smith sneaks into the cell marked on the map containing Erica's father.
E10	Jack and his guard capture Smith as he enters the cell.
E11	The guard disarms Smith.
E12	The guard locks Smith in the cell.

Questions:

1. Would you expect that Smith can get out of the cell and save Dr. Cohen safely?

   1.1 Your answer: □ Yes □ No

   If your answer is 'Yes', how (describe briefly):

   1.2 What information in the story most strongly shaped those expectations (circle all that apply)? I1
   I2 I3 I4 E0 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 E12 None

   1.3 How much would you expect that your answer will actually occur after **E12**?

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

In the next page, you will see what **E13** event is.

Main story (Continued from the previous page)

E13	The guard unlocks the door.

Questions:

2. Is **E13** what you expected?

   2.1 Your answer:

   a. Yes, this is just what I expected.

   b. Not exactly what I expected, but close to it

   c. Different from what I expected, but plausible

   d. No, this is not at all what I expected.

   If your answer is not 'a', what did you expect? Describe briefly:

   2.2 What information in the story most strongly shaped those expectations (circle all that apply)?
   I1 I2 I3 I4 E0 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 E12 None

In the next page, you will see the events **E14** and **E15**.

Main story (Continued from the previous page)

E14	Actually, before going to the island, Smith hid a diamond in his shoe.
E15	Smith bribed the guard with the diamond in his shoe.

Questions:

2. Is **E14/E15** what you expected?

   2.3 Your answer:

   a. Yes, this is just what I expected.

   b. Not exactly what I expected, but close to it

   c. Different from what I expected, but plausible

   d. No, this is not at all what I expected.

   If your answer is not 'a', what did you expect? Describe briefly:

   2.4 What information in the story most strongly shaped those expectations (circle all that apply)?
   I1 I2 I3 I4 E0 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 E12 None

3. Based on your experiences reading stories and watching movies in this genre, how typical (or common) are situations like those in **E13/ E14/E15** to occur in fictional stories or movies?

E13	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always
E14	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always
E15	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always

4. How much would you rate the importance of the following events contributing to the story overall?

E13 (Unlock the door)	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely
E14 (Hide the diamond)	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely
E15 (Bribe the guard)	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely

In the next page, you will see the rest of the story.

Main story (Continued)

E16	Smith leaves the cell.
E17	Smith sneaks to the lab where Dr. Cohen is captured.
E18	Smith fights the guards in the lab.
E19	Smith takes Dr. Cohen from the lab.
E20	Smith and Dr. Cohen ride the boat to shore.

5. While reading from E1 through E20, if any, choose the appropriate level of emotions that you felt. Please refer to the definitions of surprise, suspense, and curiosity.

Surprise	The emotion felt when expectations about what is going to happen are violated by what in fact does happen

5.1 Rate the degree of surprise that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel surprise (circle all that apply)?

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20

Suspense	An emotion or state of mind arising from a partial and anxious uncertainty about the progression or outcome of an action, especially one involving a positive character

5.2 Rate the degree of suspense that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel suspense (circle all that apply)?

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20

Curiosity	An intrinsically motivated desire for information or knowledge which is partially described or has some missing gaps at the time

5.3 Rate the degree of curiosity that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel curiosity (circle all that apply)?

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20

6. After reading from E1 through E20, select what you think were the six important events (or situations) contributing to the story plot overall:

E0 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20

7-1. Choose your *most* favorite character in the story:

Jack Dr. Cohen Smith Erica the guard none

Why (describe briefly):

7-2. If you could play a character in the story, which character would you pick?

Jack Dr. Cohen Smith Erica the guard none

8. How would you rate this story in terms of its coherence? In other words, how well do all the actions fit together?

1: Not at all coherent

2: A little coherent

3: Moderately coherent

4: Very coherent

5: Extremely coherent

9. How would you rate this story in terms of its interestingness?

1: Not interesting at all

2: A little interesting

3: Somewhat interesting

4: Very interesting

5: Extremely interesting

10. When you first read E2, how did you think that the diamond in someone's shoe could be relevant in the story?

Thank you so much for your time!

Story 2A:

Background Setting

I1	In 2012, mankind faces severe environmental problems. The process of desertification has spread to North America. The sea level has been raised significantly by shrinking glaciers.
I2	An environmentalist named Mr. Greenpeace, head of the World Environmental Foundation and an ex staff sergeant in the British special force, is aware of these urgent problems, planning to persuade the U.S. President to take prompt actions to prevent the coming disaster. Mr. Greenpeace is at his office in London, being about to fly to Washington DC.
I3	Meanwhile, Dr. Evil, a billionaire psychopath, plans to assassinate the President for his personal revenge. His plans are complicated by the security at the White House, where only invited people can enter.
I4	In a nearby suburb of Washington DC., a man named Tom, who is a single father of a three-year old girl named Iris, is hoping to give his daughter a Christmas present. Tom, a computer programmer, has been unemployed for six months.
I5	Tom has a shiny silver ring that was given to him by his wife long time ago. Unknown to Tom, the ring is magical; when worn, whispering a special spell 'etaudarg anna wi' will cause the ring to send out a magical pulse that will put anyone within a ten foot radius to sleep. Dr. Evil knows about the secret of this ring.
I6	Tom's goal is to get a limited special edition *Dora The Explorer* doll for Iris's Christmas present. The limited special edition *Dora The Explorer* doll is very popular but rare and expensive. Tom tries to sell or trade his ring for the special edition *Dora The Explorer* doll through craigslist. One day before Christmas, Tom receives an email from Dr. Evil that he has the limited special edition *Dora The Explorer* doll and he is willing to trade it for Tom's ring. Tom is invited to Dr. Evil's billionaire castle.

Main story

E1	Tom visits Dr. Evil's castle and trades his ring for the limited special edition *Dora The Explorer* doll. As a result, Tom obtains the special edition *Dora The Explorer doll* that Iris wants; Dr. Evil obtains the ring. After meeting Dr. Evil, Tom suspects that Dr. Evil is planning something evil against the President.
E2	Tom puts the special edition *Dora The Explorer* doll under the Christmas tree.
E3	Dr. Evil withdraws some cash from an ATM in the bank.
E4	Dr. Evil buys a gun from an arm dealer. The gun is made out of composite materials designed to avoid detection by metal detectors.
E5	Mr. Greenpeace travels from London to Washington D.C., the U.S. capitol.
E6	Mr. Greenpeace gives a speech about the importance of taking prompt actions to save the Earth.
E7	Being impressed by Mr. Greenpeace's speech, the U.S. President announces that he will raise funds to support Mr. Greenpeace's environmental foundation and whoever donates more than one million dollars will be invited to the White House for a fundraising party. The president also invites Mr. Greenpeace to the fund-raising party at the White House.
E8	Mr. Greenpeace goes to the White House.
E9	Dr. Evil watches the TV and finds out that a donation will get him invited to the White House.
E10	Dr. Evil donates one million dollars to the White House.
E11	The President invites Dr. Evil to the fund-raising celebration party.
E12	Dr. Evil travels to the White House with the ring and the gun.
E13	Dr. Evil uses the ring of power to put all the secret service agents to sleep. As a result, there is no one guarding the president.
E14	Tom, suspecting Dr. Evil’s evil plan, sends a warning email to the White House.
E15	The President receives Tom's email and reads it on his smart phone.
E16	As a precaution, the President puts on a bullet-proof vest before going to the fundraising party.
E17	Dr. Evil aims his gun and fires it at the President.
E18	The President is shot in the chest and falls to the floor.

Questions:

1. Would you expect that Dr. Evil achieve his goal to assassinate the President?

   1.1 Your answer: Yes No

   If your answer is 'No', why or how (describe briefly):

   1.2 What information in the story most strongly shaped those expectations (circle all that apply)?

   I1 I2 I3 I4 I5 I6 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10

   E11 E12 E13 E14 E15 E16 E17 E18 None

   1.3 How much would you expect that your answer will actually occur after **E18**?

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Main story (Continued from the previous page)

E19	Mr. Greenpeace arrives and seizes Dr. Evil.
E20	After being seized, Dr. Evil looks at the President collapsed on the floor and laughs hysterically.
E21	The President slowly stands up.

Questions:

2. Is **E21** what you expected?

2.1 Your answer:

a. Yes, this is just what I expected.

b. Not exactly what I expected, but close to it

c. Different from what I expected, but plausible

d. No, this is not at all what I expected.

If your answer is not 'a', what did you expect? Describe briefly:

2.2 What information in the story most strongly shaped those expectations (circle all that apply)?

I1 I2 I3 I4 I5 I6 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10

E11 E12 E13 E14 E15 E16 E17 E18 E19 E20 None

3. Based on your experiences reading stories and watching movies in this genre, how typical (or common) are situations like those in **E14/ E15/ E16** to occur in fictional stories or movies?

E14	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always
E15	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always
E16	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always

4. How much would you rate the importance of the following events contributing to the story overall?

E14	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely
E15	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely
E16	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely

In the next page, you will see the rest of the story.

Main story (Continued from the previous page)

E22	The President gives his press conference, committing considerable support to the World Environment Foundation in order to save the Earth.
E23	The next day on Christmas, Iris finds a Christmas present for her, the special edition *Dora The Explorer* doll that she wants to have. Iris holds the *Dora The Explorer* doll preciously. Tom is happy watching Iris holding the doll.

Questions:

5. While reading from E1 through E23, if any, choose the appropriate level of emotions that you felt. Please refer to the definitions of surprise, suspense, and curiosity.

Surprise	The emotion felt when expectations about what is going to happen are violated by what in fact does happen

5.1 Rate the degree of surprise that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel surprise (circle all that apply)?

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20 E21 E22 E23

Suspense	An emotion or state of mind arising from a partial and anxious uncertainty about the progression or outcome of an action, especially one involving a positive character

5.2 Rate the degree of suspense that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel suspense (circle all that apply)?

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20 E21 E22 E23

Curiosity	An intrinsically motivated desire for information or knowledge which is partially described or has some missing gaps at the time

5.3 Rate the degree of curiosity that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel curiosity (circle all that apply)?

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20 E21 E22 E23

6. After reading from E1 through E20, select what you think were the six important events (or situations) contributing to the story plot overall:

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20 E21 E22 E23

Among your selection, choose the most important event:

7-1. Choose your *most* favorite character in the story:

Tom Dr. Evil Mr. Greenpeace Mr. President Iris none

Why (describe briefly):

7-2. If you can play a character in the story, which character would you pick?

Tom Dr. Evil Mr. Greenpeace Mr. President Iris none

8. How would you rate this story in terms of its coherence? In other words, how well do all the actions fit together?

1: Not at all coherent
2: A little coherent
3: Moderately coherent
4: Very coherent
5: Extremely coherent

9. How would you rate this story in terms of its interestingness?

1: Not interesting at all
2: A little interesting
3: Somewhat interesting
4: Very interesting
5: Extremely interesting

Thank you so much for your time!

Story 2B:

Background Setting

I1	In 2012, mankind faces severe environmental problems. The process of desertification has spread to North America. The sea level has been raised significantly by shrinking glaciers.
I2	An environmentalist named Mr. Greenpeace, head of the World Environmental Foundation and an ex staff sergeant in the British special force, is aware of these urgent problems, planning to persuade the U.S. President to take prompt actions to prevent the coming disaster. Mr. Greenpeace is at his office in London, being about to fly to Washington DC.
I3	Meanwhile, Dr. Evil, a billionaire psychopath, plans to assassinate the President for his personal revenge. His plans are complicated by the security at the White House, where only invited people can enter.
I4	In a nearby suburb of Washington DC., a man named Tom, who is a single father of a three-year old girl named Iris, is hoping to give his daughter a Christmas present. Tom, a computer programmer, has been unemployed for six months.
I5	Tom has a shiny silver ring that was given to him by his wife long time ago. Unknown to Tom, the ring is magical; when worn, whispering a special spell 'etaudarg anna wi' will cause the ring to send out a magical pulse that will put anyone within a ten foot radius to sleep. Dr. Evil knows about the secret of this ring.
I6	Tom's goal is to get a limited special edition *Dora The Explorer* doll for Iris's Christmas present. The limited special edition *Dora The Explorer* doll is very popular but rare and expensive. Tom tries to sell or trade his ring for the special edition *Dora The Explorer* doll through craigslist. One day before Christmas, Tom receives an email from Dr. Evil that he has the limited special edition *Dora The Explorer* doll and he is willing to trade it for Tom's ring. Tom is invited to Dr. Evil's billionaire castle.

Main story

E1	Tom visits Dr. Evil's castle and trades his ring for the limited special edition *Dora The Explorer* doll. As a result, Tom obtains the special edition *Dora The Explorer doll* that Iris wants; Dr. Evil obtains the ring. After meeting Dr. Evil, Tom suspects that Dr. Evil is planning something evil against the President.
E2	Tom puts the special edition *Dora The Explorer* doll under the Christmas tree.
E3	Dr. Evil withdraws some cash from an ATM in the bank.
E4	Dr. Evil buys a gun from an arm dealer. The gun is made out of composite materials designed to avoid detection by metal detectors.
E5	Mr. Greenpeace travels from London to Washington D.C., the U.S. capitol.
E6	Mr. Greenpeace gives a speech about the importance of taking prompt actions to save the Earth.
E7	Being impressed by Mr. Greenpeace's speech, the U.S. President announces that he will raise funds to support Mr. Greenpeace's environmental foundation and whoever donates more than one million dollars will be invited to the White House for a fundraising party. The president also invites Mr. Greenpeace to the fund-raising party at the White House.
E8	Mr. Greenpeace goes to the White House.
E9	Dr. Evil watches the TV and finds out that a donation will get him invited to the White House.
E10	Dr. Evil donates one million dollars to the White House.
E11	The President invites Dr. Evil to the fund-raising celebration party.
E12	Dr. Evil travels to the White House with the ring and the gun.
E13	Dr. Evil uses the ring of power to put all the secret service agents to sleep. As a result, there is no one guarding the president.
E14	Dr. Evil aims his gun and fires it at the President.
E15	The President is shot in the chest and falls to the floor.

Questions:

1. Would you expect that Dr. Evil achieve his goal to assassinate the President?

   1.1 Your answer: Yes No
   If your answer is 'No', why or how (describe briefly):

   1.2 What information in the story most strongly shaped those expectations (circle all that apply)?

   I1 I2 I3 I4 I5 I6 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10

   E11 E12 E13 E14 E15 None

   1.3 How much would you expect that your answer will actually occur after **E15**?

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

In the next page, you will see **E16**.

Main story (Continued from the previous page)

E16	Mr. Greenpeace arrives and seizes Dr. Evil.
E17	After being seized, Dr. Evil looks at the President collapsed on the floor and laughs hysterically.
E18	The President slowly stands up.

Questions:

2. Is **E18** what you expected?

2.1 Your answer:

a. Yes, this is just what I expected.

b. Not exactly what I expected, but close to it

c. Different from what I expected, but plausible

d. No, this is not at all what I expected.

2.2 If your answer is not 'a', what did you expect? Describe briefly:

What information in the story most strongly shaped those expectations (circle all that apply)?

I1 I2 I3 I4 I5 I6 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10

E11 E12 E13 E14 E15 E16 E17 None

In the next page, you will see the events **E19/ E20/ E21**.

Main story (Continued from the previous page)

E19	Actually, Tom, suspecting Dr. Evil's evil plan, sent a warning email to the White House.
E20	The President received Tom's email and read it on his smart phone.
E21	As a precaution, the President put on a bullet-proof vest before going to the fundraising party.

2. Is **E19/ E20/ E21** what you expected?

2.3 Your answer:

a. Yes, this is just what I expected.

b. Not exactly what I expected, but close to it

c. Different from what I expected, but plausible

d. No, this is not at all what I expected.

If your answer is not 'a', what did you expect? Describe briefly:

2.4 What information in the story most strongly shaped those expectations (circle all that apply)?

I1 I2 I3 I4 I5 I6 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10

E11 E12 E13 E14 E15 E16 E17 E18 None

3. Based on your experiences reading stories and watching movies in this genre, how typical (or common) are situations like those in **E19/ E20/ E21** to occur in fictional stories or movies?

E19	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always
E20	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always
E21	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always

4. How much would you rate the importance of the following events contributing to the story overall?

E19	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely
E20	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely
E21	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely

In the next page, you will see the rest of the story.

Main story (Continued)

E22	The President gives his press conference, committing considerable support to the World Environment Foundation in order to save the Earth.
E23	The next day on Christmas, Iris finds a Christmas present for her, the special edition *Dora The Explorer* doll that she wants to have. Iris holds the *Dora The Explorer* doll preciously. Tom is happy watching Iris holding the doll.

Questions:

5. While reading from E1 through E23, if any, choose the appropriate level of emotions that you felt. Please refer to the definitions of surprise, suspense, and curiosity.

Surprise	The emotion felt when expectations about what is going to happen are violated by what in fact does happen

5.1 Rate the degree of surprise that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel surprise (circle all that apply)?

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20 E21 E22 E23

Suspense	An emotion or state of mind arising from a partial and anxious uncertainty about the progression or outcome of an action, especially one involving a positive character

5.2 Rate the degree of suspense that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel suspense (circle all that apply)?

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20 E21 E22 E23

Curiosity	An intrinsically motivated desire for information or knowledge which is partially described or has some missing gaps at the time

5.3 Rate the degree of curiosity that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel curiosity (circle all that apply)?

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20 E21 E22 E23

6. After reading from E1 through E23, select what you think were the six important events (or situations) contributing to the story plot overall:

E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20 E21 E22 E23

7-1. Choose your *most* favorite character in the story:

Tom Dr. Evil Mr. Greenpeace Mr. President Iris none

Why (describe briefly):

7-2. If you could play a character in the story, which character would you pick?

Tom Dr. Evil Mr. Greenpeace Mr. President Iris none

8. How would you rate this story in terms of its coherence? In other words, how well do all the actions fit together?

1: Not at all coherent
2: A little coherent
3: Moderately coherent
4: Very coherent
5: Extremely coherent

9. How would you rate this story in terms of its interestingness?

1: Not interesting at all
2: A little interesting
3: Somewhat interesting
4: Very interesting
5: Extremely interesting

Thank you so much for your time!

Story 2C:

Background Setting

I1	In 2012, mankind faces severe environmental problems. The process of desertification has spread to North America. The sea level has been raised significantly by shrinking glaciers.
I2	An environmentalist named Mr. Greenpeace, head of the World Environmental Foundation and an ex staff sergeant in the British special force, is aware of these urgent problems, planning to persuade the U.S. President to take prompt actions to prevent the coming disaster. Mr. Greenpeace is at his office in London, being about to fly to Washington DC.
I3	Meanwhile, Dr. Evil, a billionaire psychopath, plans to assassinate the President for his personal revenge. His plans are complicated by the security at the White House, where only invited people can enter.
I4	In a nearby suburb of Washington DC., a man named Tom, who is a single father of a three-year old girl named Iris, is hoping to give his daughter a Christmas present. Tom, a computer programmer, has been unemployed for six months.
I5	Tom has a shiny silver ring that was given to him by his wife long time ago. Unknown to Tom, the ring is magical; when worn, whispering a special spell 'etaudarg anna wi' will cause the ring to send out a magical pulse that will put anyone within a ten foot radius to sleep. Dr. Evil knows about the secret of this ring.
I6	Tom's goal is to get a limited special edition *Dora The Explorer* doll for Iris's Christmas present. The limited special edition *Dora The Explorer* doll is very popular but rare and expensive. Tom tries to sell or trade his ring for the special edition *Dora The Explorer* doll through craigslist. One day before Christmas, Tom receives an email from Dr. Evil that he has the limited special edition *Dora The Explorer* doll and he is willing to trade it for Tom's ring. Tom is invited to Dr. Evil's billionaire castle.

Main story

E0	Tom visits Dr. Evil's castle and trades his ring for the limited special edition *Dora The Explorer* doll. As a result, Tom obtains the special edition *Dora The Explorer doll* that Iris wants; Dr. Evil obtains the ring. After meeting Dr. Evil, Tom suspects that Dr. Evil is planning something evil against the President.
E1	Tom puts the special edition *Dora The Explorer* doll under the Christmas tree.
E2	Someone sends an email.
E3	Dr. Evil withdraws some cash from an ATM in the bank.
E4	Dr. Evil buys a gun from an arm dealer. The gun is made out of composite materials designed to avoid detection by metal detectors.
E5	Mr. Greenpeace travels from London to Washington D.C., the U.S. capitol.
E6	Mr. Greenpeace gives a speech about the importance of taking prompt actions to save the Earth.
E7	Being impressed by Mr. Greenpeace's speech, the U.S. President announces that he will raise funds to support Mr. Greenpeace's environmental foundation and whoever donates more than one million dollars will be invited to the White House for a fundraising party. The president also invites Mr. Greenpeace to the fund-raising party at the White House.
E8	Mr. Greenpeace goes to the White House.
E9	Dr. Evil watches the TV and finds out that a donation will get him invited to the White House.
E10	Dr. Evil donates one million dollars to the White House.
E11	The President invites Dr. Evil to the fund-raising celebration party.
E12	Dr. Evil travels to the White House with the ring and the gun.
E13	Dr. Evil uses the ring of power to put all the secret service agents to sleep. As a result, there is no one guarding the president.
E14	Dr. Evil aims his gun and fires it at the President.
E15	The President is shot in the chest and falls to the floor.

Questions:

1. Would you expect that Dr. Evil achieve his goal to assassinate the President?

   1.1 Your answer: Yes No
   If your answer is 'No', why or how (describe briefly):

   1.2 What information in the story most strongly shaped those expectations (circle all that apply)?

   I1 I2 I3 I4 I5 I6 E0 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10

   E11 E12 E13 E14 E15 None

   1.3 How much would you expect that your answer will actually occur after **E15**?

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

   In the next page, you will see **E16**.

Main story (Continued from the previous page)

E16	Mr. Greenpeace arrives and seizes Dr. Evil.
E17	After being seized, Dr. Evil looks at the President collapsed on the floor and laughs hysterically.
E18	The President slowly stands up.

Questions:

2. Is **E18** what you expected?
   2.1 Your answer:
   a. Yes, this is just what I expected.
   b. Not exactly what I expected, but close to it
   c. Different from what I expected, but plausible
   d. No, this is not at all what I expected.

   2.2 If your answer is not 'a', what did you expect? Describe briefly:

   What information in the story most strongly shaped those expectations (circle all that apply)?

   I1 I2 I3 I4 I5 I6 E0 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10

   E11 E12 E13 E14 E15 E16 E17 None

In the next page, you will see the events **E19/ E20/ E21**.

Main story (Continued from the previous page)

E19	Actually, Tom, suspecting Dr. Evil's evil plan, sent a warning email to the White House.
E20	The President received Tom's email and read it on his smart phone.
E21	As a precaution, the President put on a bullet-proof vest before going to the fundraising party.

2. Is **E19/ E20/ E21** what you expected?

2.3 Your answer:

a. Yes, this is just what I expected.

b. Not exactly what I expected, but close to it

c. Different from what I expected, but plausible

d. No, this is not at all what I expected.

If your answer is not 'a', what did you expect? Describe briefly:

2.4 What information in the story most strongly shaped those expectations (circle all that apply)?

I1 I2 I3 I4 I5 I6 E0 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10

E11 E12 E13 E14 E15 E16 E17 E18 None

3. Based on your experiences reading stories and watching movies in this genre, how typical (or common) are situations like those in **E19/ E20/ E21** to occur in fictional stories or movies?

E19	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always
E20	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always
E21	1	2	3	4	5
	Never	Sometimes	Half of times	Quite often	Always

4. How much would you rate the importance of the following events contributing to the story overall?

E19	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely
E20	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely
E21	1	2	3	4	5
	None	A Little	Moderate	Lots	Extremely

In the next page, you will see the rest of the story.

Main story (Continued)

E22	The President gives his press conference, committing considerable support to the World Environment Foundation in order to save the Earth.
E23	The next day on Christmas, Iris finds a Christmas present for her, the special edition *Dora The Explorer* doll that she wants to have. Iris holds the *Dora The Explorer* doll preciously. Tom is happy watching Iris holding the doll.

Questions:

5. While reading from E1 through E23, if any, choose the appropriate level of emotions that you felt. Please refer to the definitions of surprise, suspense, and curiosity.

Surprise	The emotion felt when expectations about what is going to happen are violated by what in fact does happen

5.1 Rate the degree of surprise that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel surprise (circle all that apply)?

E0 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20 E21 E22 E23

Suspense	An emotion or state of mind arising from a partial and anxious uncertainty about the progression or outcome of an action, especially one involving a positive character

5.2 Rate the degree of suspense that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel suspense (circle all that apply)?

E0 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20 E21 E22 E23

Curiosity	An intrinsically motivated desire for information or knowledge which is partially described or has some missing gaps at the time

5.3 Rate the degree of curiosity that you felt:

1	2	3	4	5
None	A Little	Moderate	Lots	Extremely

Unless your answer is 'None',

At which situation or situations in the story did you feel curiosity (circle all that apply)?

E0 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20 E21 E22 E23

6. After reading from E0 through E23, select what you think were the six important events (or situations) contributing to the story plot overall:

E0 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10
E11 E12 E13 E14 E15 E16 E17 E18 E19 E20 E21 E22 E23

7-1. Choose your *most* favorite character in the story:

Tom Dr. Evil Mr. Greenpeace Mr. President Iris none

Why (describe briefly):

7-2. If you could play a character in the story, which character would you pick?

Tom Dr. Evil Mr. Greenpeace Mr. President Iris none

8. How would you rate this story in terms of its coherence? In other words, how well do all the actions fit together?

1: Not at all coherent
2: A little coherent
3: Moderately coherent
4: Very coherent
5: Extremely coherent

9. How would you rate this story in terms of its interestingness?

1: Not interesting at all
2: A little interesting
3: Somewhat interesting
4: Very interesting
5: Extremely interesting

10. When you first read **E2**, how did you think that 'someone sends an email' could be relevant in the story?

Thank you so much for your time!

Post-Experiment Questionnaire

Please complete the following list of questions.

You may choose to NOT answer any of the following questions by skipping those questions.

1. Please write any suggestions about how you think the story could be improved:

2. Please write any suggestions about how you think the experiment could be improved:

Thanks a lot!