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STORY EXPERIENCE IN A VIRTUAL SAN STORYTELLING  
ENVIRONMENT:  
A CULTURAL HERITAGE APPLICATION FOR CHILDREN AND YOUNG ADULTS

A DISSERTATION  
SUBMITTED TO THE DEPARTMENT OF COMPUTER SCIENCE,  
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IN FULFILLMENT OF THE REQUIREMENTS  
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By  
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2005

Supervised by  
Edwin H. Blake



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A lot of our culture is lost in our lives – the old stories that were told by mothers and fathers who would go into the bush and then return to tell the others what they had seen.... We have no stories to tell our children. We have nothing to pass on.

We will have to find the strength to make a place for ourselves in this world. Otherwise there will soon be no more of us. We will all be gone. And so will our memories. Only our paintings will remain behind to remind you of us.

*Quote from Mario Mabongo, a !Xu Bushman  
National Geographic  
(Godwin, 2001)*

## Abstract

This dissertation explores virtual storytelling for conveying cultural stories effectively. We set out to investigate: (1) the strengths and/or weaknesses of VR as a storytelling medium; (2) the use of a culturally familiar introductory VE to preface a VE presenting traditional storytelling; (3) the relationship between presence and story experience. We conducted two studies to pursue these aims. Our aims were stated in terms of effective story experience, in the realm of cultural heritage. This was conceptualised as a story experience where story comprehension, interest in the story's cultural context and story enjoyment were achieved, and where boredom and confusion in the story were low. This conceptualisation was empirically validated by our studies. Three storytelling scenarios were created to tell a traditional San story: text (T); a storytelling VE with no introductory VE (VR+NI); a storytelling VE with a hip-hop themed introductory VE (VR+I). These scenarios comprised our experimental conditions. Questionnaires, measuring interest in hip-hop and the story experience aspects identified above, were developed and psychometrically validated. Study 1 was conducted with a sample of 44 high-school learners and Study 2 with 98 university students. Both studies used a between-subjects design. Study 2 was a refined version of Study 1, improving Study 1's questionnaires for use in Study 2 and considering two additional variables: attention to the story and perceived strangeness of the story.

For our first aim, story experience in the text and VR storytelling scenarios were compared. In Study 1 and 2, comprehension was significantly higher in the T condition than in the two VR conditions combined and attention was higher in Study 2's T condition. Therefore, we conclude that text is better for achieving story comprehension. In Study 1, interest and enjoyment were significantly higher in the VR condition, while boredom was higher in the T condition. But, no significant differences between text and VR were noted for these variables in Study 2. Comparisons of the T and VR conditions across Study 1 and 2 showed a particularly poor story experience in Study 1's T group; we speculate that this was due to differences in Study 1 and 2's samples and procedures. Barring this, there were no interest, enjoyment or boredom differences between T and VR across Study 1 and 2. Thus, we conclude, conservatively, that text and VR are equally good in terms of interest enjoyment and boredom. Confusion was higher in Study 1's T condition, but this result was counter-intuitive since this condition had also shown higher comprehension. In contrast, Study 2's VR condition showed significantly higher confusion and lower strangeness. We conclude that Study 1's participants had reported strangeness rather than confusion and, while virtual storytelling resulted in more confusion, it also resulted in less perceived strangeness of the story. Presence and story experience in the VR+NI and VR+I storytelling scenarios were compared for our second aim. The introductory VE only had an effect for participants who showed a pre-existing interest in hip-hop. In Study 1's VR+I condition, hip-hop interest was a significant predictor of enjoyment. In Study 2's VR+I condition, those who identified hip-hop as a favourite music genre showed significantly higher presence than those who identified other genres as a favourite. This suggests that strongly themed introductory VE's do not benefit virtual storytelling, and that content familiarity and preference interact with VE content to influence virtual experiences. Regarding our third aim, we did not find strong evidence of a relationship between presence and story experience since presence only correlated significantly with interest in Study 1.

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# Chapter 1

## Introduction

Many papers on virtual storytelling begin by emphasizing the importance of storytelling as a cultural phenomenon and then base the importance of virtual storytelling on this fact. It is true that stories are one of the remarkably universal attributes of cultures the world over and are a fundamental way of preserving culture (Turner, 1993). But, much of what is termed 'virtual storytelling' is very little like the storytelling, the cultural phenomenon, which occurs in real life. A great number of media have been used to tell stories historically, starting with the most fundamental – oral storytelling, and progressing through print, radio, film and television. Each medium evolved over time and each added new characteristics to the art of storytelling (Madej, 2003). The rapid development of computer technology has brought with it our latest storytelling medium: virtual reality (VR). Consistent with the vast scope a digital medium offers, the ways in which VR has been used for storytelling so far are diverse. From digital books to systems which allow users to become autonomous story characters to complex artificial intelligence created to generate narrative structure automatically (Hayes-Roth, 1999; Madej, 2003; Reidl, 2003; Szilas, 2003). This diversification may be interpreted as virtual storytelling attempting to 'find its feet' as past media before it have done: evolving into an established medium and discovering what new aspects it has to offer the tradition of storytelling.

Another area in which VR has become very popular is that of preserving cultural heritage. VR has been used to produce a number of compelling museum displays and has shown its potential for resurrecting past sites and cultures virtually and preserving currently fragile sites and cultures. Though virtual cultural heritage has received relatively little attention in Africa, VR in storytelling and cultural heritage has been embraced by the international research community, resulting in a proliferation of applications of both kinds. Unfortunately, the bulk of the research in these areas seems to focus on the technologies used rather than how the applications are received by users. Where user evaluation is considered, the techniques used are usually not very rigorous and the outcomes are not highly generalisable. We believe that in order to utilise VR optimally for both storytelling and cultural heritage it is important to gain an understanding of its capabilities and effectiveness from the point of view of a user. This underlying aim influenced and informed the approach adopted in our research. We were not interested in trying out a new variation of virtual storytelling but rather in pausing for a moment to consider the nature of virtual storytelling and explore whether VR really is capable of telling stories properly in the first place.

We attempted to achieve this by looking at virtual storytelling in a literal, simple way and conducting a rigorous investigation of user experience in virtual storytelling. Additionally, we wished to conduct our research in the context of cultural heritage: another area where VR may be of great importance. We therefore undertook an investigation of VR as a medium for conveying existing cultural stories, specifically San stories. The San, a hunter-gatherer people indigenous to southern Africa, have a rich tradition of oral storytelling which has long served as a means for passing their culture on through generations. Today there are very few San living the traditional hunter-gatherer lifestyle, and their stories are not told nearly as widely as they once were. Recognition and preservation of San culture is essential lest this early African culture be lost. Since their stories are able to give invaluable insight into the San culture, it is important

to, not only preserve the stories themselves, but also to bring them to the attention of the general public in an engaging way. We feel that VR has an important role to play in the preservation of fragile cultures, whose cultural heritage is on the verge of disappearing. The San is such a culture and, as with many indigenous African cultures, preservation poses a particular challenge since their culture and narratives have traditionally survived through an oral storytelling tradition. Such a tradition is difficult to fully capture with text, but may well be aptly portrayed in a virtual environment (VE).

San stories also pose an interesting challenge for virtual storytelling: they are unique and different from the stories to which most contemporary audiences are accustomed. We were interested in how well a VE could convey these narratives given that their style and content were likely to be unfamiliar to most audiences. This ties into another major aspect of this research: an investigation of how to improve the effectiveness of virtual storytelling where potentially unfamiliar content, such as San stories, must be conveyed. We explore priming as a means of achieving this. In short, priming is a technique where users are exposed to material related to a VE's content *before* they experience the VE that may place them in the correct frame of mind for receiving the VE (Nunez & Blake, 2003). Priming material is usually related to the content of the VE. We wished to examine whether this technique would be useful for making a potentially culturally remote VE more familiar and engaging. In this dissertation we explore whether priming in the form of a culturally familiar introductory VE can make virtual storytelling more effective as a whole.

## 1.1 Aims and Hypotheses

In this dissertation we present research which inquired into what it means for a story to be experienced effectively and whether VR is capable of achieving this. Additionally, we explored the use of priming, in the form of an introductory VE, to increase the effectiveness of storytelling in VR, particularly where a traditional cultural story must be conveyed. And, since we wished to understand virtual storytelling better, we also investigated the relationship between presence, a fundamental subjective experience in VR, and story experience.

Three main aims were pursued:

1. To investigate the strengths and/or weaknesses of VR as a storytelling medium.
2. To investigate the effectiveness of using a culturally familiar introductory VE to preface a VE presenting traditional storytelling.
3. To investigate the relationship between presence and story experience in virtual storytelling.

Three hypotheses were posited regarding these aims:

1. Virtual storytelling will result in a more effective story experience than reading a story text.
2. A contemporary, culturally familiar introductory VE used to preface a VE presenting traditional storytelling will improve story experience.
3. Presence will be related to an effective story experience.

In order to evaluate VR as a storytelling medium, we compare it to another ubiquitous storytelling medium – text. San stories are only available as text today, however traditionally these stories would not be read but told by a storyteller. Most of these texts are close to the stories transcribed directly from the San and, thus, retain much of the spoken rhythm and diction (Lewis-Williams, 2000; Parkington, 2002). We believe that recreating San oral storytelling in VR would enable a San story to be brought to life in a way that text is not able to do by capturing something of their original, performative spirit. Therefore, we hypothesised that VR will lead to a better story experience than reading a story text and, in the case of San stories, prove a valuable means for preserving oral storytelling heritage.

Our second aim stemmed from two concerns, firstly creating a good VE requires a great deal of effort and a range of skills, thus it would be useful to know if there are ways to boost the final effectiveness of a storytelling VE. Secondly, we were concerned that the historical nature of the San story might be too culturally remote to most users and, thus, fail to engage them. As mentioned earlier, we decided to explore the use of priming in the form of an introductory VE, experienced before a San storytelling VE, as a means of increasing the effectiveness of the San storytelling VE. We further speculated that presenting the introductory VE in a theme which was culturally familiar to users would ‘grab’ their attention and allow them to experience the virtual San storytelling more effectively.

Our final aim forms part of understanding virtual storytelling better. Presence has long been deemed an important characteristic of virtual experiences (Lombard & Ditton, 1997; Schuemie *et al.*, 2001). In past research there has been uncertainty regarding the link between presence and task performance in VR (Ijsselstein *et al.*, 2000; Schuemie *et al.*, 2001). Given that we deemed an effective story experience as an important goal in virtual storytelling we were interested in seeing how this related to presence, another important goal of most VEs. Since both of these imply favourable experiences, we hypothesised that presence and story experience would be related to each other in a virtual storytelling.

## 1.2 Overview of the Research

A first step in achieving our aims was to develop an understanding of what it means to convey a story well or effectively. This understanding was necessary so that we could have criteria on which to judge, the strengths and weaknesses of VR as a storytelling medium and the benefits of using an introductory VE in virtual storytelling. Therefore, we developed a conceptualisation which proposed a number of desired and undesired properties of a so-called ‘effective story experience’. In this research, an effective story experience was defined as being one in which story comprehension was achieved, an interest in the story’s cultural context was generated and the story was enjoyed; boredom and confusion were considered undesirable (this is presented in full in Section 3.1, Chapter 3).

Two studies were conducted, one with a sample of 44 high-school learners and another with a sample of 98 undergraduate university students. In both studies participants experienced one of the following three storytelling scenarios, each conveying the same traditional San story:

1. *Story Text*: The story printed on a page.
2. *Virtual Storytelling with No Introductory VE*: A visual and audio desktop VE in which a San storyteller avatar tells the story to a San gathering and the user around a fire in a cave.
3. *Virtual Storytelling with Introductory VE*: Same as the scenario described above, but is preceded by a hip-hop themed introductory VE which conveys information about the San and their storytelling tradition.

Story experience was measured in each of the above three storytelling scenarios and presence was measured in the virtual storytelling scenarios. Since the story experience properties we wished to examine were fairly unique, there were no pre-existing questionnaires we could use to measure them. Therefore we developed questionnaires to measure these story experience properties, each of them evaluated for psychometric soundness. Over the course of this research these questionnaires were refined to produce a set of valid and reliable questionnaires for measuring the various aspects of story experience. A questionnaire was also developed to measure participant's interest in hip-hop culture, another factor considered in our research.

In order to evaluate VR's performance as a storytelling medium against text, we set out to compare the first two storytelling scenarios. To judge the benefit of prefacing a San storytelling VE with a contemporary-themed introductory VE, the last two storytelling scenarios were compared. Note that hip-hop was chosen as the contemporary theme of the introductory VE; in order to control for any effects this choice of theme may have had on story experience, we also measured each participant's interest in hip-hop. For those participants experiencing a virtual storytelling scenario, the relationships between presence and the story experience properties were investigated. We also checked whether our conceptualisation of an effective story experience was empirically supported by looking at the correlations between the various story experience properties proposed by our conceptualisation.

### 1.3 Outline of Dissertation

*Chapter 2:* In Chapter 2 we present background literature used in formulating our research on virtual storytelling. Storytelling and VR are first discussed separately. Storytelling as a cultural phenomenon and the evolution of storytelling in different media from oral to digital is discussed. Some VR fundamentals are presented including the notions of presence and priming. Next we discuss past work on virtual storytelling, paying special attention to the different kinds of virtual storytelling applications that exist and distinguishing between linear and non-linear storytelling. We also look at the similarities and differences between narration in film and VR and methods that have been used to evaluate virtual storytelling applications. The evaluation of story experience outside the realm of virtual storytelling is also presented. Next, the recent use of VR for preserving cultural heritage is detailed. Lastly, the state of San cultural heritage, and specifically San folklore, is addressed.

*Chapter 3:* Chapter 3 constitutes our synthesis of the literature presented in Chapter 2 and we show how our approaches to investigating virtual storytelling and research aims (as outlined in Section 1.1 above) were derived from this. Since our three aims all involve story experience in some way, the so-called 'effective story experience' conceptualisation developed in Chapter 3 is central to our research. We also discuss our aims and approach to achieving these aims: evaluating VR as a storytelling medium by comparing it to text; evaluating the benefits of a culturally familiar introductory VE by prefacing a San storytelling VE with a hip-hop themed introductory VE and evaluating the relationship between presence and story experience.

*Chapter 4:* The theoretical approach and research aims discussed in Chapter 3 are formalised into an experimental design in Chapter 4. Our aims were used to formulate research questions, experimental variables and hypotheses. Two studies, labelled Study 1 and Study 2, with the same design but different samples and slightly different procedures are described. Three storytelling scenarios were required to answer our research questions: story text, virtual storytelling without an introductory VE and virtual storytelling with an

introductory VE. The questionnaires used in our studies are detailed, paying special attention to those which were specifically created to measure interest in hip-hop and story experience. The remainder of this chapter outlines the equipment, samples and experimental procedures used in the two studies. The next two chapters deal with our two chief research tools: the storytelling scenarios and the custom-made questionnaires.

- Chapter 5:* Chapter 5 details the three storytelling scenarios used in our experiments. The San story presented in all three scenarios is discussed and the two virtual storytelling scenarios are described from the user perspective. Both virtual storytelling scenarios feature a San storytelling VE: one scenario includes a hip-hop themed introductory VE, while the other does not. Thereafter more detail is given regarding the design and implementation of the virtual storytelling scenarios including the storyboarding technique used and basic implementation details.
- Chapter 6:* In Chapter 6 we present detailed psychometric analyses of the questionnaires which were created specifically for this research. These include questionnaires for measuring interest in and familiarity with hip-hop subculture and the various factors identified in our story experience conceptualisation (outlined in Chapter 3). The concepts of validity, reliability and skew along with the tests used to evaluate these are described. The results of psychometric analysis for Study 1's questionnaire are presented first; these were used to refine the questionnaires for use in Study 2. The amendments made to the questionnaires and the psychometric results for the refined questionnaires are also presented. The questionnaires and the extent to which they were successful measures are discussed. A summary of the psychometric outcomes is also provided.
- Chapter 7:* The results of the experiments in our two studies are presented in Chapter 7. First, the statistical procedures used to analyse the data obtained from our experiments are described. Next the results of both studies are presented. For each study we tested the influence of demographic factors, the validity of our story experience conceptualisation, the effect of storytelling medium (text or VR) and the introductory VE on story experience and the relationship between presence and story experience. A summary of our major finding is provided at the end of this chapter.
- Chapter 8:* The findings detailed in Chapter 7 are discussed in Chapter 8. The results of Study 1 and 2 are considered in conjunction. We begin by discussing the influence of demographic factors and the validity of our story experience conceptualisation. Next, the effect of storytelling medium on story experience, the effect of an introductory VE on story experience and the relationship between presence and story experience are discussed.
- Chapter 9:* This chapter concludes the dissertation; our aims and experimental design are summarised and our final conclusions regarding our findings are made. The novel contributions of this dissertation are pointed out and suggestions for future research are put forward.

## Chapter 2

### Background

All societies tell stories; it is intrinsic to cultural experience (Turner, 1993). Storytelling is an everyday practice and exists in many different forms, such as myths, films, novels, songs, plays, rituals and folklore (Turner, 1993). All these narratives play an integral role in the formation of cultural identity and allow us to gain valuable insight into a culture's values, ideals and subtleties. In this chapter we discuss the background literature which influenced the virtual storytelling research presented in this dissertation. First, storytelling and virtual reality (VR) are discussed separately. Next, background on virtual storytelling is presented, including a synthesis of how virtual storytelling experiences have been evaluated in past studies. We also present ways in which story experience has been evaluated outside of virtual storytelling research. Next, we discuss the use of VR for preserving and presenting cultural heritage. Finally, the cultural heritage and folklore of the San are discussed.

#### 2.1 Storytelling

Storytelling serves a number of purposes; it preserves culture by passing cultural narratives on to future generations, teaches moral lessons and entertains audiences. By investigating the narratives of different cultures, the similarities and differences across cultures may be noted. Stories have long been the subject of research in a field called narratology (Turner, 1993). Famous folklorist Vladimir Propp, who analysed Russian folk-tales, discovered that structural similarity existed in many different folk-tales; this led to the formulation of a basic structure that many folk-tales and modern narratives possess (Turner, 1993). Anthropologist Claude Levi-Strauss investigated the myths of ancient cultures and found that they were often used as a means of making sense of the world and explaining its contradictions. For instance, primitive myths would often attribute natural disasters to the anger of a god. Strauss also noted that cultural specificity played a role in how common structures in narratives, such as those formulated by Propp, were transformed in different cultures (Turner, 1993).

##### 2.1.1 Storytelling Media

Historically, many different media have been used to convey stories, the oldest known being spoken or oral storytelling. With the invention of new technologies, such as the printing press and camera, a diversity of media came to be used for telling stories, for example print, radio, film, television and, most recently, computer (Madej, 2003). Madej (2003) discusses the development of these media within the context of narratives for children and shows that, as each medium developed, it evolved to add its own distinctive contribution to the tradition of storytelling. Printed stories allowed publishing houses to edit stories as desired and, eventually, for story text to be accompanied by illustrations. With radio, film and television stories began to incorporate an audio aspect as well as visual movement. Computers enabled stories to be textual, visual, audio, as well as interactive (Madej, 2003). Digital and virtual storytelling will be discussed further in Section 2.3 below.

## 2.2 Virtual Reality

Virtual Reality (VR) has rather wide ranging definitions, but in essence it refers to a mediated representation of a real space or situation (Lombard & Ditton, 1997). Typically, computer technology is used to create and mediate this representation and users are enabled to interact with it. Usually VR also seeks to immerse users' senses in a simulated world or space (Schuemie *et al.*, 2001). Overall, VR may be described by three defining characteristics: it allows users a certain amount of autonomy to control their virtual experience; it interacts with users; and it, usually, produces a sense of presence (see Section 2.2.1) in users (Zeltzer, 1992). Some hold an even broader view of VR to the extent that books, in particular fiction works, may be considered a form of virtual reality insofar as it aims to create a simulated world mediated through paper and text (Lombard & Ditton, 1997). In this research we will consider VR as a simulation of reality created and mediated by computer technology. VR in this form has found many uses in a broad range of fields such as entertainment, education, flight simulators and as aides in clinical and behavioural therapies (Lombard & Ditton, 1997).

There is a common perception that expensive and sophisticated equipment is required to run VR applications. The term "immersion" is used as an objective description of the extent to which a VR system encases a user's senses in a virtual environment (VE) (Lombard & Ditton, 1997; Slater & Wilbur, 1997). Indeed, many VR applications may make use of sophisticated equipment such as data gloves, head-mounted displays or motion tracking devices. However, low-cost VR is also important in making the implementation and deployment of VR applications practical. Often the expensive and exclusive nature of VR technology places it out of reach of the general public (Pausch *et al.*, 1996). Pausch *et al.* (1996) point out the importance of "building high quality, low cost VR systems". Furthermore, the need for high-fidelity VR applications can be decreased by providing engaging content and tasks within a VE (Pausch *et al.*, 1996). In fact, compelling VEs may also be displayed using ordinary desktop computers, which are much less costly than the more high-profile VR hardware (Mania & Chalmers, 2001; Brown *et al.*, 2003). In the South African context, the expense of high fidelity equipment may put VR out of the reach of the general public. Therefore, a low-budget approach to VR, which makes use of affordable, accessible equipment, such as desktop computers may be more appropriate for reaching a wide audience.

An important consideration when creating VR applications is that of user experience. A VE, after all, is developed to be used efficiently by people (Lombard & Ditton, 1997). It is useful, in creating VEs, to understand the goals of potential users, as well as users' strengths and weaknesses (Wickens & Baker, 1995). It is particularly important to consider users who are novices to using VR and computers and ensure that VEs are easy to use (Pausch *et al.*, 1996). Users who are unfamiliar with computers, may find interacting with a VE difficult, possibly hindering their virtual experience (Lombard & Ditton, 1997). It has been found that a VR experience can be overwhelming for novice users and that sometimes that content and experience is sometimes more to novice users than the VR technology (Pausch *et al.*, 1996). Additionally, novice users tend to have high expectations of VR experiences (Pausch *et al.*, 1996). It is important to take this into account; if a VE does not come close to meeting expectation, it may fail to convey content as intended (Pape *et al.*, 2001). Compared with research on VR technology, there has been little work regarding users and VR. While there have been some good studies exploring users and VR (see Pausch *et al.*, 1996; Dinh *et al.*, 1999; Mania & Chalmers, 2001; Murphy & Pitt, 2001; Brown *et al.*, 2003 for examples), few rigorously focus on users.

### 2.2.1 Presence and Task Performance

Presence is the most widely used metric of subjective experience in a VE (Lombard & Ditton, 1997). A great number of definitions exist for presence but the most common and simple is that it is the feeling of *being in a place*, often described as 'being there' (Lombard & Ditton, 1997; Witmer & Singer, 1998). For good reviews of the presence concept and research see (IJsselsteijn *et al.*, 2000; Freeman *et al.*, 2001; Schuemie *et al.*, 2001). It might be said that a person generally feels present in their real environments such as their offices or homes. However, people can also feel a sense of being in place that is not real, for instance someone watching a film or reading a book may forget, to an extent, about their real surroundings as they become absorbed in the world of a film or book. Ideally, VR applications seek to make users completely forget their real environments by immersing them in a VE (Lombard & Ditton, 1997). The extent to which a VE is experienced as a real environment may be interpreted as a reflection of how well a VE creates the illusion of reality.

Unfortunately, presence is not a simple matter of experiencing something as real or not. The nature of presence is imprecise and there is significant debate around this phenomenon and its contributing factors (Freeman *et al.*, 2001; Schuemie *et al.*, 2001). A number of researchers agree that presence is a multi-dimensional phenomenon but there is, as of yet, no agreed upon model of presence (IJsselsteijn *et al.*, 2000; Schuemie *et al.*, 2001). Also, since presence is subjectively experienced, some people experience presence more easily than others (Lombard & Ditton, 1997; Witmer & Singer, 1998). A number of studies have shown that high fidelity and immersive VR results in higher levels of presence (Lombard & Ditton, 1997). A highly immersive VR set-up might make use of a head-mounted display so that a visual VE fills users' field of view. But low or non-immersive VR systems are also capable of achieving presence (Obeysekare *et al.*, 1996; Brown *et al.*, 2003; Whitton, 2003). However, there is still some debate as to whether it is the form of a VE or the content that contributes more greatly to presence or how form and content might interact to bring about presence (Lombard & Ditton, 1997).

Theoretical contention aside, presence is often used as a metric of a VE's success with users. However, a number of studies have undertaken to measure presence together with measures of a VE's usefulness, such as task performance or recall of content (Pausch *et al.*, 1997; Mania & Chalmers, 2001; Schuemie *et al.*, 2001). Studies which experimentally investigate presence and task performance often make use of VEs featuring very specific tasks to be completed; this limits the extent to which findings may be broadly generalised to VR. However, a number of factors which increase presence have been found to also enhance learning and task performance in VEs (Pausch *et al.*, 1997; Witmer & Singer, 1998). But, there is no surety as to specific task characteristics where presence facilitates performance (Lombard & Ditton, 1997). In fact, some researchers speculate that certain kinds of tasks in VR may benefit from low presence (Schuemie *et al.*, 2001). Additionally, features intended to increase the realism of a VE might also increase the cognitive load placed on users, resulting in a decreased sense of presence (Wickens & Baker, 1995). All in all, a direct link between presence and task performance has not been proven and results regarding this relationship are varied and unclear (Witmer & Singer, 1998; Schuemie *et al.*, 2001).

### 2.2.2 Priming

The notion of priming draws from cognitive psychology and a small number of VR studies have made use of it (Brown *et al.*, 2003; Nunez & Blake, 2003). In essence priming involves exposing users to some kind of information before they experience a VE. The information might be in the form of printed text or a video and is usually related to the VE's content (Nunez & Blake, 2003). Priming is intended to create a cognitive awareness of and predisposition toward a forthcoming experience (Nunez & Blake, 2003). Pausch *et al.* (1996) refer to a similar concept, namely a "pre-immersion background story", which is intended to give users a context before experiencing a VE and reduce the severity of moving from a real to virtual world.

The idea behind priming is based on the theory of schemas which proposes that people do not interpret the world based solely on information obtained by their senses but also by information already stored in long-term memory. It is believed that this information is encoded as schemas – simple ideas connected to each other by associations (Nunez & Blake, 2003). For instance, in a ‘television’ schema the concept ‘television’ might be associated with the concepts like ‘remote’ and ‘television show’. In practice, when we encounter a television, the television schema would be activated, creating certain expectations such as expecting to find a remote to operate the television and expecting to experience a visual and audio television show. Thus, there is already awareness of what to expect from a television, based on information stored in the ‘television’ schema. So, interacting with a television is not discovered and learned afresh each time we encounter a television! In the context of VR, priming can be used to activate appropriate schemata in order to make it easier to process a forthcoming VE and place users in a correct frame of reference for receiving the VE’s content (Pausch *et al.*, 1996; Nunez & Blake, 2003).

## 2.3 Virtual Storytelling

Earlier, in Section 2.1, different storytelling media used historically were described. The advance of computer technology has introduced a digital medium for storytelling which combines the properties of past storytelling media (Madej, 2003). Digital storytelling is able to use text, the visual and audio aspects of television and radio storytelling and the interactivity that may have been possible during live, oral storytelling performances (Madej, 2003; Silver *et al.*, 2003). In addition to this, digital storytelling may also incorporate the engagement and interactivity of computer games and VR (Madej, 2003). In essence, virtual storytelling may be defined as the use of VR technology to tell stories. This rather broad definition actually allows for a broad range of virtual storytelling applications. For instance, it includes story creation applications some of which use artificial intelligence to generate stories that conform to traditional narrative structures (Reidl, 2003; Szilas, 2003) and others which allow users to create their own stories (Machado *et al.*, 2000). There are also many different ways a narrative might be presented in virtual and digital storytelling ranging from digital books (Madej, 2003) to virtual characters acting as human storytellers (Roussou, 2001; Brown *et al.*, 2003), some virtual storytelling systems even allow storytelling agents and users to interact (Silver *et al.*, 2003; Geigel & Schweppe, 2004).

### 2.3.1 Linear and Non-linear Storytelling

Traditionally stories are linear, consisting of a predefined beginning, middle and end (Pearce, 1994). Although a story may change slightly when conveyed by different storytellers or writers, essentially the same narrative is presented at each retelling (Pearce, 1994). Non-linear, or interactive, storytelling allows those experiencing the story to influence the course of the narrative. This may happen in a number of ways, for instance, they might be required to choose from a number of activities or story branches at various points, or they may be allowed to enter the story as a character (Hayes-Roth, 1999). The end result is that eventual story delivery is variable with each retelling (Pearce, 1994). VR has been used to convey both linear (Bimber *et al.*, 2003; Brown *et al.*, 2003) and non-linear narratives, and interactive storytelling has become popular in virtual storytelling research (Bers *et al.*, 1998; Murphy & Pitt, 2001; Geigel & Schweppe, 2004). Particularly those in which users, often school children, can collaborate in either experiencing or creating narratives (Benford *et al.*, 2000; Jackson & Fagan, 2000; Machado *et al.*, 2000).

There is speculation that interacting with a story’s narration increases engagement in the story, but this link is by no means well-established (Schell, 2005). In terms of presence, it is a widely accepted assumption that interactivity increases presence, however a link between these two has,

also, not been proven empirically (Lombard & Ditton, 1997). Schell (2005) suggests that interactivity is a means of increasing user's psychological proximity in an entertainment or game experience. Psychological proximity refers to the extent to which users are compelled to use empathy and imagination to place themselves into an entertainment experience (Schell, 2005). The higher one's psychological proximity or the closer one feels to a narrative, the more it should hold one's interest. However, introducing interactivity into narration also means that the storyteller loses full control of the narrative (Schell, 2005).

On the one hand, interactivity offers the potential benefits of involving an audience in the storytelling process. But, on the other hand, interactivity limits the control a VE author has over the narrative that is eventually delivered to users (Clarke & Mitchell, 2001). In some cases, interactivity may compromise good storytelling by complicating the narration and losing touch with the author's intended narrative (Clarke & Mitchell, 2001; Roussou, 2001). Consider the case where a narrative is pre-determined and must be conveyed as is, in other words a traditional linear story. Ideally, we still wish convey such a narrative in an engaging way that invokes a user's empathy and imagination, but without allowing the audience to influence the course of narrative events. Here, it may be that realistic simulation, a fascinating story and a compelling storyteller character are more important in creating the illusion of storytelling in VR (Roussou, 2001). But, is it worthwhile using VR to convey a narrative, without exploiting its ability to provide interactivity? Virtual storytelling should not be seen only as an interactive storyteller or a means for simulating existing linear storytelling media. In the realm of linear storytelling, VR may be able to offer something distinct as a storytelling medium. We will now discuss virtual storytelling in comparison to another well-known, linear storytelling medium: film.

### 2.3.2 Film and Virtual Storytelling

Virtual storytelling may be viewed as a descendant of film; both of these are able to combine the use of visual, audio and even text in telling stories (Madej, 2003; Zagalo, 2003). This is very useful since techniques, such as storyboarding, narration, cinematography and characterisation, which have been honed in film, may be used to inform the creation of compelling storytelling in VR (Clarke & Mitchell, 2001). As a narrative form, film consists of a number of conventions, i.e. common traits found in different films, particularly within film genres (Bordwell & Thompson, 2001, p.39-58). Audiences' prior experience of film allows conventions to be learnt and accepted so that they act as cues for what audience should expect in future film experiences. New conventions are created by introducing innovative elements into films (Bordwell & Thompson, 2001). Similarly, an eventual goal for VR as a storytelling medium is to develop a set of communication techniques which are shared and understood by VE authors and audiences (Pausch *et al.*, 1996).

While very similar, film and VR differ in a fundamental way. In film a viewer's experience consists of visual and audio scenes edited together, all completely determined by a director. Whereas in VR, users have greater control over what they experience by using the interface to control their movement and point of view within a virtual space (Clarke & Mitchell, 2001; Zagalo, 2003; Schell, 2005). Even where users do not directly influence a VE's narrative as in interactive storytelling, they have more control over their experience than in film. This has been referred to as an intrinsic conflict between pre-constructed narrative and user exploration in VEs (Pausch *et al.*, 1996). Allowing users free reign to navigate a virtual space is an essential part of simulating a real space and it adds to enjoyment of a VR experience (Pausch *et al.*, 1996). But, the uncertainty of what VR users will choose to explore may concern VE authors, since the virtual space must look good from all possible viewpoints and the narration is partially controlled by the user (Pausch *et al.*, 1996; Schell, 2005). Schell (2005) suggests that VE authors can still control user experience, not by taking control away from users, but by indirectly influencing users. A VE's layout can influence where users will look by drawing their attention to certain areas and they are more likely to explore areas which catch their attention (Schell, 2005). Virtual characters may also be used to direct the attention of users (Pausch *et al.*, 1996).

Furthermore, navigation may be influenced by using barriers consistent with reality, for instance a virtual fence or closed door (Pausch *et al.*, 1996). Thus, storytelling in VR, whether linear or non-linear, has the ability to become a less deterministic and passive experience than that of film and more of an experience in which users may feel like participants. Furthermore, this is possible without necessarily sacrificing control over narrative.

### 2.3.3 Evaluating Virtual Storytelling

Content has been identified as a key driver in the field of digital storytelling (Brown *et al.*, 1999). Additionally, Pausch *et al.* (1996) found experience and content to be of greater importance than technology among novice users of a virtual storytelling system. However, many virtual storytelling studies focus largely on virtual storytelling architectures and technology, rather than user experience or quality of storytelling; for examples of this kind of work see (Machado *et al.*, 2000; Bimber *et al.*, 2003; Geigel & Schweppe, 2004). While there are studies which measure user experience, many of these are conducted as a means of evaluating a particular storytelling system, more akin to a usability evaluation (Bers *et al.*, 1998; Bimber *et al.*, 2003; Silver *et al.*, 2003). This limits the extent to which their results may be generalized to other storytelling systems and VR as a storytelling medium.

Among the techniques used to measure user experience of virtual storytelling are informal user studies, retrospective surveys and questionnaires. Many user studies of virtual storytelling systems provide anecdotal evidence, such as noting participant's behaviour and comments during or after system use (for example Machado *et al.*, 2000; Silver *et al.*, 2003 and to a lesser extent Pausch *et al.*, 1996). In addition to observation, some studies make use of surveys completed after a user's virtual storytelling experience. Retrospective surveys have been used to collect information about aspects of a VE which participants liked or disliked, presence and acceptability of user control levels (Pausch *et al.*, 1996). Surveys have also been used, in the context of pilot study, to assess overall user impressions of a virtual storytelling prototype (Bimber *et al.*, 2003). Presence is often used as a measure of user experience in virtual storytelling. A high sense of presence is generally interpreted as an indication of a storytelling VE's success (Dinh *et al.*, 1999; Brown *et al.*, 2003). In addition to presence, some studies have measured factors such as spatial memory of a VE, user's patterns of exploration and ratings of enjoyment in a VE (Pausch *et al.*, 1996; Dinh *et al.*, 1999; Murphy & Pitt, 2001; Brown *et al.*, 2003). However, none of these studies have focused on user's experience of the narrative conveyed in a VE. Brown *et al.* (2003) tested the effects of visual and audio mediation on VE and story presence, story enjoyment and involvement.

Schell (2005) describes a framework for assessing the entertainment value of a story or game experience by evaluating the extent to which it is able to hold an audience or user's interest. This approach consists of plotting the interest value of each event in the experience on an interest curve which spans the duration of the experience. Three factors which determine the interest value of an event are discussed:

- *Inherent interest*: refers to the fact that some events are, by their nature, more interesting than others. For instance, unusual events are more interesting than ordinary ones, so a story about a world-wide invasion by giant talking lobsters would likely be more interesting than one about someone brushing their teeth. Within a story plot, events may also derive inherent interest based on how they relate to other events.
- *Poetry of presentation*: describes aesthetics; the more beautifully and creatively an event is presented, the more engaging and interesting it will be. For instance, a beautifully filmed movie scene can hold an audience's interest even though it may not be depicting an inherently interesting event.

- *Psychological proximity*: the extent to which a user is compelled to place themselves into an experience or a narrative. This concept has been discussed in Section 2.3.1 above.

A story or game which rates highly on these three factors is likely to hold one's interest, but an excess of one factor can make up for paucity of another. For instance, the simple shapes falling downward in the *Tetris* videogame may not hold much inherent interest or poetry of presentation, but a player can still derive much entertainment from the psychological proximity of directly manipulating the shapes (Schell, 2005).

## 2.4 Evaluating Story Experience

Though virtual storytelling research has not typically focused on story experience, there is a long history of evaluating how people experience stories in traditional media. Many of these studies investigate recall and understanding of story content and, sometimes, enjoyment of stories. Studies involving storytelling and story experience have been used to gain insight into human memory. Bartlett (1932) conducted a series of experiments which investigated participants' memory of a North-American folk-tale entitled *The War of the Ghosts*. Participants read the story and then attempted to reproduce the story in writing after a fifteen minute interval and after that at increasing time intervals as much as six and a half years. The aim of these experiments was to see how accurately the story was remembered and identify patterns in how the memory of story changed over time (Bartlett, 1932). A number of reasons are cited for using a folk-tale in these experiments; Bartlett wished to assess how participants handled the cultural and social unfamiliarity of the story as well as the lack of rational order in the story events. Additionally, Bartlett was interested in observing how the vivid visual imagery and supernatural elements in the story were dealt with (Bartlett, 1932).

In the context of educational research, a number of studies have focused on storytelling with young school children. Here the goal is usually to understand how stories are received and understood by children for the purposes of informing educational techniques used in schools. Carlisle & Felbinger (1991) compared results on comprehension tests given to children who had either listened to or read a story. The aim of their study was to gain insight into comprehension difficulties and performance across these two modalities. In their study comprehension was measured using the sentence verification technique (SVT), considered applicable for measuring both listening and reading comprehension (Carlisle & Felbinger, 1991). A SVT test consists of a number of sentences derived from story sentences so that they are either true or false according to the story; participants are required to identify the sentences as true or false (Royer, 2001). The SVT will be revisited in Section 4.5, Chapter 4.

A number of these studies also compare across different storytelling media. For instance Ricci & Beal (2002) compared children's story memory across the following media: audio cassette, audiovisual digital book, audiovisual digital book with direct interaction and passive observation of another's interaction. The interactive version could be classified as a form of virtual storytelling as it allowed children to click on certain objects and click to go to the next page of the story (Ricci & Beal, 2002). Story memory was measured using free recall of the story, sequencing story pictures correctly and testing memory for story facts and ability to make inferences about the story (Ricci & Beal, 2002). The children were informed, before experiencing the story, that there would be questions about the story afterward. Thus, explicit learning, which occurs consciously, was measured (Reber, 1995). This is different from incidental learning which "takes place in the absence of intent to learn or instructions to that effect" (Reber, 1995). Incidental learning would be measured where participants are unaware that there will be a test of story comprehension. Ricci & Beal's study found that the only medium which differed significantly from the others was audio cassette, where children consistently performed worse. The children were also asked to rate their enjoyment of the story; this did not vary across the different media (Ricci & Beal, 2002). A similar study investigated

young children's attention to story meaning (de Jong & Bus, 2002). Here, a story was presented to children repeatedly in three different ways: read out loud by an adult, reading and listening to a digital "talking" book and a digital "talking" book interspersed with interactions and games. They observed that, particularly for young children, the interactions and games distracted them from the story content and resulted in a more fragmented experience of the story, depending on which interactions were chosen (de Jong & Bus, 2002).

From this research, we see that people's experience of stories, in both traditional and digital storytelling media, has been studied in educational and psychological research. The techniques used to evaluate story experience in these kinds of studies may be useful in studies that seek to better understand virtual storytelling.

## 2.5 VR and Cultural Heritage

In their review of research challenges and opportunities in information technology for 2010, Brown *et al.* (1999) suggest cultural heritage as one of three main application domains for human-centred computing and VE's. So far VR has been used to create quite a number of cultural experiences and has certainly shown a capacity for producing compelling displays and promise as a keeper of history. At a very practical level, computer and VR technology allows for historical artefacts and facts to be permanently recorded and can be used to reconstruct past sites and civilizations digitally. A major benefit of using VR is that it allows users to visit places and experience events which would not be possible in the real world (Bowman *et al.*, 1999; Jackson & Fagan, 2000). For instance, VR can be used to present past events which the general public would not be able to otherwise experience today. An example of this is Virtual Harlem, which allows users to experience key events of the Harlem Renaissance during the 1920's and 1930's (Johnson *et al.*, 2001).

We have already discussed the unique characteristics VR is able to bring to storytelling, namely the ability to immerse users in a simulated world and provide an interactive experience. These characteristics are also able to lend innovation and value to the processes of preserving cultural heritage and creating of museum exhibits (Anstey *et al.*, 2000). This makes for a change from traditional museum exhibits, which typically present culture statically either as visual and text material or as a collection of artefacts. VR presents the opportunity to people to create their own experiences of cultural heritage. The first-hand interaction provided by VR can allow users to actively learn and construct cultural knowledge rather than passively experiencing cultural heritage (Jackson & Fagan, 2000; Johnson *et al.*, 2001). Virtual Harlem, mentioned above, was used as part of a university English Literature course to encourage students to understand and engage critically with the historical context of the Harlem Renaissance and its artistic effects (Johnson *et al.*, 2001; Park *et al.*, 2001). Another interactive VE of North Main Street Cork City in Ireland was created in order to stimulate interest and exploration of local ruins (Murphy & Pitt, 2001). This application allowed users to switch between current-day and 17<sup>th</sup> century versions of the area. However initial user testing showed that, especially children, showed more interest in the interactive features as opposed to the VE content (Murphy & Pitt, 2001).

Authenticity is an important consideration for VR applications aimed at preserving cultural heritage since the goal is often to create an accurate record and educate users. The majority of work in this area strives toward, at least some level of authentic content, particularly where archaeological sites and artefacts are reconstructed (Devlin & Chalmers, 2001; Baracchini *et al.*, 2004; Sundstedt *et al.*, 2004). However, VR may be used to present both realistic and abstract content (Jackson & Fagan, 2000) and some virtual museum exhibits do not always aim for authentic reconstruction. For instance, a virtual reconstruction of the ancient city of Miletus and the Temple of Zeus in Olympia chose to focus on interactive educational features rather than authentic reconstruction (Gaitatzes *et al.*, 2001).

## 2.6 San Cultural Heritage

The San (also known as the “Bushmen”) are an indigenous hunter-gather people considered amongst the earliest human inhabitants of southern Africa. Sites of their famous rock art tradition date back over 20 000 years (Parkington, 2002). Since the start of colonialism in the late 1400’s, San populations were dramatically diminished by European settlers (Smith *et al.*, 2000). Additionally, their hunter-gatherer lifestyle became increasingly difficult to sustain and, today, very few San practice this traditional lifestyle (Godwin, 2001). In fact, the San have been described as being on the brink of “cultural extinction” (Godwin, 2001, p.94) and, consequently, preservation of San cultural heritage is of utmost importance to ensure that this fascinating culture is not lost.

One of the most famous and contentious museum exhibits of the San is the San diorama, a collection of full-body casts of San figures set in a hunter-gatherer camp. The diorama was displayed at the South African Museum in Cape Town for 42 years, and became one of the museum’s most popular exhibits. In 2001, the diorama was closed down since it was believed that it reflected South Africa’s past apartheid ideology which considered white people superior to so-called black and coloured groups (Rall, 2001). The newsletter announcing the diorama’s closure is shown in Figure 2.1. The creation of the diorama in 1911 was intended to be an anthropologically correct preservation of the San and their hunter-gatherer lifestyle. Throughout its public life, the diorama featured more prominently as natural history exhibit than a cultural one (Rall, 2001; Sachs, 2001). Additionally the display represented an idealised version of the San’s hunter-gatherer lifestyle without depicting their history of struggle with colonialism (Rall, 2001). In the context of apartheid’s end in South Africa, there has been considerable and contentious debate as to whether diorama’s representation of the San was appropriate, which ultimately led to its closure (Gosling, 2001; Rall, 2001). However, San cultural heritage should still be available to the public. In order to fill the gap left by the diorama’s closure, and to improve where it fell short, new ways of representing the San authentically and sensitively are needed. In particular, it is important to allow museum goers to form their own opinions about the San, this can be achieved through exhibits which are objective and impose no particular viewpoint on the audience (Singer, 2001).

Sachs (2001) points out that the full diversity of a country’s people should be represented in its museums. Furthermore, it is important to depict cultures’ ordinary, everyday aspects and creating a sense of discovery and theatre while imparting knowledge (Sachs, 2001). It was hoped that this research would produce an application to convey a fundamental, everyday, part of San lifestyle, that of storytelling.


### 2.6.1 San folklore

The Bleek and Lloyd collection at the University Cape Town is one of the most extensive archives of San folklore. The collection is a meticulous recording, conducted by Wilhelm Bleek, Lucy Lloyd and Dorothea Bleek, of San stories told by some of the last traditional San living in Cape Town, South Africa during the late 19<sup>th</sup> century (Lewis-Williams, 2000 p.1-41; Parkington, 2002 p.8-13). Records such as these illustrate the extensive oral storytelling tradition of the San and give readers invaluable insight into their culture (Parkington, 2002). We have already discussed storytelling’s universal cultural significance, in Section 2.1 above, and in San culture it is no different. Telling stories is a fundamental way of passing culture and values onto future generations and storytellers play a highly esteemed role in African societies (Russel, 1998).

A vast majority of San stories describe an early time when humans and animals co-existed, sometimes as hybrid human-animals beings. These stories often contain supernatural elements, such as shape-shifting beings and an intermingling of the real and spirit worlds (Bleek, 1923; Lewis-Williams, 2000 p.8; Smith *et al.*, 2000 p.81). A common figure found in mythology the

world over is that of the trickster. In San mythology, the trickster is regarded as a magical god or sorcerer. He is embodied as a praying mantis and is most commonly called Kaggen. Kaggen is considered both malevolent and heroic and is credited with cunning, malicious pranks as well as the creation of the earth's present elements and animals (Bleek, 1923; Lewis-Williams, 2000 p.8; Smith et al., 2000 p.80).

Today San folklore is almost exclusively accessible through texts such as the Bleek and Lloyd collection, of which only a small subset was initially published (Lewis-Williams, 2000 p.33-35). Some commercial publications of San folklore are also available; for instance (Lewis-Williams, 2000) which presented previously unpublished stories from the Bleek and Lloyd archive. In some cases, San stories have been adapted by contemporary poets into anthologies, see for instance (Watson, 1991; Krog, 2004). Brown *et. al.* (2003) developed a San storytelling application in which a user was able to enter a cave and sit around a fire with a group of hunters and listen to a traditional San story told within a group of San hunters. The work presented in this thesis continues on from this work.

**Events@SAM**  
 APRIL 2001 ★ Volume 2 ★ Number 3  
 WEB ADDRESS: <http://www.museums.org.za/sam/index.htm>  
 SOUTH AFRICAN MUSEUM  
 The South African Museum forms part of Iziko Museums of Cape Town

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**Debating the Diorama**

Within the changing social context of South Africa, museums have a responsibility to reconsider their roles as sites of memory, inspiration and education. The South African Museum, together with the other museums that form Iziko Museums of Cape Town, is currently rethinking directions and priorities. In this context a decision has been taken to 'archive' the famous hunter-gatherer diorama while its future is reviewed. It will not be dismantled but will be closed to the public from the end of March 2001. This move shows commitment to change and encourages debate within the Museum, with the public and especially with people of Khoisan descent.

Visitor surveys over the past forty years show that the diorama is the most popular exhibition in the South African Museum (SAM). The technical mastery of the display and the human scale and realism of the cast figures draw viewers into an idealized representation of a past way of life. The casts themselves have a history dating back to 1911 when scientists were concerned with making an exact physical record of the 'Bush and Hottentot' races, believed at the time to be near extinction. Although the people who were cast were no longer living as hunter-gatherers, they were identified as being 'pure Bushmen' on the basis of appearance and language. In the Museum the casts were first shown as examples of physical types but, as the focus of anthropology shifted towards cultural ecology, they were redisplayed in the diorama to show hunting and gathering as a way of life.

Early in the 1960s the SAM changed when the colonial history collections were transferred to the South African Cultural History Museum (SACHM). Khoisan and other anthropology collections remained with natural history in the SAM, separated from the fields of history covered by the SACHM. Critics see this as an expression of apartheid ideology. On the other hand, defenders of the diorama argue that its presence in the SAM affirms the importance of the San as the first people of South Africa and gives recognition to their way of life. From the SAM perspective the problem is that these exhibitions do not demonstrate that anthropology includes all humankind. Instead of showing only 'other cultures', new exhibitions will focus on themes that embrace all people.

Following the recent restructuring of national museums, the SAM and SACHM are once again part of a single organization, now under the Iziko banner. This provides an opportunity to rethink how we use our collections in the public presentation of history. We invite you to participate in the debates about the diorama and the wider issues of representation in our museums.

Please put your comments in writing and send them to P O Box 61, Cape Town 8000, or fax 021 424 6716, or email [mval@sammuseum.ac.za](mailto:mval@sammuseum.ac.za)

Figure 2.1: The April 2001 South African Museum newsletter announcing the closure of the San diorama at the South African Museum in Cape Town.

## Chapter 3

# Our Approach: Telling a Story Properly

What does it mean to tell a story well? In the Chapter 2 we presented literature on storytelling, virtual reality (VR) and virtual storytelling. We also looked at how past studies have evaluated virtual storytelling (see Section 2.3.3) along with research from other fields that focused more purely on investigating subjective experience of stories (see Section 2.4). In this chapter we will, very briefly, discuss our synthesis of the background literature and derive from this our approach to investigating virtual storytelling. Overall, we were interested in looking at whether VR is capable of delivering stories effectively, particularly where indigenous African stories are concerned. As pointed out in Section 2.3, many virtual storytelling applications, particularly in the realm of cultural heritage, have already been created. We were interested, not in creating another example of virtual storytelling in practice, but rather in pausing for a moment to consider the nature of virtual storytelling, explore whether VR has the ability to tell stories properly and how its storytelling facilities might be maximised.

Before we could begin evaluating VR's capability as a storytelling medium, we had to revisit the first question posed in this chapter: what does it mean to tell a story well? Our conceptualisation of a so-called effective story experience is presented in Section 3.1. Our approach to evaluating VR as a storytelling medium is discussed next, in Section 3.2. The notion of using an introductory VE as priming in virtual storytelling is discussed in Section 3.3. Finally, the potential relationship between presence and story experience in virtual storytelling is discussed in Section 3.4.

### 3.1 An Effective Story Experience

Describing something as intangible as story experience is not an easy task given its subjective nature. Like presence, it is most likely a multi-dimensional phenomenon (IJsselsteijn *et al.*, 2000), influenced by a number of factors. Therefore, our conceptualisation of story experience considers a number of properties that might characterise an effective story experience. The purpose of this research was not to provide an exhaustive list, but to derive a number of benchmarks by which to evaluate VR's performance as a storytelling medium and the benefits of using an introductory VE. The properties we have considered in this research were based on the literature presented in Chapter 2 (see Sections 2.3 and 2.4), intuition and, in some cases, mere curiosity as to what role certain factors might play in story experience.

#### 3.1.1 Comprehension

We have mentioned that an important social function of stories is to pass culture on through successive generations (see Section 2.1) (Turner, 1993). Also, educational and psychological studies have long examined comprehension and how story content is retained (see Section 2.4). A number of VR studies which deal with task performance have also used recall of VE content as a measure of a VE's effectiveness (see Section 2.2.1). Thus, it seems that much of the goal of telling a story is to convey a narrative so that recipients understand the content. Like Bartlett

(1932), we were also interested in noting how the unusual nature of a traditional San story would be received by a modern audience (see Section 2.4). San stories are very different from the folktales and fairytales with which most western audiences are accustomed (Lewis-Williams, 2000). As with much African storytelling and some conventional fairytales, San stories are fantastic rather than realistic, often containing supernatural elements and featuring humans and animals as characters (Bleek, 1923; Russel, 1998; Lewis-Williams, 2000). Additionally, since the stories were translated from the San's native tongue into English the grammar may seem incorrect and there is also often repetition of phrases which adds a sometimes rhythmic quality (Bleek, 1923; Lewis-Williams, 2000).

### 3.1.2 Interest

In our research, we were focused not only on conveying a story, but doing so in the context of cultural heritage. In light of this, we felt that it was not only important that users comprehend the content, but that a subsequent interest in the cultural context of the story is generated. In this project, the cultural context is that of San folklore and culture. After all, the preservation of cultural heritage revolves around ensuring that such heritage is not forgotten as the examples given in Section 2.5 show. As such cultural heritage and museum exhibits should engage visitors' attention but also foster a genuine interest beyond the experience. Here, education is not necessarily the goal, but rather an enduring interest in and desire to find out more about the culture. The idea of fostering interest exists in the literature, for example (Murphy & Pitt, 2001), but not as a formal measure and, to the best of our knowledge, has not been operationalised in the context of VR and cultural heritage.

### 3.1.3 Enjoyment

There are many examples where an effort is made to present stories in an enjoyable way. In story books for children, story content is often accompanied by pictures; in oral storytelling additional dramatic elements are often incorporated such as dramatic pauses, exaggerated character voices and physical gestures (Hayes-Roth, 1999; Madej, 2003; Schell, 2005). This idea is illustrated in the cartoon strip in

Figure 2.1 (Cham, 2005). Furthermore, writers, playwrights and poets endeavor to tell stories in a skilful, engaging way. Filmmakers make use of special stylistic and narration techniques to present entertaining stories to their audiences (Bordwell & Thompson, 2001, p59-92, 156-350; Schell, 2005). In short, telling stories in an engaging way may be considered a craft where an important goal is often (though not necessarily always) the creation of an entertaining, enjoyable experience. Furthermore, enjoyment indicates a focus of attention (Csikszentmihalyi, 1991). Therefore we felt that enjoyment should also be considered as part of an effective story experience. A number of studies on storytelling, both in the realm of traditional media, such as oral and text stories, and VR, have measured enjoyment of stories (see Sections 2.3.3 and 2.4).

### 3.1.4 Boredom

Using the reasoning given in Section 3.1.3 above for considering enjoyment in story experience, we decided to also take boredom into account. It stands to reason that boredom might be considered as occurring when an experience is *not* enjoyable or engaging. As such we considered it in this research to verify the validity of the enjoyment construct (see Section 3.1.3 above) by means of discriminant validity (Anastasi, 1982). Discriminant validity checks the validity of the measures of two theoretically inversely associated factors, in this case enjoyment and boredom.

### 3.1.5 Confusion

Another potentially negative aspect of story experience is that of confusion. When one wishes to convey a story such that the content is understood, it makes sense the story should be coherent and make sense to the audience. Therefore, we consider confusion in the story as undesirable. As with comprehension, we were interested in noting confusion, given that San stories are likely to be perceived as unusual by modern, western audiences (see Section 3.1.1).



Figure 3.1: An illustration of the idea of experience in storytelling. © Jorge Cham 2005

## 3.2 Storytelling Medium

In order to assess VR's capabilities as a storytelling medium we set out to compare it to a common alternative medium, namely text. A major motivation for investigating VR's ability to deliver an effective story experience was the balance between effort and pay-off. Creating a virtual environment (VE) potentially requires a great deal of effort and a wide range of skills such as 3D modelling, animation, soundtrack recording and editing, VE scripting and programming. VE creation is arguably far more time and resource consuming than reproducing a story as text. So, we wished to examine whether virtual storytelling is a worthwhile endeavour in comparison to the more widespread medium of text. The possible benefit of allowing users to interact with narrative in virtual storytelling has already been discussed in Section 2.3.1. However, in this research we have focused on linear storytelling for two reasons, firstly, we wished to keep the VR *vs.* text comparison simple and, secondly, we did not want users to be able to manipulate the content of the San story. The San stories are a cultural heritage which were, largely, recorded as the San told them, thus it did seem appropriate to allow users to alter them since it would likely compromise the authenticity and style of the content.

We felt that San folklore was an especially apt application area for comparing text and VR. Today San folklore is mostly available as texts such as the original Bleek and Lloyd collection, selected publications from this collection and adapted anthologies (see Section 2.6.1). However, San storytelling, as with most African storytelling, was traditionally an oral practice (Russel, 1998; Parkington, 2002). In fact, texts such as the Bleek and Lloyd collection were transcribed almost exactly as the San told them (Lewis-Williams, 2000; Parkington, 2002). So while many San stories have been preserved as text, their original delivery would have been a live, oral retelling by a traditional storyteller. We anticipated that the use of VR would enable the recreation of a traditional oral storytelling experience. It was hoped that presenting a San story using a San storyteller avatar within a VE might be closer to a true representation of the stories and capture something of their original, performative spirit. If our comparison of text and VR showed that a more effective story experience is achieved using VR, then it would be proven as a valuable alternate storytelling medium and, in the case of indigenous folklores, an important tool for preserving oral storytelling heritage.

### 3.3 Using an Introductory Virtual Environment

Since the creation of VEs requires a great investment of effort and skill (as mentioned in Section 3.2 above), we wanted to explore how to optimise the effectiveness of virtual storytelling. If one is going to undertake the creation of a virtual storytelling application, it makes sense that one should make best use of VR's resources and impart the most effective story experience possible. We were particularly interested in boosting the quality of story experience given the unconventional style of San folklore (see Sections 2.6.1 and 3.1.1). In general, content is interpreted and understood subjectively, based on an individual's previous experiences and knowledge (Bruner, 1990). So, if the content of a VE is too unfamiliar or obscure, users may fail to extract enough meaning in order to have an effective story experience or achieve a sense of presence. Since we were attempting to convey a kind of story that was likely to be unfamiliar to most users, we felt it was important to seek ways in which to make the experience more accessible and interesting. We thought that it may be useful to introduce San storytelling (the unfamiliar content) in more familiar terms, following the principles of constructivist learning (Resnick, 1991).

In Section 2.2.2, we discussed the concept of priming and pre-immersion background stories as ways of placing users into an appropriate frame of mind before experiencing a VE. We therefore decided to investigate the use of a similar tool in our San storytelling VE. Instead of using text or video as priming material, we wished to explore the use of an actual VE as priming material. The VE would operate just like more conventional priming by providing information on the content of a forthcoming VE, in our case a San storytelling VE. We will refer to a VE used as priming as an introductory VE.

Furthermore, since we were aiming to convey culturally unfamiliar content, we also wished to see if using a culturally familiar and contemporary VE might improve the effectiveness of the San story experience. We theorised that using familiar material to prime users might provide a scaffolding of activated, pre-existing cognitive constructs upon which unfamiliar content might be understood. Furthermore, we were curious as to whether the use of an introductory VE with a contemporary, well-known cultural context might act as a bridge to the San VE, whose cultural context was more historical and possibly unknown. In order to test the effects of such an introductory VE we compared a scenario in which users experienced a San storytelling VE *vs.* a scenario in which the San storytelling VE is preceded by an introductory VE with a contemporary theme. We wished to test the effect of the introductory VE on both story experience and presence.

#### 3.3.1 A Hip-hop Theme

As for a contemporary, familiar cultural theme for the introductory VE; hip-hop was chosen since it is a contemporary subculture with a distinctive and easily recognisable style. However, this choice may be considered arbitrary and any other well-known, contemporary subculture might have been appropriate. We felt that hip-hop was appropriate here as it showed some similarity to San culture. Key aspects of San culture is their storytelling, rock art, music and dance traditions (Bassett, 2001; Parkington, 2002). These may be seen to correspond to the key aspects of hip-hop culture: rapping, graffiti, dj-ing and break dancing, respectively (Ards, 1999). Rapping refers to a musical style where lyrics are spoken or chanted over music, which often consists of samples from existing music recordings (Shusterman, 1992). Rap has been described as a hybrid cultural expression which incorporates a great number of expressive systems, including African storytelling (Mitchell, 1996). Additionally, some rap functions as "street-smart moral fables" (Shusterman, 1992). Thus, rap may be considered as means of telling stories orally. Graffiti, reminiscent of San rock art, involves the creation of spray painted art and tags in urban spaces (Ards, 1999). Dj-ing is the practice of making music and break dancing is a dance style distinctive to hip-hop (Ards, 1999).

### 3.4 Presence and Story Experience

Presence is widely considered a defining characteristic and goal of a VR experience. Our discussion of presence in Section 2.2.1 points out that it is an important consideration when creating a VE and ways of maximising presence have been widely studied. We felt, given how fundamental presence is to a VR experience, that it was important to look at the role it might play during a VR experience specifically created for storytelling. The uncertain relationship between presence and task performance was discussed in Section 2.2.1. While presence is an important goal in VR, its usefulness in terms of a VE's goals and task performance is uncertain. We wished to explore presence in relation to story experience, in our view the chief goal of virtual storytelling.

We were also interested in the effect an introductory VE (see Section 3.3) might have on presence. Of course, there was the possibility, where the introductory VE was used, that moving between two VE's with different environmental and time settings might compromise the reality of the overall experience and thus decrease presence while still improving the story experience. In general, we wanted investigate whether the goals of achieving presence and conveying a story in a VE could be mutual or if creating a convincing VE might compromise the intended story experience.

## Chapter 4

### Experimental Design: Two Studies

In Chapter 3 we discussed the theoretical approach and aims of this research, namely investigating virtual reality (VR) as a storytelling medium, the use of an introductory virtual environment (VE) and the relationship between presence and story experience. In this chapter we formalise our experimental design. The ideas discussed in Chapter 3 are used to formulate a number of research questions (Section 4.1) and define our experimental variables (Section 4.2). Two studies, called Study 1 and Study 2, were designed to answer our research questions (4.3) and a number of hypotheses regarding the outcomes of these experiments were formulated (Section 4.4). Full details of these two studies are also described in this chapter, namely the questionnaires (Section 4.5) and equipment (Section 4.6) used and the experimental samples and procedures used in each study (Sections 4.7 and 4.8).

#### 4.1 Research Questions

A number of research questions were formulated according to the ideas presented in Chapter 3. These correspond to the evaluation of VR as a storytelling medium by comparing it to text, testing the effect of using a culturally familiar introductory VE to preface a VE containing historical, traditional storytelling and testing for a relationship between presence and story experience. Note also that all of these research questions are defined in terms of our conceptualisation of an effective story experience:

1. Can a virtual storytelling environment produce an effective story experience? In terms of our definition of an effective story experience (see Section 3.1, Chapter 3), this question comprises a number of parts:
  - a. Can story comprehension be achieved using virtual storytelling?
  - b. Can interest in a story's cultural context be generated using virtual storytelling?
  - c. Can enjoyment of a story be achieved using virtual storytelling?
  - d. Can boredom in a story be minimised by using virtual storytelling?
  - e. Can confusion in a story be minimised by using virtual storytelling?
  
2. Does a contemporary, culturally familiar introductory VE used to preface a VE presenting traditional storytelling improve the effectiveness of the story experience and/or presence? In terms of story experience, this question comprises a number of parts:
  - a. Does the introductory VE improve story comprehension?

- b. Does the introductory VE lead to a greater interest in the story's cultural context being generated?
  - c. Does the introductory VE improve enjoyment of the story?
  - d. Does the introductory VE decrease boredom in the story?
  - e. Does the introductory VE decrease confusion of the story?
3. Is presence related to an effective virtual story experience?

## 4.2 Experimental Variables

Three independent variables and four dependant variables were defined for our studies. These variables are described below along with the codes that were used to identify them during statistical analysis.

### 4.2.1 Independent variables:

The following independent variables were manipulated in our research in order to observe the effects on the dependent variables (Howell, 1987).

- *Storytelling Medium*: This variable has two levels and is manipulated by using either virtual reality (VR) or text (T) to convey a story.
- *Introductory VE*: This variable has two levels and is manipulated by either including the introductory VE in a storytelling VE (I) or not (NI).

The following independent variables were not manipulated. They were recorded in order to augment the results obtained in the dependant variables and allow more control.

- *Hip-hop Interest* (HI): a measure of participants' level of interest in hip-hop music and culture.
- *Interest Baseline*: consists of two parts:
  - *Tendency to Interest* (tIB): a measure of participants' tendency to show interest in folklore and South African cultures.
  - *San Awareness* (sIB): a measure of participants' existing awareness of the San and their folklore before their storytelling experience in this study.

HI was included since the choice of a hip-hop theme in our introductory VE could well have been substituted with some other contemporary, well-known culture. Therefore, we wished to control for any effects arising from using hip-hop specifically. For instance, if participants did not like hip-hop, the introductory VE might actually detract from the San VE.

Interest baseline information was collected so that we could more accurately interpret results for dependant variable Interest (INT). By taking tIB into account we were able to conduct a more complete analysis of how much interest arose as a result of the San story experience, as opposed to a participants' inherent tendency to show interest in folklore and South African cultures. Similarly, we hoped to control for any effects that participants' existing knowledge of the San (sIB) might have on the levels of interest prompted by the story experience.

### 4.2.2 Dependant variables:

For our first study we looked at the following dependant variables:

- *Comprehension* (C): a measure of understanding of the story.
- *Interest* (INT): the level of interest in and desire to find out more about San culture and folklore.
- *Enjoyment* (ENJ): the extent to which the story experience was enjoyable.
- *Boredom* (BOR): the level of boredom during the story experience.
- *Confusion* (CON): the extent to which the story was confusing.
- *Presence* (P): a measure of the presence experienced during the virtual story experience.

In the second study we added the following variables to our investigation; the reasons for adding these will be described in Chapter 8, Sections 8.3.1 and 8.3.3 respectively:

- *Attention* (ATT): the extent to which the story held participants' attention.
- *Strangeness* (STR): a measure of how strange the story seemed to participants.

## 4.3 Design

Our research questions required that VR be evaluated as a storytelling medium, the effect of an introductory VE in virtual storytelling be gauged and the relationship between presence and story experience be observed. This called for two main comparisons: text *vs.* VR and not using an introductory VE *vs.* using an introductory VE. Therefore, the following three storytelling scenarios, all conveying the same traditional San story, were created:

1. *Story Text* (T): The story printed on a page.
2. *Virtual Storytelling with No Introductory VE* (VR+NI): A visual and audio desktop VE in which a San storyteller avatar tells the story to a San gathering and the user around a fire in a cave. This VE has no introductory VE.
3. *Virtual Storytelling with Introductory VE* (VR+I): Same as the VR+NI scenario described above, but is preceded by a hip-hop themed introductory VE which conveys information about the San and their storytelling tradition.

The design and implementation of the virtual storytelling scenarios is described in Chapter 5. These scenarios represent an operationalisation of the independent variables, *Storytelling Medium* (VR/T) and *Introductory VE* (NI/I), outlined in Section 4.2.1 above. In order to judge the effect of storytelling medium we intended to compare the T (text story) and VR+NI (virtual storytelling) scenarios. To judge the effect of the introductory VE we intended to compare the VR+NI (no introductory VE included) and VR+I (introductory VE included) scenarios. This design is presented in Table 4.1.

Two studies were conducted to test our hypotheses (these are presented in Section 4.4 below) via these comparisons. Both studies consisted of one experiment each; the first with a sample of high-school learners and the second with a sample of undergraduate university students. A between-subjects design was used in both studies, thus, each participant experienced only one of the three storytelling scenarios outlined above. Allowing participants to experience more than one of the storytelling environments would, most likely, have introduced extraneous learning effects on comprehension (C). Participants in both studies were divided randomly and as evenly as possible into three experimental conditions, one for each of the storytelling scenarios: T, VR+NI and VR+I.

Storytelling Medium	Introductory VE
Text (T)	
Virtual Reality (VR)	No Introductory VE (NI)
	Introductory VE (I)

Table 4.1: Factorial design for studying the difference between the three storytelling scenarios: T, VR+NI and VR+I. The effect of storytelling medium is judged by comparing the Text Storytelling (T) and Virtual Storytelling with no Introductory VE (VR+NI) scenarios. The effect of using an introductory VE is judged by comparing the Virtual Storytelling with No Introductory VE (VR+NI) and Virtual Storytelling with Introductory VE (VR+I) scenarios.

#### 4.4 Hypotheses

It was expected that virtual storytelling would offer an improvement over the more ubiquitous storytelling medium of text. This prediction was based on the fact that desktop VE would offer more sensory, namely audio and visual, stimulation over words on a page. Additionally, VR allowed for the simulation of San oral storytelling using a storyteller avatar and culturally appropriate setting. We felt that this way of telling a San story would be more true to the original oral storytelling tradition and might thus prove more compelling to users, resulting in a more effective story experience (see Section 3.2, Chapter 3).

The use of a contemporary, culturally familiar introductory VE to preface a VE presenting traditional San storytelling was expected to improve participants' overall experience of the San story. It was thought that the use of such an introductory VE might act as a bridge to the more culturally unfamiliar content of the San storytelling VE. We hoped that this introductory VE would pique participant's interest at the outset of their experience, allowing them to become more engaged in the virtual San storytelling and leading to improved story and presence experiences (see Section 3.3, Chapter 3).

Further, we expected that presence would be positively related to an effective story experience. In other words, if people were highly present in the storytelling VE then they would also have an effective story experience and vice versa. We theorized that if an audience found the VE convincing and realistic enough to feel present, they were likely to also become engaged in the storyteller and the story (see Section 3.4, Chapter 3).

Stated formally, our hypotheses are as follows:

1. Virtual storytelling will result in a more effective story experience than reading a story text. This implies:
  - a. Virtual storytelling will result in greater story comprehension (C), interest (INT) and enjoyment (ENJ) than reading a story text.
  - b. Virtual storytelling will result in less boredom (BOR) and confusion (CON) than reading a story text.

2. A contemporary, culturally familiar introductory VE used to preface a VE presenting traditional storytelling will improve story experience. As above this implies:
  - a. The introductory VE will result in greater story comprehension (C), interest (INT) and enjoyment (ENJ).
  - b. The introductory VE will result in less boredom (BOR) and confusion (CON).
3. Presence (P) will be related to an effective story experience. In other words:
  - a. Presence (P) will relate positively to the comprehension (C), interest (INT) and enjoyment (ENJ) variables.
  - b. Presence (P) will relate negatively to boredom (BOR) and confusion (CON).

In Study 2, two new variables were added: attention (ATT) and strangeness (STR). We expected that virtual storytelling would result in less attention being paid to the story since a VE may contain many objects which can distract one's attention from the narrative being presented. In representing oral San storytelling in a VE, a cultural context for the San story was provided in the form of a culturally appropriate storytelling setting and characters. We hypothesized therefore that virtual storytelling would result in people finding the story less strange in comparison to those reading the story text. Thus the following two hypotheses were formulated for attention and strangeness:

1. Reading a story text will result in greater attention (ATT) being paid to the story than experiencing the story in a VE.
2. Virtual storytelling will result in less perceived strangeness (STR) of the San story than reading the story text.

## 4.5 Questionnaires

Questionnaires were required to measure the following dependent and control variables:

- Hip-hop Interest (HI)
- Comprehension (C)
- Tendency to Interest (tIB)
- San Awareness (sIB)
- Interest (INT)
- Enjoyment (ENJ)
- Boredom (BOR)
- Confusion (CON)
- Presence (P)

Additionally, in Study 2 we measured the following variables:

- Attention (ATT)
- Strangeness (STR)

A particular challenge in this study was obtaining reliable and valid questionnaires for the dependent and control variables. This was since all the variables we wished to examine, with the exception of presence, were relatively unique to our study. As such, there were no existing standard questionnaires for these variables. For example, there were no questionnaires for measuring interest in hip-hop culture, comprehension of a San story or interest in San culture.

In this section we will elaborate on each questionnaire, paying particular attention to the content of the questionnaires which were specifically created for this research. Recall that two studies were conducted for this research (see Section 4.3), using data from the first study we conducted psychometric analyses of the questionnaires we had created in order to test their validity and reliability. Using these results, amendments were made to the questionnaires for the second study in order to improve them. The psychometric analyses for the questionnaires used in both studies along with the rationales for the questionnaire amendments are presented in Chapter 6. The complete questionnaire sets used for the first and second studies, with annotations are presented in Appendix B and Appendix C respectively.

#### 4.5.1 Hip-hop Interest (HI)

Two measures of HI were used. First, a multiple choice item asking participants to select their favorite music genre from the following options: classical, hip-hop, alternative, rhythm and blues (RnB), rock and jazz. The same multiple choice item was used in both studies.

Second, a number of items on a seven-point Likert-type response scale (with 'fully agree' and 'fully disagree' as anchors). In the first study, the Likert-type scale consisted of two items which measured general interest in music, two items which measured enjoyment of hip-hop and rap music and one item which measured awareness of hip-hop popular contemporary subculture. In the second study, the items relating to general interest in music were removed since they decreased the reliability of the Likert-type scale (as measured by Cronbach's alpha coefficient - see Section 6.3.1, Chapter 6). Three new items were added: two measured enjoyment of hip-hop music and fashion and one measured participants' opinion on classical music's current relevance. This last item was included out of a curiosity as to how hip-hop interest might relate to participants' opinion of classical music. See Section B.2, Appendix B and C.2, Appendix C for the HI questionnaires from both studies.

#### 4.5.2 Comprehension

Recall that a major goal of this study was to investigate the difference between text and VR as storytelling media. Therefore we were not only looking at a difference of medium but also a difference in sensory modality; as text the story content was conveyed visually via reading and in a VE the story content was taken in aurally, by listening to the storyteller avatar. For this reason, we required a comprehension measure that was appropriate for measuring both reading and listening comprehension. Although there were no existing questionnaires that would test comprehension for our particular San story, educational research and theory has a long history of reading and listening comprehension measures from which we were able to draw (Sarroub & Pearson, 1998). A number of techniques for creating comprehension tests were examined and four were ultimately employed:

##### *Cloze Test*

In a cloze test, sentences from the story text are presented with every fifth word deleted and participants are required to fill in the missing words (Sarroub & Pearson, 1998). We modified this technique slightly and made use of cloze items which had important noun words eliminated.

We also allowed a certain amount of leniency by accepting synonyms for the correct words as correct answers as suggested by Sarroub & Pearson (1998).

There is a fair amount of contention regarding the cloze test's aptness for measuring comprehension (Sarroub & Pearson, 1998). We therefore employed it minimally and used only the following cloze sentence in our first study:

The story was about how the Mantis made the  
\_\_\_\_\_ and the \_\_\_\_\_.

This question derives from the title of the San story: 'How the Mantis Made the Eland and the Moon'. It was our intention that the answers given in this sentence would indicate whether participants had grasped, at a very basic level, what the San story had been about. Since this sentence required two answers to be filled in this cloze test consisted of two items. However, these items gave a mixed outcome in our psychometric analyses (see Section 6.3.2, Chapter 6). We attempted to improve its use in the second study by extending the item above and adding three more cloze sentence items (see Section C.3, Appendix C).

#### *Sequence Test*

This test measures how well participants understood the narrative flow of events in a story. Each question presents a list of events from the story and participants are required to answer an accompanying question by choosing one of the events in the list (Sarroub & Pearson, 1998). Five sequence questions were created for our first study (see Section B.3, Appendix B). Here is an example of one:

What happened first in the story?

- a. The mantis went to find some honey.
- b. The mantis rubbed sweet honey into the Eland's ribs.
- c. The mantis picked up a piece of Kwammang-a's shoe and soaked it in the water by the reeds.

For the second study we added two more sequence items (see Section 6.4.2, Chapter 6). However, adding these items required that some of the existing five items change slightly to ensure that all the items remained independent and that the options given in each item did not inadvertently imply the answer to any other item. The sequence test items used in both studies may be compared by referring to Appendix B and Appendix C respectively.

#### *Sentence Verification Technique (SVT)*

The SVT is a means of constructing a comprehension test using sentences from the story text. It works by deriving four sentences from any sentence in the story text:

1. *Original*: The sentence as it appeared in the story.
2. *Paraphrase*: Constructed by changing as many words as possible in the original sentence without altering the meaning of the sentence.
3. *Meaning Change*: Constructed by changing one or two words in the sentence such that the meaning is changed.
4. *Distractor*: Appears similar to the original sentence and fits in with the story content, but is unrelated in meaning to any of the story events.

Participants are presented with the sentences and required to state for each whether they were true or false according to the story. The original and paraphrase sentences are always true, whereas the meaning change and distractor sentences are always false (Royer, 2001). The SVT is one of the few comprehension testing methods considered applicable for measuring both reading and listening comprehension (Carlisle & Felbinger, 1991). Royer (2001) points to a number of reasons for the SVT's applicability to reading and listening comprehension, such as:

- SVT tests measure story comprehension rather than sentence comprehension
- SVT performance varies in accordance with working memory capacity
- SVT listening and reading comprehension are related in a manner predicted by comprehension theory

Furthermore, numerous studies have proven the validity and reliability of the SVT (Royer, 2001).

In the first study, three sets of the above sentence types were created using the SVT. For the second study, an extra set of sentences was added and minor changes were made to existing sentences in an attempt to improve this scale's reliability (see Section 6.5.2, Chapter 6). In both studies the sentences were presented in their sets of four on the questionnaire but the ordering of sentence types was randomised to ensure that participants would be unable to detect a consistent answering pattern. For instance if the sentences were always placed in the order specified in the explanation above, participants might notice that the order of answers are always true, true, false, false. They might then use this perceived pattern in answering rather than their own understanding of the story. The SVT items used in both studies are presented in Sections B.3 and C.3 in Appendix B and Appendix C, respectively.

#### *Specific Content Questions*

Ricci and Beal (2002) made use of specific questions to test the extent to which children were able to retain explicit story information and make inferences regarding implied story information. We used specific questions in a similar way:

1. *Inference Questions:* These questions required participants to use story information to make inferences about the story
2. *Fact Questions:* These questions tested participants' recall of information explicitly presented in the story.

The inference questions simply required a 'Yes' or 'No' answer, while the fact questions required a written content answer. A score of two was given if the answer to a fact questions was perfectly correct, one if the answer was partially correct and zero if the answer was incorrect. Three inference and three fact questions were included in the first study's questionnaire. Specific content questions were only used in the first study due to the lack of variance participant responses to the inference questions and the lack of reliability in the fact questions (see Section 6.5.2, Chapter 6).

### 4.5.3 Interest

A questionnaire was devised to collect data for two control variables, *tIB* and *sIB* (see below), as well as dependant variable, *INT*. Thus, this questionnaire consisted of the following subscales:

1. *Interest Baseline*: consisted of two parts:
  - a. *tIB*: a measure of tendency to be interested in folklore and South African cultures.
  - b. *sIB*: a measure of existing awareness of the San and their folklore.
2. *Interest (INT)*: a measure of the level of interest in the San and desire to find out more about the San.

The questionnaire consisted of two *tIB* items, one gauged a tendency to enjoy myths and fairytales and the other, a tendency to show interest in South African cultures. *sIB* was also measured using two items which measured the extent to which participants had heard of the San and San folklore respectively before the study. The *INT* variable was measured using eight items; these inquired into how interesting the participants thought the San were and whether they might take part in activities related to finding out more about the San, such as attending a museum exhibit. All items were presented as statements and participants were asked to rate how much the statement applied to them on a seven-point Likert-type scale. Reverse items were also used so that there was no answer bias in participant responses (Anastasi, 1982). The same interest questionnaire was used for both studies and is shown in Sections B.4 and C.4, Appendix B and Appendix C.

### 4.5.4 Enjoyment, Boredom, Confusion, Attention and Strangeness

The questionnaire items measuring enjoyment, boredom, confusion, attention and strangeness were presented as statements which participants were required to rate on a seven-point Likert-type scale. In order to keep the entire questionnaire set at a reasonable length, relatively few items were used for these variables.

In the first study, two items required participants to rate their level of enjoyment of the San story and one item each on how boring and confusing the San story was (see Section B.4, Appendix B). The items used for measuring enjoyment were based upon an enjoyment measure employed by Brown *et al.* (2003) in their study of virtual San storytelling. In the second study, the same items were used to measure enjoyment, boredom and confusion. The results of our first study prompted the addition of an item for measuring confusion along with two more dependent variables for investigation in our second study: attention and strangeness (see Sections 8.3.1 and 8.3.3, Chapter 8). One item was used to measure attention, and strangeness was measured using four items.

### 4.5.5 Presence

An existing questionnaire, the IGroup Presence Questionnaire (IPQ), was chosen to measure presence (P) (Igroup, 2000). While there is no standard questionnaire for measuring presence, a number of questionnaires exist in the field of VR research (Witmer & Singer, 1998; Schubert *et al.*, 1999; Schuemie *et al.*, 2001). However, most of these questionnaires have not been proven statistically valid and reliable. Two questionnaires have been shown to be valid and reliable: the ITC Sense of Presence Inventory (ITC-SOPI) and the IPQ (Schuemie *et al.*, 2001). The ITC-SOPI may be applied to a wide range of media while the IPQ applies specifically to presence in a VE (Igroup, 2000). The IPQ focuses on measuring three factors: the sense of being physically present in a VE (spatial presence), attention given to the VE and realism (Igroup, 2000). We chose to use the IPQ since it has been proved valid and reliable, was applicable to desktop VR and we had used it successfully in past research (Brown *et al.*, 2003).

## 4.6 Equipment

Four desktop computers were used to run the virtual storytelling scenarios for the experiments in both our studies; two computers were used to run the VR+NI scenario (virtual San storytelling with no introductory VE) and two for the VR+I scenario (virtual San storytelling with introductory VE). Their hardware details are given in Table 4.2 below.

	Processor	Graphics Card	Memory
<b>VR+NI, Machine 1:</b>	Intel Pentium 4, 2.4GHz	GeForce FX 5200 with 64 RAM	512 MB RAM
<b>VR+NI, Machine 2:</b>	Intel Pentium 4, 3.0GHz	RADEON 9500 PRO with 128 MB	512 MB RAM
<b>VR+I, Machine 1:</b>	Intel Pentium 4, 2.8GHz	GeForce FX 5700 with 218 RAM	512 MB RAM
<b>VR+I, Machine 2:</b>	Intel Pentium 4, 2.8GHz	GeForce FX 5700 with 218 RAM	512 MB RAM

Table 4.2: Hardware details for the four desktop computers used to run the virtual storytelling scenarios in both studies. Two computers were used to run the VR+NI scenario (virtual San storytelling with no introductory VE) and two for the VR+I scenario (virtual San storytelling with introductory VE).

From Table 4.2 above, we can see that there were some differences in the two machines used for the VR+NI scenarios. Differences in hardware pose a potential extraneous variable since certain machines might have run a VE slower or faster than another. Ideally, identical machines would be used, however due to limited availability of equipment we were constrained to making use of different computers. We were fortunate to have seven computers from which to select the four required for our experiments. In order to minimise the possibility of differing hardware affecting our experimental results, we selected machines whose hardware was as similar to each other possible, particularly with regards to their processing power and graphics cards. Furthermore, we ensured that the machines used ran the VE's at approximately the same average frame rate. The frame rate recorded during the VE run-time varied between 25 and 30 fps for all four computers. Thus there was no significant difference in the performance at which the computers ran the VR storytelling scenarios. The VE's were all displayed on identical 17" monitors at the same resolution; audio was output through stereo headphones. Participants each used a keyboard and optical mouse to navigate the VE's. All peripherals used, namely keyboards mouse and headphones, were also identical.

## 4.7 Study 1

### 4.7.1 Sample

Many studies involving human participants often rely on university students to make up their samples. However, university students form a particular group within the greater population so results from such studies may be limited in generalisability (Smart, 1966). Furthermore, we wished to conduct one of our studies using a sample for which we felt storytelling and cultural education was important: high-school learners. Hence, a sample of high-school children aged 15 to 17, from The Settlers High School, Bellville, partook in Study 1's experiment. The study design was reviewed and approved by the University of Cape Town's Science Faculty Ethics Approval Board.

Twelve learners experienced the virtual San storytelling with no introductory VE (VR+NI) scenario and 12 experienced the virtual San storytelling with introductory (VR+I) scenario. Two participants were unable to complete their questionnaires due to class time running out; one from the VR+NI group and one from the VR+I group. A total of 64 children experienced the text storytelling (T) scenario. Twenty-two questionnaire responses from the T group were selected at random to match the number of VR subjects for VR *vs.* T comparative analysis. This made for a total sample of 44.

#### 4.7.2 Procedure

Study 1's experiment was conducted with three different high-school classes, in the same classroom (shown in Figure 4.1), during one school day. Each consisted of thirty children on average. It was our intention that some of the children in each class would read the San story (T scenario) while others would be taken to a computer room to experience one of VR storytelling scenarios: VR+NI or VR+I. The experiment was conducted as follows for each of the three classes:

##### *Introduction to the Study*

At the start of each class an experimenter was introduced to the class by their teacher. The experimenter explained that the class would be taking part in a study dealing with San stories and that some learners would be staying in the classroom to do something while others would be going elsewhere. The learners were given no further information regarding what exactly they would be doing so as to decrease the chance of them forming expectations about their own or each other's forthcoming experiences.

##### *Experimental Group Assignment*

There were three experimental conditions in this study: T, VR+NI and VR+I. Four computers were used to run the VR scenarios, two for VR+NI and VR+I each (see Section 4.6). These were set up in one experimental room, which meant that four participants were able to experience the VR scenarios simultaneously, each at their own computer. During each forty-five minute class, we estimated that we could safely accommodate two such groups of four learners. Thus, after the experimenter's introduction to the study, 8 learners from the class were randomly chosen to form the VR+NI and VR+I groups.

However, each class consisted of thirty learners on average. Thus, to ensure even sample sizes in each condition, we did not require all of the remaining students in the class to experience the T scenario. However, we wished to keep all the students occupied during the class time to eliminate the chance of unoccupied students interfering with those taking part in the experiment. Therefore, we arranged for the full remainder class to read the San story. As mentioned in Section 4.7.1 above, a subset of the questionnaires completed by those who read the text was randomly selected to form the T group considered in our analyses.

##### *Story Experience*

Participants in the T condition were informed that they would be reading a San story. Each learner was given a text copy of the San story and asked to read it through once and then turn the text face down on their desks. When everyone had finished reading the story, the texts were collected by the experimenter.

Those in the VR conditions were taken to the experimental computer room in groups of four. The students were asked to take a seat at any of the four computers, this constituted random assignment into the VR+NI or VR+I conditions. Once seated, they were told that they would be experiencing a San story in a VE. The navigational principles and controls (keyboard and mouse) were explained and they were provided with a training VE on their computers. This training VE consisted of a house with a number of doorways and levels to explore; navigational controls were reiterated as onscreen text during the running of this VE. Screenshots of the training VE are shown in Appendix H. The learners were allowed to practice navigating the training VE until they felt comfortable with the controls.

After the training VE, participants were informed that they would be experiencing the main VE and that they were free to explore this VE as they wished. They were also informed that they could walk up to and look at anything that they found interesting in the VE and if they saw people in the VE they could walk up to them to see what they might have to say. The learners were then asked to put on the headphones provided at each computer. The experimental room was darkened by closing the curtains and switching off the lights and the students experienced the storytelling VE's under the supervision of an experimenter. When the virtual San storytelling was complete, the learners were escorted back to their classroom by an experimenter.

### *Questionnaires*

After their story experiences, all participants were informed that they would be completing a set of questionnaires regarding their experience of the San story. The learners were informed that all questionnaires would be anonymous and that they would in no way be used as a reflection of their abilities by their school or otherwise. They were asked to read the questionnaire instructions and informed that they could ask the experimenter for further explanation required. The learners were also instructed to fill out their questionnaires independently and not to talk to each other during this time. This was to prevent them from influencing each other's answers.

Additionally, participants were not informed that a questionnaire would follow their story experience; this was to ensure that any story comprehension attained would be incidental, rather than explicit (see Section 2.4, Chapter 2). Informing participants in our experiments that a questionnaire would follow their story experience might have implied a test on story comprehension. This might have resulted in forced attention to the story whereas we wanted to measure the story comprehension attained passively, since we felt that this was a more appropriate reflection of real world story experiences.

The questionnaires were completed in the following order, with the exception that those in the T condition were not given the IGroup Presence Questionnaire:

- Hip-hop Interest Questionnaire
- Comprehension Questionnaire
- Interest, Enjoyment, Boredom and Confusion Questionnaire
- IGroup Presence Questionnaire (IPQ)

See Appendix B for the entire Study 1 questionnaire set. Both groups started with the hip-hop interest questionnaire. In addition to measuring hip-hop interest (HI) we used this questionnaire as a distraction task to eliminate the chance that participants might recall the story from short-term memory in the comprehension questionnaire. Ricci & Beal (2002) used a similar distraction task to ensure that responses to their comprehension tests are not rehearsed from short-term memory, which would soon be forgotten.

*Debriefing*

Finally, participants were thanked for their cooperation and were requested not to discuss the experiment with others in the school until the end of the school day so as not to 'spoil' the experience for later participating classes. Since we were conducting our experiment with more than one class during the day, we wished to control for the possibility that children in the earlier classes might tell those in the later classes about the experiment and bias their response to the experiment. Participants were also informed that if they felt uncomfortable about anything they had experienced during the experiment or had any questions they could pass these on to the experimenters through their class teacher.



Figure 4.1: The classroom in which each of the three classes participating in Study 1 met at the start of the experiment.



Figure 4.2: The experimental computer room set up in the high-school at which Study 1 was conducted. In this room, four desktop computers were used to run the virtual storytelling scenarios; two for the virtual San storytelling with no introductory VE scenario (VR+NI) and two for the virtual San storytelling with introductory VE (VR+I). Four participants experienced the virtual storytelling scenarios simultaneously. We ensured that participants could not see any other computer monitors in the room by using the computers as partitions between adjacent monitors. While running the virtual scenarios, the room was darkened by drawing the curtains and turning off the lights.

## 4.8 Study 2

### 4.8.1 Sample

Study 2's experiment was conducted with a sample of 98 Computer Science and Psychology undergraduate university students from the University of Cape Town. Thirty students experienced the text storytelling (T) scenario, 33 experienced the virtual San storytelling with no introductory VE (VR+NI) scenario and 35 experienced the virtual San storytelling with introductory VE (VR+I) scenario. Three participants' questionnaires from the VR+NI group and 8 from the VR+I were excluded from analysis due to technical failure of the VE and incomplete questionnaires. This left us with a sample of 30 in the T scenario, 30 in the VR+NI scenario and 28 in the VR+I scenario.

### 4.8.2 Procedure

As in Study 1, an experimental room was set up with four computers to run the VR storytelling scenarios; two each for the VR+NI and VR+I conditions. Study 2 took place over a period of four days; twenty sessions in the experimental room were designated for the VR conditions. Two sessions, accommodating 15 to 20 participants were designated for the T condition.

#### *Introduction to Study*

Participants were first introduced to the Study 2 during participant recruitment. An experimenter visited a number of Computer Science and Psychology undergraduate lectures. At the start of each lecture, the experimenter informed the students that a study on San storytelling was taking place and that participants were needed. They were also informed that participants would be paid R20. The experimenter returned at the end of the lecture so that anyone who wished to partake in the study could sign up.

#### *Experimental Group Assignment*

There were three experimental conditions in this study: T, VR+NI and VR+I. As mentioned earlier, sessions for all the conditions were pre-determined. Students signed up for times which suited them best, thus falling randomly into either a VR or T session.

#### *Story Experience*

The story experience for all the conditions were handled as in Study 1 (see Section 4.7.2 above). Unfortunately, the VR storytelling scenarios failed to work as expected in nine instances due to software failure, in these cases the VE was restarted. Some participants also asked the experimenter present for navigational assistance during their VE experience. In both these cases, participant's questionnaires were excluded from consideration in our data analysis. This was since both these situations involved a break from the VE and contact with the experimenter; we thought this might introduce extraneous effects. Once the virtual San storytelling was complete, VR participants were escorted to an empty room with desks in order to complete their questionnaires.

### *Questionnaires*

After their story experiences, participants completed the following questionnaires:

- Hip-hop Interest
- Comprehension
- Interest, Enjoyment, Boredom, Confusion, Attention and Strangeness
- IGroup Presence Questionnaire (IPQ)

These questionnaires were a refined version of those used in Study 1. See Appendix C for the entire Study 2 questionnaire set. The instructions given to the students were the same as those given to Study 1's participants (see Section 4.7.2) and participants in the T condition did not complete the IPQ.

### *Debriefing*

Once the completed questionnaires had been collected from participants, they were thanked for their time and paid R20 for partaking in the study.



Figure 4.3: The experimental computer room set up in the university at which Study 2 was conducted. In this room, four desktop computers were used to run the virtual storytelling scenarios; two for the virtual San storytelling with no introductory VE scenario (VR+NI) and two for the virtual San storytelling with introductory VE (VR+I). Four participants experienced one of the virtual storytelling scenarios simultaneously. We ensured that participants could not see any of the other computer monitors in the room by using partitions in our set-up. During the running of the virtual scenarios, the room was darkened by closing the blinds and turning off the lights.

## Chapter 5

### Creating the San Storytelling Scenarios

Before the two studies described in Chapter 4 could be conducted, we required the three following San storytelling scenarios:

1. *Text Storytelling (T)*: The San story printed on a page.
2. *Virtual Storytelling with No Introductory VE (VR+NI)*: A visual and audio desktop VE in which a San storyteller tells the San story to a gathering and the user around a fire. This VE has no introductory VE.
3. *Virtual Storytelling with Introductory VE (VR+I)*: Same as the VR+NI scenario described above, but is preceded by a hip-hop themed introductory VE.

In this chapter we will describe the San story used in these scenarios and the virtual storytelling scenarios, as experienced by a user, are described. Next, we delve deeper and detail the design and implementation of the two virtual storytelling scenarios, VR+NI and VR+I.

#### 5.1 The San Story

The same San story was used in all three of the storytelling scenarios described above. Since Kaggen the mantis is considered such an important figure in San folklore (see Section 2.6.1, Chapter 2), we decided to seek out a story about this character and his magical powers. The story chosen was taken from one of the earliest published collections taken from the Bleek & Lloyd archives: *The mantis and his friends: Bushman folklore collected by the late Dr. W.H.I. Bleek and Dr. Lucy C. Lloyd* (Bleek, 1923). This collection contains two versions of a story about how Kaggen created the eland and the moon. The eland, a large species of antelope, is the most revered of hunted animals to the San, since it is considered to be Kaggen's favourite (Bleek, 1923).

The two versions of the story were very similar but each also contained unique elements. The two versions were, therefore, combined and slightly adapted to form the story text used in the text and virtual storytelling scenarios. Prof. J. Parkington, an archaeologist at the University of Cape Town and expert on the San was consulted to ensure that this story adaptation did not compromise the content or style of the original stories. The full story text is presented in Appendix A.

## 5.2 Virtual San Storytelling Description

### 5.2.1 San Storytelling VE

In the San storytelling VE, users are placed in a mountainous, outdoor environment at dusk. In the distance a gathering of San people can be seen sitting around an animated fire in a large rock shelter or cave with San rock paintings on the cave walls. The gathering consists of an adult man, two young children and an elderly woman, who also acts as the storyteller. The gathering sits in a circle around the fire; the storyteller and man sit on tall rocks opposite each other, while the two children sit cross-legged on the floor. The VE, as it is first viewed by the user, is shown in Figure 5.1 below.



Figure 5.1: The cave in the San storytelling VE as it is first viewed by the user. There are rock paintings on the cave walls along with a hanging bag and quiver. The San gathering, seen in the distance, consists of an elderly woman (the storyteller, sitting on the left), a San man (sitting on the right) and two San children (sitting on the floor), is visible.

A simple African music track plays softly in the background to set the scene, and ambient outdoor sounds, such as wind blowing and crickets chirping, create the outdoor soundscape. As the user walks toward the gathering, the San man stands up and looks in the general direction of the user. When the user has almost reached the gathering, the background music fades out and the San man speaks to the user:

“Come closer, friend.”

However, in the event that the user takes longer than 10 seconds to walk toward the gathering after the San man has already stood up, he also offers this invitation to encourage the user to move toward the gathering (see Figure 5.2).

After this invitation, the San man sits down and the elderly woman, who is also the storyteller, speaks:

“I was just about to tell a story, the one about how the mantis made the eland, please sit down with us and listen.”

The storyteller then begins to tell the story; she is animated throughout the story narration, moving her head and body and using hand gestures extensively. The storyteller during narration is shown in Figure 5.3. The San gathering react during the storytelling by exclaiming, gesturing and moving their heads (see Figure 5.4). The rock paintings on the cave wall relate to the story that is being told. For instance, a large painting of an eland, visible in Figure 5.4, is one of the most prominent rock paintings.

Brown *et al.* (2003) found that including story related visuals, such as rock art, in a storytelling VE increased user's involvement in the story. The story narration lasts approximately 10 minutes, during which the user is free to explore the cave area. The user may examine the fire, rock paintings and other artefacts which have been placed in the cave, such as a grinding stone and a bag and quiver hung from wooden pegs in cracks on the cave wall. When the storytelling has finished all the lights in the VE gradually fade to black, indicating the end of the virtual story experience.



Figure 5.2: The San gathering in the cave, sitting around a fire. Here the San man is inviting the user to join the San gathering. This happens as the user walks up to the gathering or if the user takes more than 10 seconds to walk toward to the gathering.



Figure 5.3: The San storyteller model, shown here, is animated throughout the story narration moving her head and body and using hand gestures extensively. The animations of the storyteller model were rotoscoped from video footage of an actress narrating the San story.



Figure 5.4: The San storyteller (left) tells the story to the San gathering, who react by exclaiming and gesturing throughout the story narration. The rock paintings on the cave wall in background relate the story.

### 5.2.2 San Storytelling VE with Introductory VE

This storytelling scenario is identical to the one described in Section 5.2.1 above except that it is preceded by an introductory VE with a contemporary, culturally familiar theme, namely hip-hop. Here the user is first placed in an urban VE, within a fenced in area, facing a hip-hop avatar standing next to a radio. Behind the hip-hop avatar are a number of graffiti covered walls and a door with the word 'San', in graffiti, on it (see Figure 5.5). The hip-hop actor is rapping the following lyrics about the San and Kaggen, the mantis:

"Y'all gots to understand da San  
Indigenous peeps of da motherland  
Makin' rock art, working real hard and huntin'  
Your peeps be frontin'  
We be jammin', dancin' rhymin'  
Making mad beats now for keeps  
I hopes you like dis story about Him  
Kagg'n da Mantis speaks  
Don't despise this gifted, thriftd, swifted and mighty  
Creator, da maker of da Hartebeest, da moon,  
Soon you gon hear how he made the E-land too  
So listen to me man as I usher you into the world of the San.  
Let's jam!"

The hip-hop avatar raps these lyrics through once and continues to rap them in a loop until the user walks toward him. When this happens the actor stops rapping and speaks to the user:

"Yo! Did you know dar way back in the day, the San people used to live right here in southern Africa. They lived right off the fat of the land, hunting and eating roots and berries. One of the things they loved to do was to tell stories, especially around a fire. Check it out! Through that door you can hear a real San story!"

This dialogue along with the earlier rap prepares, or primes users for the content of the San VE. During the rap and dialogue, the hip-hop avatar is animated with rapper-like movements. After the dialogue, the lights in the urban VE fade down somewhat, the door marked with "San" graffiti opens and the hip-hop actor turns to indicate that the user may walk through the door (see Figure 5.6). The user walks through the door and through a short passage to emerge in the San storytelling VE (as described in Section 5.2.1) through an archway carved out of a mountain (see Figure 5.7). Once the user has moved into the San storytelling VE, the San door closes and a boulder covers the archway so that the user is not able to move back into the introductory VE.



Figure 5.5: The hip-hop themed introductory VE, this figure shows the hip-hop avatar rapping next to a radio. The animations of the hip-hop model were rotoscoped from video footage of a hip-hop music artist rapping the San rap and monologue. The graffiti-covered walls are visible behind the hip-hop avatar. The door marked “San” leads into the San storytelling VE.



Figure 5.6: After the hip-hop rap and dialogue, the lights in the introductory VE fade down, the door marked “San” opens and the hip-hop avatar turns to indicate that the user may walk through the door.



Figure 5.7: When the user walks through the door marked “San” in the hip-hop themed introductory VE, they enter a short passage and emerge in the San storytelling, viewed here through an archway at the end of the passage.

### 5.3 Virtual Environment Design: Storyboards

In planning the San and hip-hop VEs described in Sections 5.2.1 and 5.2.2 above, we borrowed from a well-known planning technique used in film: storyboarding. Film storyboards serve two main purposes during a film’s pre-production phase. Firstly, it is a means of visualising planned scenes and allows for ideas to be refined, before a film shoot begins. Secondly, storyboards facilitate communication between a film’s director and production crew (Katz, 1991). While there is no standard format for storyboards, they are essentially a series of annotated sketches representing a sequence of shots. The sketches and annotations should convey all the director’s requirements for each shot (Katz, 1991; Bordwell & Thompson, 2001). Given the diversity of people involved in film-making, for instance cinematographers, editors, lighting and stunt crew, costume and set designers etc, storyboards must convey a great deal of precise information (Katz, 1991). This includes cinematography, sound, editing between shots and mise-en-scene, which encompasses setting, costumes, acting and lighting. (Bordwell & Thompson, 2001).

While VR and film share some similarities, they are also very different (see Section 2.3.2, Chapter 2). In VR, the mise-en-scene and the soundscape may be controlled by the author to a certain degree but cinematography and editing make little sense since the user controls their own viewpoint. Hence, representing every frame a user will see is not possible in a VE storyboard in the way that a film storyboard may represent every shot. For our purposes, we created a storyboard which would show the frame sequence of a typical walkthrough of the intended VEs. The annotations to the storyboard sketches conveyed information about the VE’s mise-en-scene, namely the setting, avatars and lighting, and the sound. We also added VR specific information regarding interactions, the user and any required special effects.

Refer to Appendix E for full descriptions of these categories and for the storyboard created for the San VE and the hip-hop themed introductory VE. Note that the VE’s ultimately created (see Section 5.2) are very similar to, but not precisely as they were initially planned at the time of storyboarding.

## 5.4 Virtual Environment Implementation

The VEs described in Section 5.2 were implemented using a VR authoring tool called VR Direct. This tool is a scripting engine and user interface built on top of a commercial games engine and was created as part of the CAVES (Collaborative African Virtual Environment Systems) research project in the Collaborative Visual Computing Lab, University of Cape Town.

Most VE content was created professionally, by Atomic Visual Effects in Cape Town, using the modelling and animation tool Maya. The storyboards and reference sketches were used to specify the required models. Content was then imported into VR Direct, whose user interface allows objects to be placed as wished, sound and lighting to be applied and interactions between objects, avatars and users to be scripted. User defined scripts written in the scripting language Python, may also be executed in a VE authored in VR Direct.

Within the VR Direct environment, any actor model may be set as the user avatar with first or third-person perspective. The user avatar's actions are equivalent to the animation sequences available on the model associated with the user's avatar. So if the model has a walk animation, the user's avatar will be able to walk in the VE and so on. A model was created to serve as the user avatar and was given forward and backward walking and side stepping animations. A first-person perspective was chosen for the user avatar. Additionally, the sound of footsteps were set to accompany the walking animation/action of the user's avatar.

All audio, with the exception of background music and ambient sounds were spatialised, i.e. they were associated with objects in the VE. Therefore, the sounds associated with an object would become louder or softer as the user moved toward or away from the object. Additionally, the stereo output of a sound was determined by the orientation of the user point of view in relation to the object. In our experiments, audio was output via headphones, thus the amount of sound played in each ear piece varied as users used the mouse to look around the VE.

### 5.4.1 San Storytelling VE

Given the importance of authenticity in cultural heritage exhibits (see Section 2.5, Chapter 2), every effort was made to create the San storytelling VE as authentically as possible.

#### *Cave Setting*

The outdoor setting of the San storytelling VE was created using a large dome-shaped skybox. Digital photographs taken in the Cederberg region of the Western Cape, South Africa were stitched and blended together to form a panoramic image, used to texture the skybox. The San people once inhabited the Cederberg region and it is one of the richest regions of San rock art (Parkington, 2003). Cave, mountain and boulder models were placed in the skybox. The cave was modelled on those found in the Cederberg region and digital photographs of Cederberg caves were used to texture the cave model. The cave walls were also textured with photographs of San rock art (Bassett, 2001; Parkington, 2002). The rock art textures were chosen such that they related to the San story. Users were free to navigate most of this setting freely, but to ensure that they did not wander into the empty, outer parts of the skybox, invisible boundaries were placed at the edges of the cave and mountains. Images of the cave model, rock art used and VE's boundaries are shown in Section F.1, Appendix F, and the rock art textures are shown in Section F.2, Appendix F.

The setting was originally intended to contain a hut (see Section E.2, Appendix E). However, consultation with archaeologist Prof. J. Parkington, revealed that this was not typical of San

dwelling in the Cederberg region, upon which we had based our setting. Thus, we created a more typical nomadic San camp, including a hearth, grinding stone and a bag and quiver in the cave model. San photographs and books were used by an artist to create sketches of these objects which served as modelling references (see Section F.3, Appendix F). Prof. J. Parkington was further consulted on the correct placement of these objects. For instance, bags and quivers were typically hung by wooden pegs in cracks in the cave wall (Parkington, 2002).

The fire was created using a combination of billboards, scripting and dynamic lighting. The flames were created using fifteen different billboards, each textured with slightly transparent flame images of similar size and colouring. The billboards were placed in the hearth area at the same position, with only one visible at a time. A Python script iterated through the fifteen flame billboards setting the currently visible flame billboard to be invisible and setting the next to be visible every 0.2 seconds. This gave the appearance of moving flames. Within the hearth, two light sources were placed roughly next to each, these randomly changed positions within the hearth every 0.3 seconds. Thus the fire light appeared to move along with the flames. The brightness of the two lights were also set to vary randomly, within a bounded interval, every 0.7 seconds. Thus the overall fire light seemed to continually change.

#### *San Storyteller and Gathering*

Particular attention was paid to creating models with the clothing and physique of the San people. Numerous photographs of the San were used by an artist to create detailed sketches of the San gathering in front, side and back profile. The sketches were reviewed by Prof. J. Parkington and refined in accordance with his suggestions. The final sketches were used as reference in the modelling of the San figures. A reference sketch of the San storyteller is shown in Figure 5.8; all the character reference sketches are shown in Section F.3, Appendix F.

The storyteller's voice was provided by a local voice-over actress<sup>1</sup>. During the recording of the story narration, the actress's natural hand gestures were also video taped. The animations of the storyteller model were made to mimic this footage using the rotoscoping technique. Since we wanted the rest of the San gathering to react to the story narration realistically, each model was given a set of animations which were scripted to play throughout the storytelling. The San children were able to turn their heads left and right, lean forward and gesture with one and both hands. The San man was able to lean toward one of the children sitting on the ground and nod at him, lean forward to place his chin on a hand as though concentrating and gesture with one and both hands. The San man's animation sequences for greeting the user (see Section 5.2.1) included standing up, gesturing to the user to join the gathering and sitting down.

#### *Soundtrack*

The San VE's music track (see Section 5.2.1), was composed and recorded by a music artist<sup>2</sup>. The track consisted of a simple acoustic guitar piece backed by a xylophone. Outdoor sounds, such as a wind blowing and crickets chirping were also recorded and edited together to form the ambient, outdoor soundtrack. A specialised fire sound clip was used for the fire. As mentioned earlier, a local voice-over actress provided the voice of the storyteller. The San man's voice was provided by the music artist who composed the background music. Additionally, three teenagers from an extra-mural high-school drama class in Okiep were recorded making exclamation sounds, such as 'ah!', 'aiee' and 'jool', resulting in sixteen sound clips of surprise, laughing, astonishment etc. These were edited into the story narration soundtrack at appropriate parts of the story to give the sound of an audience reacting to the story narration.

<sup>1</sup> Dawn Langdown  
Jazzart. <http://www.jazzart.co.za/>. 2005.

<sup>2</sup> Oswald Musokwa



Figure 5.8: An example of a reference sketch used to model the San storyteller. This sketch shows the storyteller figure viewed from the front. The complete set of character reference sketches are shown in Section F.3, Appendix F.

#### *Interactions*

Two triggers were used in the San VE, both based on proximity from the storyteller avatar. The first trigger has a wide radius which covers a large proportion of the San VE around the storyteller. When activated, the San man stands up and looks in the general direction of the user. A second trigger was set to fire when the user is quite close to the storyteller. When activated, the San man, still standing after the activation of the first trigger, gestures toward the rest of the San gathering, invites the user to join them and sits down. A few seconds later the storyteller begins telling the story. Visualisations of these two triggers are shown in Section F.1, Appendix F. What if the user does not continue to move toward the gathering after setting off the first trigger? We did not feel it would be natural for the San man to stand waiting indefinitely for the user to reach the gathering. Therefore, if the second trigger is not set off by the user within 10 seconds of the first trigger being fired, it is scripted to automatically fire. So, if the user has halted or moved in an opposite direction after setting off the first trigger, the San man's invitation and the storyteller's story may encourage the user to move towards the gathering.

We have already described how the San man and children models were given animations to be played during the storytelling and how sounds of exclamation were edited into the storytelling soundtrack. Both of these were intended to create the illusion of the San gathering reacting to the storyteller. To make the illusion complete, VR Direct's scripting interface was used to ensure that the reaction animations and sounds were realistically synchronised. Where there were no reaction sounds from the San gathering for longer than 20 seconds, filler animations were scripted so the San figures moved slightly every so often rather than sitting unrealistically motionless. This idea borrows from that of Perlin noise where the use of animations at random intervals allows virtual actors to appear 'alive' by moving, even if only slightly, constantly (Perlin & Goldberg, 1996).

### 5.4.2 Hip-hop Themed Introductory VE

#### *Urban Setting*

As in the San VE, a skybox was used to create the urban setting of the introductory VE. This skybox was textured with a panoramic image of the Cape Town skyline at dusk. The user interacts with the hip-hop avatar within a fenced area which contains a number of graffiti-covered walls. Digital photographs of urban graffiti were used to texture these walls. The door leading to the San world was a model with two animation sequences: open and close. The “San” graffiti on the door was digitally created. We wanted to ensure that the user interacted with and heard all the information given by the hip-hop avatar. Therefore, the fences were used as visible barriers preventing the user from wandering around irrelevant parts of the urban VE. Simple building, street and street light models were used to populate the rest of the setting. Images of the urban setting and models are shown in Appendix G.

In order to create the link between the introductory and San VEs, the urban skybox was placed *inside* the San skybox. The door in the introductory VE led the user through a passage which led out of the urban skybox and into the center of the San skybox. Within the San VE, the urban skybox was masked by a mountain model. The skybox setup is shown in Figure 5.9.

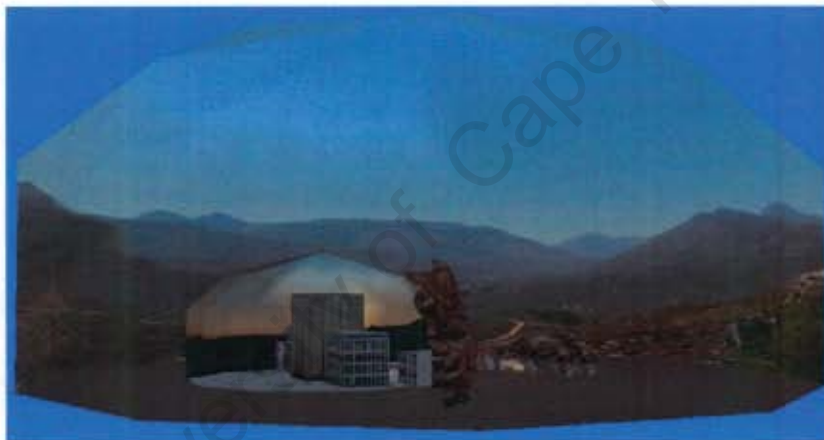


Figure 5.9: This figure shows to the skybox setup for the San storytelling VE with introductory VE. The outer skybox is that of the San VE; the urban skybox (left) of the introductory VE was placed inside the San skybox. The two skyboxes were joined by a short passage and, in San VE, the urban skybox is masked by a mountain model (center). The San cave is shown on the right.

#### *Hip-hop Avatar*

The hip-hop avatar was modelled with baggy clothing and sneakers to give the appearance of a hip-hop rapper. A music artist<sup>3</sup> provided the voice of the hip-hop avatar, during the voice recording he acted out the rap and dialogue physically; this was video-taped. As with the San storyteller, this footage was used to animate the hip-hop model using the rotoscoping technique.

<sup>3</sup> Oswald Musokwa

### *Soundtrack*

In order to set the scene of an urban environment in the introductory VE, ambient city sounds were played in the background. Further, it was important to ensure that the rap and dialogue contained priming information for the San VE but also demonstrated a hip-hop style. Therefore, we collaborated with the music artist who voiced the hip-hop avatar. We described the basic elements we wished convey in the introductory VE regarding the San people, their storytelling tradition and the character of Kaggen the mantis. Using this information, the artist wrote the lyrics for the rap and dialogue used in the VE (see Section 5.2.2). He also composed background music (consisting mostly of synthesised drum beats) for the rap.

### *Interactions*

In Section 5.2.2 above, we describe how the hip-hop avatar performs a looped rap until approached by the user, at which point he stops rapping and speaks to the user. This was effected by a trigger which is set off when the user walks toward the hip-hop avatar. However, since all users were required to hear the full information given by the hip-hop avatar, we wanted to ensure that users would hear the entire rap at least once. Hence, if the user activates the trigger before the hip-hop avatar has run through the rap once, the hip-hop avatar will complete the rap first and then begin the monologue. Once the monologue is complete, an internal trigger reduces the lighting in the introductory VE, opens the door to the San VE and causes the hip-hop avatar to indicate the way through the door. We decided against using forced camera movements or textual menus as planned in the storyboards since this would likely have compromised the realism of the VE.

Since the introductory VE was physically located within the San VE's skybox, we needed to ensure that users were not able to move back into the introductory VE once they had passed into the San VE. A straight line trigger was placed at the end of the passage connecting the two VEs, once crossed, the San door was closed. A small distance after the end of the passage, another straight line trigger ensured that the archway into the San VE was covered with a large boulder. So, if users in the San VE happened to look behind them, in the direction of the door and passage, it would have, seemingly, disappeared.

## **5.5 Pilot Evaluation of Virtual Environments**

Before conducting any experiments, we ran a pilot evaluation of our VR storytelling scenarios to ensure there were no unforeseen problems with their design, implementation and overall usability. Five university students participated in this test; first they were trained in the navigation of the VE's and then experienced one of the two VR storytelling scenarios. Thereafter, an experimenter asked them to give their comments on the VEs, in particular aspects which they did not like along with any suggestions on how they could be improved.

The following issues were raised and resolved before conducting our experiments:

- Some participants found that the footstep audio that accompanied their avatar while walking was too loud; the volume of the footstep audio was lowered.
- Two participants reported missing the start of the San story and not being 'ready' to listen to the story at the start of the storyteller's narration; the VE was altered so that the storyteller character began the story a few seconds later. We considered giving users the option of determining the start of the story themselves, for example, by pressing a key. But we felt that this kind of user input might compromise the realism of the VE,

since it might seem unusual for the storyteller to wait on the user. Additionally, requiring the user to give keyboard input might interfere with their presence in the VE as it would entail an action that would remind them of the computer mediated nature of their experience (Lombard & Ditton, 1997).

- In Section 5.4.1 above, we describe how reaction sounds and animations were used to give the appearance of the San gathering reacting to the storyteller. Recall that ‘filler’ animations were also used so that the San gathering would not appear stationary for unrealistically long time periods. Two participants noted that these animations were not accompanied with sound and found them distracting. Obvious filler animations were therefore eliminated and those remaining were spaced out more sparingly over the duration of the story narration.

There were a number of issues raised which we were unable to resolve:

- Most participants noted that as avatars in the VE spoke, they lacked eye and mouth movements and this compromised their realism. Simulating the facial movements to accompany audio speech realistically is a very challenging and well-known computer graphics problem (Terzopoulos *et al.*, 1997; Cosker *et al.*, 2004). Unfortunately, we did not have the time or resources to add facial animation to our avatars before the experiments. After our experiments, however, the San storytelling VE was improved for possible use as a museum exhibit. As part of this, a professional animator added facial animation to all models in the San gathering. The storyteller’s mouth movements were also partially synchronized with the story narration soundtrack.
- Some participants commented that the user walking speed was too slow. One participant also noted that the speed of backward walking was slower than forward walking and this made navigation harder. As explained in Section 5.4, the actions available to users in the VE were tied to the animations sequences available on a user avatar’s model. Thus, walking speed of a user’s avatar was determined by the walking animation of the avatar’s model. Altering an avatar’s walking speed entailed adjusting the walking animation of the associated model in Maya. Time constraints prevented us from backtracking this far in our implementation pipeline.
- In a related issue, one participant mentioned that they might have liked to be able to perform the action of sitting down to listen to the story and since the San storyteller invites users to “sit with us [the San gathering]...” (see Section 5.2.1). Again, adding a sit action for users would have involved adding a sit animation to the avatar’s model.

There were also issues raised where, upon consideration, we opted not make suggested changes:

- One participant wanted to be able to open the door in the hip-hop introductory VE themselves rather than waiting for the hip-hop avatar to open it. This was not changed since our study design required that all participants experiencing the virtual San storytelling with introductory VE experience the full introductory VE before entering the San VE. Thus the door to the San VE was kept closed until the hip-hop character’s rap and monologue was finished.
- A few participants reported that they did not understand the San story and found it confusing. One participant in particular mentioned that all the San names made the story difficult to follow. However, our research dealt with creating effective story experiences despite the use of material which was likely to be unfamiliar to users. Since we had chosen to use a San story for this purpose, it would have been incorrect to alter its content or nature. Indeed, if experiment participants found the story confusing or

incomprehensible this would be an important result, not one that we could seek to minimise by changing the very material we were aiming to impart.

The following positive observations were made regarding the VE's:

- All participants expressed either a desire to explore the cave environment or a sense of being drawn toward the cave and the San gathering. Most participants enjoyed having the freedom to explore while having the main cave area to attend to. One participant stated that while the VE encouraged exploration it was clear that the story was the focal point of the environment. While another participant reported a greater interest in exploring the VE than focusing on the story. Overall, this was affirming since we had aimed to create a VE where the story would engage users' attention without noticeably restricting navigation in the VE. Furthermore, this result prepared us for the possibility that VE users might choose to explore the VE rather than attend to the story.
- Four participants mentioned that they enjoyed the audio aspect of the VEs. Especially popular was the gradual fading in and out of background music, ambient sounds, sounds made by the San gathering during the story and the use of specialised sound.

## Chapter 6

### Psychometric Analysis

The majority of the variables explored in our research were measured using questionnaires which were designed specifically for our studies. These questionnaires have been described in Section 4.5, Chapter 4 and are presented in full in Appendix B and Appendix C. These questionnaires were used in two studies which explored story experience in text and VR, the use of a culturally familiar introductory VE in virtual storytelling and the relationship between presence and story experience in virtual storytelling. These studies were labeled Study 1 and Study 2, respectively. Study 1 was conducted with a sample of high-school learners, while Study 2 was conducted with a sample of undergraduate university students. After each study, before analysing the data gathered, comprehensive psychometric analyses of the custom-made questionnaires were carried out in order to determine their validity and reliability.

The psychometric analyses involved identifying problematic questionnaire items which were then excluded from consideration. This is significant because the process of determining the values of all our variables from our data consisted of summing together the values of individual questionnaire items. For instance, an overall comprehension score was derived by adding together the scores obtained on each individual item in the comprehension questionnaire. Clearly no analyses could be performed before the total values for each variable were determined. And since the psychometric analyses determined which questionnaire items would be counted toward each variable's total value, it was a necessary initial step in the data analysis of each study. Additionally, knowing whether a questionnaire had worked as desired also had implications for the conclusions we were able to draw from our results. In particular if significant results had been obtained for a variable which was measured using an unsound questionnaire, then we would have been unable to make valid conclusions based on that result. This chapter describes the psychometric analysis of the custom-made questionnaires used in Study 1 and 2, namely those measuring hip-hop interest, comprehension, interest, enjoyment, confusion, boredom, attention and strangeness. We begin by describing the statistical procedures used to test the questionnaires' validity and reliability (Section 6.1) and to test for questionnaire level of difficulty and the existence of experimental bias (Section 6.2). Next the psychometric results for Study 1 and 2 are presented in Sections 6.3 and 6.4 respectively. The effectiveness of the custom-made questionnaires is summarised and discussed in Section 6.5. Finally, a summary of the outcomes of the psychometric analyses is presented in Section 6.6.

#### 6.1 Validity and Reliability

The validity and reliability are two distinct properties of any questionnaire or test. Validity concerns the actual phenomenon which a test aims to measure and how well it succeeds in doing so. For instance, say a test aims to measure the usability of computer system by measuring the time it takes users to complete a task. However, this test also measures may not succeed in measuring usability but rather the subject's overall speed of work, familiarity with similar systems etc. Therefore, because it measures something other than pure usability, it is a low validity test. This is termed construct validity and is generally a matter of judgment on the nature

of a test or its items. Another kind of validity, known as concurrent validity, is a commonly used objective method for evaluating validity. Concurrent validity may be defined as the extent to which different measures for the same phenomenon agree (Anastasi, 1982). This is equivalent to examining the extent to which a questionnaire's items appear to measure the same factor. If a set of items correlate significantly, then they likely measure the same factor and are, thus, concurrently valid (Anastasi, 1982). Since inter-item correlations are calculated, a scale must consist of at least two items for concurrent validity to be assessed.

Reliability refers to the consistency of the scores obtained on the test when used repeatedly in different studies or the extent to which the individual questionnaire items agree on the measurement of a factor (Anastasi, 1982). For the latter, imagine a ten item questionnaire intended to measure subjects' impression of a computer system's usability. The ten items all aim to measure impressions of usability; a reliability calculation would measure the consistency of the scores for each item and determine the extent to which the items agree. This is also known as inter-item consistency (Anastasi, 1982; Cronbach, 1990). Reliability may be determined by calculating Cronbach's alpha coefficient or Kuder-Richardson 20 (KR20) value. Cronbach's alpha coefficient is used when dealing with continuous scales, where items may have a range of values and KR20 is applicable to dichotomous scales, where items may only take on one of two values (Gregory, 1991). A Cronbach's alpha coefficient or KR20 value of 0.8 or higher, within a range of 0 to 1, is considered acceptable for scale reliability (Anastasi, 1982). At least three items are required in order to calculate Cronbach's alpha coefficient and KR20 (Anastasi, 1982). It is also possible to determine which of a questionnaire's items decrease a scale's overall reliability value. We often found that those items which decreased overall reliability also did not show a high degree of concurrent validity with the other items in the questionnaire. Where this was the case, the item(s) in question were judged as problematic and excluded from consideration.

## 6.2 Skew

For some questionnaires, it was useful to examine the distribution of participants' responses to each item for skewness. More specifically, skewness was used to evaluate level of difficulty in the comprehension questionnaire and to test for experimental bias in subjective questionnaires. A standard normal distribution is symmetric about its mean, whereas a skewed distribution is not symmetric, but leans toward either of the domain's extents. If a distribution leans toward the upper extent of the domain, it is negatively skewed; if it leans toward the lower extent, it is positively skewed (Underhill & Bradfield, 1996). Each distribution has a skew value; additionally 95% confidence intervals for skew may be calculated based on sample size. Questionnaire items were judged as significantly skewed if their skew value lay outside its 95% confidence intervals.

For the comprehension questionnaire, skewness gave an indication of items' difficulty level. If the items were too easy then participants' responses would be skewed toward the correct answers and vice versa if items were too difficult. Gaining an idea of whether the comprehension questionnaires had been too easy or difficult allowed us to make more informed conclusions from the comprehension results obtained. For the more subjective questionnaires, namely those that measured interest, enjoyment, confusion, boredom, attention and strangeness, skewness gave an indication of whether experimenter bias might have influenced participants' responses. Experimental participants may use cues conveyed, implicitly and explicitly, by an experimenter or the experimental setting and procedure to form an idea of the experiment's nature and even its hypotheses. This may bias participant responses so as to fulfil what they perceive to be the experimenter's expectations (Orne, 1962). This was of particular concern since many of the subjective questionnaires contained items where the answer desired by the experimenter may have appeared obvious to the participants. For instance, there were items which asked whether participants found the San people interesting and whether they had enjoyed the San story. We believed that participants might easily infer that they were expected to find the San interesting and enjoy the San story. Therefore, we attempted to test whether

participants answered the subjective questionnaires according to personal opinion and their story experience or according to an experimenter effect. For example, if the enjoyment items were negatively skewed, we would have to consider the possibility that that, rather than experiencing unanimously high enjoyment, participants answered in order to please the experimenter. In such a case, results for the variable in question would have to be interpreted with greater caution.

### 6.3 Study 1

#### 6.3.1 Hip-hop Interest

Two different measures were used for hip-hop interest (HI). First, a multiple choice question in which participants chose their favorite music genre from six options, one of which was hip-hop. Second, five items consisting of statements which participants were required to rate on a 7-point Likert-type scale (see Section B.2, Appendix B). The scores on these five items were summed together to give a HI score. For analyses these two measures were labeled as HI<sub>mc</sub> and HI<sub>rate</sub> respectively; the items in HI<sub>rate</sub> were labeled HI1 - HI5. Since HI<sub>mc</sub> consisted of only one item, we were unable to assess its concurrent validity and reliability.

An inter-item correlation for HI<sub>rate</sub> showed that HI3, HI4 and HI5 correlated significantly, while HI1 correlated significantly with only HI3 (See Table 6.1 below for correlation values). Cronbach's alpha coefficient for items HI1-HI5 ( $\alpha=0.554$ ,  $n=44$ ) was not high enough to claim reliability. However, removing items HI1 and HI2, which did not correlate completely with the other items, resulted in a high enough Cronbach's alpha coefficient to claim reliability ( $\alpha=0.755$ ,  $n=44$ ). Thus, HI3, HI4 and HI5 formed a valid and reliable scale. A further significant correlation was noted between HI<sub>rate</sub> and HI<sub>mc</sub> when hip-hop was selected in HI<sub>mc</sub> ( $r=0.39$ ,  $p<0.05$ ). No such correlations were noted for any of the other music choices in HI<sub>mc</sub>. This indicated a concurrent validity between HI<sub>mc</sub> and HI<sub>rate</sub> such that a high HI<sub>rate</sub> score was related to having hip-hop as a favorite music genre.

Item	HI1	HI2	HI3	HI4	HI5
HI1	1.00	0.13	<b><i>0.33</i></b>	0.05	0.02
HI2	0.13	1.00	0.11	-0.08	-0.00
HI3	<b><i>0.33</i></b>	0.11	1.00	<b><i>0.34</i></b>	<b><i>0.60</i></b>
HI4	0.05	-0.08	<b><i>0.34</i></b>	1.00	<b><i>0.76</i></b>
HI5	0.02	-0.00	<b><i>0.60</i></b>	<b><i>0.76</i></b>	1.00

Table 6.1: Correlation matrix for items HI1, HI2, HI3, HI4 and HI5 of the HI<sub>rate</sub> scale, used to measure hip-hop interest in Study 1. Significant correlations ( $p < 0.05$ ,  $n=44$ ) are shown in bold and italic.

#### 6.3.2 Comprehension

The comprehension questionnaire used in Study 1 consisted of the following scales:

- Ccloze: Cloze Test
- Cseq: Sequence Test
- Csvt: Sentence Verification Technique (SVT) Test
- Cinf: Inference Questions
- Cfact: Fact Questions

Ccloze consisted of two items, Cloze1 and Cloze2; these did not correlate significantly with each other, indicating a lack of concurrent validity within Ccloze. Since a minimum of three items are required to calculate reliability (see Section 6.1 above), Ccloze's reliability could not be evaluated. However, we did find that both Ccloze items were negatively skewed i.e. most participants tended to answer the items correctly; this suggested that the Ccloze items were very easy.

The Cseq scale consisted of five items, labeled Seq1 - Seq5. The correlation matrix in Table 6.2 below shows the high degree of inter-item correlation in Cseq. Seq1 was the only item which did not correlate with any other item and Seq3 correlated with only one other item. Cseq was a dichotomous scale since answers were either correct or incorrect. Hence the KR20 formula was used to calculate its reliability (see Section 6.1 above). Cseq's KR20 value was not high enough (KR20=0.634, n=44) to claim reliability. But, removing Seq1 and Seq3, the items which showed low correlation with the other items, increased KR20 sufficiently to claim reliability (KR20=0.778, n=44). Thus, Seq2, 4 and 5 formed a valid and reliable scale. These items were however, found to be negatively skewed, suggesting that they were very easy.

Item	Seq1	Seq2	Seq3	Seq4	Seq5
Seq1	1.00	-0.01	-0.16	0.16	0.27
Seq2	-0.01	1.00	-0.06	<b><i>0.61</i></b>	<b><i>0.47</i></b>
Seq3	-0.16	-0.06	1.00	<b><i>0.34</i></b>	0.10
Seq4	0.16	<b><i>0.61</i></b>	<b><i>0.34</i></b>	1.00	<b><i>0.56</i></b>
Seq5	0.27	<b><i>0.47</i></b>	0.10	<b><i>0.56</i></b>	1.00

Table 6.2: Correlation matrix for items Seq1, Seq2, Seq3, Seq4 and Seq5 of Cseq, the sequence test used to measure comprehension in Study 1. Significant correlations ( $p < 0.05$ , n=44) are shown in bold and italic.

As described in Section 4.5.2, Chapter 4, Study 1's Csvt consisted of three sets of four sentences; these were labeled SVT1 - SVT12. Among these, there were 66 potential correlations, but there were only 9 significant correlations suggesting very low concurrent validity (the correlation matrix is given in Table I.1, Appendix I). Csvt also showed a low KR20 value (KR20=0.481, n=44). This value could have been increased by removing certain items, but this would have resulted in incomplete SVT sentence sets and would not have increased KR20 enough to claim reliability. Furthermore, most of Csvt's items (with the exception of SVT7, 8 and 11) were negatively skewed, indicating that they lacked difficulty.

Validity and reliability could not be calculated for Cinf since *all* participants gave the same answers to two of its three items resulting an overall variance which was too low to perform any statistical tests. Cinf data was therefore discarded. Cfact consisted of three items: Fact1, Fact2 and Fact3. Table 6.3 shows the high degree of inter-item correlation, indicating concurrent validity in this scale. But, the Cronbach's alpha coefficient for Cfact was not high enough to claim reliability ( $\alpha=0.594$ , n=37). The distributions of Cfact's items showed that Fact3 was positively skewed, suggesting a high level of difficulty in this item. It was noted that many participants did not, in fact, answer the Cfact items, effectively reducing the amount of Cfact data available for analysis and compromising their accuracy.

Item	Fact1	Fact2	Fact3
Fact1	1.00	<b><i>0.44</i></b>	<b><i>0.33</i></b>
Fact2	<b><i>0.44</i></b>	1.00	0.27
Fact3	<b><i>0.33</i></b>	0.27	1.00

Table 6.3: Correlation matrix for items Fact1, Fact2 and Fact3 of Cfact, the fact questions test used to measure comprehension in Study 1. Significant correlations ( $p < 0.05$ , n=37) are shown in bold and italic.

Once the problematic items in the comprehension scale had been identified and excluded, the concurrent validity between the comprehension scales was assessed (see Table 6.4 below). The total scores for Ccloze, Cseq and Csvt all correlated significantly, with exception that Cseq and Csvt did not correlate directly. Cfact correlated with only Cseq. Additionally, a reliability value for all the items in the comprehension questionnaire (with the problematic items excluded) was not high enough to claim overall reliability ( $\alpha=0.686$ ,  $n=31$ ).

Scale	Ccloze	Cseq	Csvt	Cfact
Ccloze	1.00	<b><i>0.34</i></b>	<b><i>0.32</i></b>	0.09
Cseq	<b><i>0.34</i></b>	1.00	0.29	<b><i>0.55</i></b>
Csvt	<b><i>0.32</i></b>	0.29	1.00	0.25
Cfact	0.09	<b><i>0.55</i></b>	0.25	1.00

Table 6.4: Correlation matrix for the total scores of the comprehension scales used in Study 1: the cloze test (Ccloze), sequence test (Cseq), SVT test (Csvt) and fact questions test (Cfact). Significant correlations ( $p < 0.05$ ,  $n=44$ ) are shown in bold and italic.

### 6.3.3 Interest

The interest questionnaire devised for this research consisted of three scales, each measuring different variables: a tendency to show interest in folklore and South African cultures (tIB), existing knowledge of the San and San folklore (sIB) and interest in the San (INT). tIB was measured using two items, tIB1 and tIB2, sIB was measured using two items, sIB1 and sIB2, and INT was measured using eight items, INT1 – INT8.

The two tIB items did not correlate with each other whereas the two sIB items did ( $r=0.44$ ,  $n=44$ ). This indicated concurrent validity for sIB but not for tIB. The reliability of these scales could not be calculated as they both consisted of only two items. All eight INT items correlated significantly (the correlation matrix is given in Table I.2, Appendix I). Cronbach's alpha coefficient for the INT scale was also high enough to claim that it was reliable ( $\alpha=0.989$ ,  $n=44$ ). Furthermore, we found no significant skew in the distributions of the INT scale items. Thus the INT scale was concurrently valid, reliable and did not appear to contain experimental bias.

### 6.3.4 Enjoyment, Boredom and Confusion

Enjoyment (ENJ) was measured by two items, ENJ1 and ENJ2, while boredom (BOR) and confusion (CON) were measured using one item for each: BOR1 and CON1 respectively. Table 6.5 shows the significant correlations between ENJ1 and ENJ2 and between CON1 and BOR1. There were also negative correlations between both ENJ items and CON1 and BOR1. The number of items measuring these variables was kept low in order to keep the overall questionnaire length of the questionnaires reasonable. Consequence the ENJ, CON and BOR scales each consisted of too few items to compute their reliability. None of the items making up these scales were significantly skewed.

Item	ENJ1	ENJ2	CON1	BOR1
ENJ1	1.00	<b><i>0.78</i></b>	<b><i>-0.32</i></b>	<b><i>-0.74</i></b>
ENJ2	<b><i>0.78</i></b>	1.00	<b><i>-0.40</i></b>	<b><i>-0.83</i></b>
CON1	<b><i>-0.32</i></b>	<b><i>-0.40</i></b>	1.00	<b><i>0.48</i></b>
BOR1	<b><i>-0.74</i></b>	<b><i>-0.83</i></b>	<b><i>0.48</i></b>	1.00

Table 6.5: Correlation matrix for the enjoyment items, ENJ1 and ENJ2, and confusion and boredom items, CON1 and BOR1, used in Study 1. Significant correlations ( $p < 0.05$ ,  $n=44$ ) are shown in bold and italic.

## 6.4 Study Two

### 6.4.1 Hip-hop Interest

As in Study 1, hip-hop interest (HI) was measured using a multiple choice question (HI<sub>mc</sub>) and a five-item scale (HI<sub>rate</sub>) (see Section 6.3.1 above). In Study 1, three of HI<sub>rate</sub>'s, HI3, HI4 and HI5, were found to be valid and reliable, hence these were retained for Study 2. A further three items, HI6, HI7 and HI8, were also added. As before, HI<sub>mc</sub> could not be psychometrically assessed as it consisted of only one item.

A correlation matrix for the HI<sub>rate</sub> items HI3 - HI8 is presented in Table 6.6; it shows that all the items correlated significantly with the exception of HI8. Cronbach's alpha coefficient for HI3 - HI8 was sufficiently high enough ( $\alpha=0.781$ ,  $n=87$ ) to claim reliability. Removing HI8 improved the reliability even further ( $\alpha=0.836$ ,  $n=87$ ). Therefore, HI8 was discarded since it did not correlate with the other HI<sub>rate</sub> items and decreased the scale's overall reliability. The remaining items, HI3 - HI7, formed a valid and reliable scale. As in Study 1, there was a significant correlation between the selection of hip-hop as a favorite music genre in HI<sub>mc</sub> and HI<sub>rate</sub> ( $r=0.50$ ,  $n=88$ ). This indicated concurrent validity between the two hip-hop interest measures and further validated HI<sub>rate</sub> as a measure of hip-hop interest.

Item	HI3	HI4	HI5	HI6	HI7	HI8
HI3	1.00	<i>0.32</i>	<i>0.74</i>	<i>0.59</i>	<i>0.38</i>	0.09
HI4	<i>0.32</i>	1.00	<i>0.46</i>	<i>0.32</i>	<i>0.45</i>	0.11
HI5	<i>0.74</i>	<i>0.46</i>	1.00	<i>0.68</i>	<i>0.51</i>	0.08
HI6	<i>0.59</i>	<i>0.32</i>	<i>0.68</i>	1.00	<i>0.51</i>	0.13
HI7	<i>0.38</i>	<i>0.45</i>	<i>0.51</i>	<i>0.51</i>	1.00	0.12
HI8	0.09	0.11	0.08	0.13	0.12	1.00

Table 6.6: Correlation matrix for items HI3, HI4, HI5, HI6, HI7 and HI8 of the HI<sub>rate</sub> scale, used to measure hip-hop interest in Study 2. Significant correlations ( $p < 0.05$ ,  $n=86$ ) are shown in bold and italic.

### 6.4.2 Comprehension

The comprehension questionnaire used in Study 1 was found to be generally unsound. Therefore, we aimed to improve upon these scales for use in Study 2. In Study 2, we employed only the three comprehension scales that had correlated significantly with each other in Study 1 (see Section 6.3.2), and included more items in each:

- Ccloze: Cloze Test
- Cseq: Sequence Test
- Csvt: Sentence Verification Technique (SVT) Test

Here, Ccloze consisted of four sentences containing, respectively, three, four, three and one omitted word(s)/blank(s) which participants were required to fill in. This made eleven items, which were labeled according to sentence and blank: Cloze1a - 1c, Cloze2a - 2d, Cloze3a - 3c and Cloze4. These items showed a very low degree of inter-item correlation, with only 4 significant correlations of a possible 55, or 7% (the correlation matrix is given in Table I.3, Appendix I). This indicated that, as in Study 1, Ccloze lacked concurrent validity. Additionally, Cronbach's alpha coefficient was too low ( $\alpha=0.460$ ,  $n=36$ ) to claim reliability. This reliability value could have been increased by removing certain items, in particular those which many

participants had left unanswered. But, the highest value attainable was not high enough to claim reliability ( $\alpha=0.633$ ,  $n=40$ ), therefore we opted to retain all items and conclude that Ccloze was not reliable. Most of the Ccloze items were also significantly skewed: Cloze1a, 1b, 1c, 2a, 3b and 3c were negatively skewed while Cloze2c, 2d and 4 were positively skewed. With the majority of its items negatively skewed, Ccloze appeared to have been too easy, overall.

In Study 1 three of the five Cseq items, Seq2, Seq4 and Seq5, proved valid and showed a KR20 value which was just high enough to claim reliability (KR20=0.778,  $n=44$ ). In Study 2, we attempted to increase the reliability further by using all items from Study 1, Seq1 – Seq5, and adding new items, Seq6 and Seq7. Table 6.7 below shows a high degree of correlation between these items, with the exception of Seq2 and Seq3, in Study2. However, the KR20 value was too low (KR20=0.623,  $n=84$ ) to claim reliability. Removing low correlation items, Seq2 and Seq3, increased KR20, but Cseq was still not reliable (KR20=0.663,  $n=84$ ). Nonetheless, it was decided to discard Seq2 and Seq3 as this would result in a scale which was valid albeit not reliable. Interestingly, a KR20 computation for the items judged as reliable in Study 1, Seq2, Seq4 and Seq5, revealed a comparatively low reliability in Study 2 (KR20=0.423,  $n=85$ ). All Cseq's items, except for Seq1, were negatively skewed, implying a low level of difficulty.

Item	Seq1	Seq2	Seq3	Seq4	Seq5	Seq6	Seq7
Seq1	1.00	-0.02	-0.06	<i>0.26</i>	<i>0.31</i>	<i>0.36</i>	<i>0.35</i>
Seq2	-0.02	1.00	0.04	0.12	0.04	0.02	0.06
Seq3	-0.06	0.04	1.00	0.19	0.19	0.08	<i>0.35</i>
Seq4	<i>0.26</i>	0.12	0.19	1.00	<i>0.38</i>	0.01	<i>0.28</i>
Seq5	<i>0.31</i>	0.04	0.19	<i>0.38</i>	1.00	<i>0.23</i>	<i>0.28</i>
Seq6	<i>0.36</i>	0.02	0.08	0.01	<i>0.23</i>	1.00	<i>0.37</i>
Seq7	<i>0.35</i>	0.06	<i>0.35</i>	<i>0.28</i>	<i>0.28</i>	<i>0.37</i>	1.00

Table 6.7: Correlation matrix for items Seq1 - Seq7 of Cseq, the sequence test used to measure comprehension in Study 2. Significant correlations ( $p < 0.05$ ,  $n=84$ ) are shown in bold and italic.

Study 2's Csvt scale consisted of the items used in Study 1, SVT1 – SVT12, and an additional sentence set, SVT13 – SVT16. SVT11 was changed to remove ambiguity (see Appendix C). Of a possible 120 inter-item correlations, there were 45 significant correlations (38%). Only SVT4 showed no direct correlation to any other item. Though there wasn't complete inter-item correlation, all the items, except SVT4, were indirectly related. Furthermore, the KR20 value for Csvt was high enough to claim reliability (KR20=0.768,  $n=85$ ). This value could have been slightly improved by removing items SVT4, 9 and 11, but, as in Study 1, we preferred not to leave incomplete sentence sets. Csvt items were all negatively skewed, suggesting an easy test.

The correlation between the total scores for each comprehension scale (see Table 6.8 below) indicated concurrent validity between the three comprehension scales used in Study 2. Additionally, the reliability value for the entire comprehension questionnaire was sufficiently high to claim overall reliability ( $\alpha=0.852$ ,  $n=45$ ).

Scale	Ccloze	Cseq	Csvt
Ccloze	1.00	<i>0.61</i>	<i>0.59</i>
Cseq	<i>0.61</i>	1.00	<i>0.64</i>
Csvt	<i>0.59</i>	<i>0.64</i>	1.00

Table 6.8: Correlation matrix for the comprehension scales used in Study 2: the cloze test (Ccloze), sequence test (Cseq) and SVT test (Csvt). Significant correlations ( $p < 0.05$ ,  $n=86$ ) are shown in bold and italic.

### 6.4.3 Interest

The interest questionnaire used in Study 2 was identical to that of Study 1, consisting of three scales: tIB, sIB and INT. The two tIB items correlated significantly ( $r=0.23$ ,  $n=88$ ) as did the two sIB items ( $r=0.37$ ,  $n=88$ ). Again, the INT items, INT1 – INT8, all correlated significantly (the correlation matrix is shown in Table I.4, Appendix I) and Cronbach's alpha indicated reliability ( $\alpha=0.854$ ,  $n=88$ ). In general the INT items in the INT scale were not significantly skewed, only INT3 was negatively skewed and INT6 was positively skewed. As in Study 1, the INT scale proved to be valid, reliable and relatively unaffected by experimental bias.

### 6.4.4 Enjoyment, Boredom and Confusion

The same enjoyment (ENJ), confusion (CON) and boredom (BOR) scales used in Study 1 were also used for Study 2. One new item measuring confusion, CON2, was added. The inter-item relationships were almost identical those of Study 1, Table 6.9 shows the correlation between the ENJ items, the CON and BOR items and the negative correlations between the ENJ items and the CON and BOR items. Additionally the two confusion items, CON1 and CON2, correlated with each other. As in Study 1, these scales consisted of too few item to determine reliability. No significant skew was found in any of the items.

Item	CON1	ENJ1	BOR1	ENJ2	ATT1	CON2
CON1	1.00	<i><b>-0.38</b></i>	<i><b>0.50</b></i>	<i><b>-0.50</b></i>	<i><b>-0.38</b></i>	<i><b>0.42</b></i>
ENJ1	<i><b>-0.38</b></i>	1.00	<i><b>-0.57</b></i>	<i><b>0.52</b></i>	<i><b>0.67</b></i>	<i><b>-0.37</b></i>
BOR1	<i><b>0.50</b></i>	<i><b>-0.57</b></i>	1.00	<i><b>-0.65</b></i>	<i><b>-0.52</b></i>	<i><b>0.36</b></i>
ENJ2	<i><b>-0.50</b></i>	<i><b>0.52</b></i>	<i><b>-0.65</b></i>	1.00	<i><b>0.45</b></i>	<i><b>-0.43</b></i>
CON2	<i><b>0.42</b></i>	<i><b>-0.37</b></i>	<i><b>0.36</b></i>	<i><b>-0.43</b></i>	<i><b>-0.33</b></i>	1.00

Table 6.9: Correlation matrix for the enjoyment items, ENJ1 and ENJ2, the boredom item, BOR1 and the confusion items, CON1 and CON2, used in Study 2. Significant correlations ( $p < 0.05$ ,  $n=88$ ) are shown in bold and italic.

### 6.4.5 Attention and Strangeness

Attention to the story and perceived strangeness of the story were only considered in Study 2. Attention (ATT) was measured using one item, ATT1, thus validity and reliability could not be assessed here. Strangeness (STR) was measured using four items: STR1 – STR4. As shown in Table 6.10, all these items correlated significantly with the exception of STR1. Cronbach's alpha coefficient for the STR scale was not high enough to claim reliability ( $\alpha=0.594$ ,  $n=86$ ). However, excluding STR1 increased this value sufficiently for reliability ( $\alpha=0.768$ ,  $n=87$ ). Thus, STR2 - 4 formed a valid and reliable scale. STR3 was negatively skewed, indicating a possible bias for this item.

Item	STR1	STR2	STR3	STR4
STR1	1.00	0.04	-0.03	0.08
STR2	0.04	1.00	<i><b>0.55</b></i>	<i><b>0.52</b></i>
STR3	-0.03	<i><b>0.55</b></i>	1.00	<i><b>0.53</b></i>
STR4	0.08	<i><b>0.52</b></i>	<i><b>0.53</b></i>	1.00

Table 6.10: Correlation matrix for the items, STR1, STR2, STR3 and STR4 of the STR scale, used to measure strangeness in Study 2. Significant correlations ( $p < 0.05$ ,  $n=86$ ) are shown in bold and italic.

## 6.5 Discussion of Questionnaires

### 6.5.1 Hip-hop Interest

Recall that two measures were used to measure hip-hop interest in Study 1 and 2: one multiple choice question and a questionnaire consisting of items rated on a 7-point Likert-type scale (see Section 4.5, Chapter 4). For the sum scale, three of its five items in Study 1 were valid and reliable. The two items which decreased the validity and reliability, HI1 and HI2, actually inquired into general music interest, whereas the three valid and reliable items referred directly to interest in hip-hop or rap, thus it is fitting that these two sets of items did not measure the same factor or agree (see Section B.2, Appendix B).

Study 2's multiple item scale consisted of the three items judged as valid and reliable in Study 1 as well as three new items. This was since we wished to increase the Cronbach's alpha coefficient for this scale to a solid 0.8 value rather than the 0.755 found in Study 1. All the items of the new scale were concurrently valid except the last item, which also decreased the overall reliability. This was not unexpected since this item inquired into participants' opinion on classical music's contemporary relevance. It was included based on the small chance that there might be a relationship between an interest in hip-hop and in classical music. With this item excluded, the scale was both valid and reliable. Also, Cronbach's alpha coefficient was higher in Study 2 at 0.836, indicating greater reliability. In both studies there was a sole correlation between the choice of hip-hop as a favorite music genre in the multiple choice question and the hip-hop interest scores. This showed a definite link between the choice of hip-hop as a favorite music genre and a high hip-hop interest score.

### 6.5.2 Comprehension

In Study 1 the comprehension questionnaire comprised five different scales: a cloze test, sequence test, sentence verification technique (SVT) test, inference questions test and a fact questions test. This comprehension questionnaire was amended for use in Study 2 such that only three scales, the cloze, sequence and SVT test, were used. In this section we consider the psychometric soundness of all the comprehension scales used in our research and evaluate Study 1 and 2's comprehension questionnaires as a whole.

#### *Cloze Test*

The cloze test used in Study 1 showed no concurrent validity and its reliability could not be determined as it consisted of only two items. For Study 2 the cloze test was extended into eleven items; only 7% of these correlated. If we assume a 5% error rate, then we can conclude that these correlations were most likely spurious, showing an absence of concurrent validity among the cloze items. The cloze test also showed a low reliability and while eliminating certain items increased its reliability value, the increase was never high enough to claim reliability in the test.

A major drawback of the cloze test in our research was that many participants did not fill in the sentence blanks. In Study 2, for instance, there were only 36 fully completed cloze tests from a sample of 86 participants. This, of course, reduced the sample of complete cloze tests available for statistical analysis and, in turn, compromised the potential accuracy of these analyses. Recall from Section 6.4.2 that the items which decreased the reliability of Study 2's cloze test were those which many participants had left unanswered. Excluding these items effectively increased the sample of completed cloze tests. Since sample size is a major contributor to the Cronbach's alpha formula, it is possible that the increase in Cronbach's alpha coefficient was due to the sample size increase rather than improved scale reliability. Therefore, the cloze test ultimately proved neither valid nor reliable.

### *Sequence Test*

A five-item sequence test was used in Study 1; by eliminating two of these items, this test emerged as the most successful comprehension scale of Study 1, proving both valid and reliable. In an attempt to further increase the sequence test's reliability, all the sequence test items used in Study 1 plus two new items were used in Study 2. As mentioned in Section 4.5.2, Chapter 4, adding the new items required that the existing items change slightly to ensure that the items remained independent of each other. In this amended scale, we found that there were two items which decreased the scale's validity and reliability. The remaining items were concurrently valid but not reliable.

At first it seemed that we had eliminated the reliability of the sequence test in Study 1 by retaining Study 1's problematic items and adding new items. However, when calculating the reliability of just the items which proved reliable in Study 1, we found that they were *not* reliable in Study 2. From this we could conclude that the slight changes made to the existing, reliable items affected their reliability, however, it must be noted that only one of the three originally reliable items was actually changed. It is also possible that the larger sample of Study 2 simply responded differently to the sequence test.

### *Sentence Verification Technique (SVT) Test*

The SVT test performed rather poorly in Study 1 with only a 14% inter-item correlation and a very low KR20 value, indicating a lack of validity and reliability. Despite this SVT was used again in Study 2 since it had correlated with the cloze test and sequence test. Additionally, SVT is very well supported by educational literature (Royer, 2001). In Study 2, an extra set of four sentences was added to the existing SVT test. The 38% inter-item correlation noted in Study 2 was a vast improvement from Study 1 and ensured that all the items, with the exception of one, were either directly or indirectly related. Therefore we conclude that this test was concurrently valid. This SVT test also proved to be reliable, another improvement over the scale in Study 1: this may have been due to the larger number of items in the Study 2 scale and/or the larger sample in Study 2.

### *Inference Questions Test*

In Study 1, all the participants answered two of the three inference questions correctly. This strongly suggests that the correct answers to these two items were too obvious. The lack of variance in participants' responses prevented us from performing any statistical tests with this data, thus inference questions were not used in Study 2.

### *Fact Questions Test*

Three fact questions were used in Study 1; these were concurrently valid but not reliable. As with the cloze test, a number of participants left the fact questions unanswered. This slightly decreased the sample of complete fact questions available for psychometric analysis. A fact test was not used in Study 2 since it only correlated with one other comprehension scale in Study 1, namely the sequence test.

### *Overall: The Comprehension Questionnaire*

The majority of the five comprehension scales used in Study 1 did not prove valid or reliable. But, the total scores for three of the scales, the cloze test, sequence test and sentence

verification technique (SVT) test correlated significantly, suggesting concurrent validity between them. Unfortunately, Study 1's comprehension questionnaire was not found to be reliable overall. This meant that we were unable to draw solid conclusions from Study 1's comprehension results.

In order to improve the comprehension questionnaire, it was amended for use in Study 2. The three scales which showed overall concurrent validity in Study 1, namely the cloze, sequence and SVT tests, were selected for use in Study 2. The idea here was to focus on fewer scales and attempt to improve their individual validity and reliability so as to improve the comprehension questionnaire's overall soundness. More items were included in each scale because number of items is a key contributor in the Cronbach's alpha and KR20 formulae; the more items in a scale the more reliable it is likely to be. Although there were still some problems with the individual scales (as discussed earlier), the amended questionnaire fared better overall. Once again there was concurrent validity between the cloze, sequence and SVT tests, but also the comprehension questionnaire proved reliable overall. In both studies we also found that the majority of the comprehension scales showed a very low level of difficulty.

A major difficulty in both studies was that of uncompleted comprehension items. This occurred in tests which required written answers, such as the cloze and fact questions tests, rather than those where an answer could be selected from a number of options, such as the sequence and SVT tests. This led us to conclude that tests requiring written answers are inconvenient since they may render incomplete data sets.

### 6.5.3 Interest

The same interest questionnaire was used for both Study 1 and 2. It consisted of three scales for measuring variables tIB (a tendency to show interest in folklore and South African cultures), sIB (existing knowledge of the San and San folklore) and INT (interest in the San). The tIB items did not correlate with each other in Study 1. However, this result made sense since one tIB item measured a tendency to enjoy myths and fairytales (tIB1) while the second measured a tendency to show interest in South African cultures (tIB2). Thus each item tapped into different tendencies, but together they proved useful in interpreting effects on the interest variable (see Sections 6.3.3). In Study 2 the tIB items did correlate implying that, for the sample in Study 2, the two different tendencies were, in fact, related. The sIB items were correlated in both Study 1 and 2, showing concurrent validity as well as a relationship between existing knowledge of the San (measured by sIB1) and of San stories (measured by sIB2). Reliability for the tIB and sIB scales could not be calculated as they each consisted of only two items.

The INT scale was the most successful custom-made scale of this research, consistently proving valid and reliable in Study 1 and 2. Furthermore, no significant skew was noted in the scale for Study 1, suggesting that experimenter bias had not affected participants' responses (see Section 6.3.3). In Study 2, significant skew was found for two INT items: one negatively and the other positively skewed. The negatively skewed item (INT3) measured interest in attending a San museum exhibit; responses were skewed in favour of attending the exhibit. The positively skewed item (INT6) measured the likelihood of seeking books on the San at a library; here responses were skewed against seeking such books. Since these items were not skewed in Study 1 one could conclude that the university student sample of Study 2 were both markedly interested in visiting museums, yet disinterested in seeking out reading material on the San. In any event, since these items were skewed in opposite directions we cannot conclude that participants' responses were biased in any one direction.

#### 6.5.4 Enjoyment, Boredom and Confusion

Only a few items were used to measure enjoyment, boredom and confusion, this was done to keep the overall questionnaire length reasonable. We were thus unable to calculate reliability values for these scales. We did find that the two enjoyment items were concurrently valid in Study 1 and 2. Since the confusion scale consisted of one item each in Study 1, its validity could not be evaluated. In Study 2, the confusion scale consisted of two items which were concurrently valid. The boredom scale consisted of one item in both Study 1 and 2; hence its validity could not be assessed in either.

The enjoyment, boredom and confusion scales, in both Study 1 and 2, showed no skew. This was a very positive result as there was a possibility that participants might try and answer these subjective questions 'correctly' in order to please the experimenter (see Sections 6.3.4 and 6.4.4). The lack of skew indicated that experimenter bias mostly likely did not influence participants' responses to these items.

#### 6.5.5 Attention and Strangeness

Attention to the story and perceived strangeness of the San story were only measured in Study 2. Since the attention scale consisted of only one item, its validity and reliability could not be assessed. We did note, however, that participant's responses to this item were not skewed indicating that this item had not been affected by experimental bias.

The strangeness scale consisted of four items asking participants to rate how strange or unusual that San story seemed to them. Three of these items formed a valid and reliable scale. The item which decreased the scale's validity and reliability asked whether participants thought that the San story was an 'ordinary fairytale' whereas the other items referred to the story's 'strangeness', 'bizarreness' and 'unusualness'. It is likely that this item did not strictly measure strangeness as the other items did. Of the three valid, reliable items, one was negatively skewed. The skewed item asked whether the characters in the story were unusual. Given that the story characters consisted of a different species of animals which behaved as people and were related to each other, one could say that the characters were extraordinarily different from those which Study 2's participants are likely to have encountered in stories and would judge as normal. So it is not too surprising that most participants found them unusual. Since skew was only observed for one item, which measured we concluded that, overall, the strangeness scale was had not been affected by experimenter bias.

### 6.6 Summary of Psychometric Outcomes

The following were the outcomes for each scale (note that validity could only be assessed where scales consisted of more than one item and reliability could only be tested for scales consisting of more than two items):

- *Hip-hop Interest:* Two scales were used to measure hip-hop interest: a multiple choice question asking participants to select their favourite music genre from a choice of classical, hip-hop, alternative, rhythm and blues (RnB), rock and jazz; and a scale consisting of statements to be rated on a 7-point Likert-type scale. The latter scale consisted of five items in Study 1; three of these formed a valid and reliable scale and two items were discarded. Three new items were added to this scale in Study 2 to form a three-item scale, one of which was ultimately discarded. In both studies the Likert-type scale was valid and reliable. Furthermore, there were concurrent validity between the choice of hip-hop as a favourite music genre in the multiple choice question and high scores on the Likert-type scale.

- *Comprehension:* The comprehension questionnaire used in Study 1 consisted of five scales: cloze, sequence, sentence verification technique (SVT), inference and fact question tests. Of these, the fact questions test was valid but not reliable and only the sequence test was both valid and reliable. On the whole, the scales showed a low level of difficulty. There was a certain degree of concurrent validity between these scales, but the comprehension questionnaire was not reliable overall. In Study 2 only three scales were used to measure comprehension. Of these, one was neither valid nor reliable (the cloze test), one was only valid (the sequence test) and one was both valid and reliable (the SVT test). While there were some problems with the individual scales, the three scales showed concurrent validity with each other and Study 2's comprehension questionnaire showed overall reliability.
- *Interest:* The interest questionnaire set out to measure three factors: a tendency to be interested in folklore and South African cultures (2 items), existing awareness of the San and their folklore (2 items) and interest in and desire to find out more about the San (8 items). The same interest questionnaire was used in Study 1 and 2. The two items measuring tendencies toward interest were concurrently valid in Study 2 but not Study 1. However, since these measured tendencies toward interest in two distinct topics we did not expect concurrent validity between these items. The two items measuring existing awareness of the San and their folklore were concurrently valid in both studies. The eight-item interest scale was valid and reliable in both studies. Also, experimental bias did not appear to affect participants' responses to the interest questionnaire in Study 1 and 2.
- *Enjoyment:* The same enjoyment scale was used to measure enjoyment in both Study 1 and 2. The two items in this scale were concurrently valid and free of experimental bias.
- *Boredom:* A one-item scale was used to measure boredom in both Study 1 and 2; this item was free of experimental bias in both studies.
- *Confusion:* A one-item scale was used to measure confusion in Study 1; this item was free of experimental bias. In Study 2 an additional item was added to the confusion scale, the two items were concurrently valid and also free of experimental bias.
- *Attention:* Attention was measured in Study 2, using a one-item scale; this item was free of experimental bias.
- *Strangeness:* Strangeness was measured in Study 2, using a four-item scale. The first item was discarded and the remaining three items formed a valid and reliable scale with only one item showing bias.

# Chapter 7

## Results

So far we have presented the two studies conducted in our research: Study 1 and Study 2. These studies investigated story experience in VR *vs.* text, as well as the use of a culturally familiar introductory VE to preface a virtual San storytelling environment. This was achieved by using a between-subjects design in both studies where participants experienced one of three storytelling scenarios: story text (T), virtual storytelling with no introductory VE (VR+NI) and virtual storytelling with introductory VE (VR+I) (described in Chapter 5). Study 1 was conducted with a sample of high-school learners while Study 2 was conducted with a sample of undergraduate university students. We have already presented the psychometric analysis of a number of questionnaires which were created specifically for these two studies in Chapter 6. In this chapter we proceed to describe the statistical procedures used to analyse the data from Study 1 and 2 and the significant results obtained. First, the use of ANOVA's for testing our research hypotheses is described. Next, the results of Study 1 and 2 are presented: for each study we first cover descriptive and demographic statistics, next the relationships between the dependent variables is explored and, finally, the outcomes of our hypotheses testing are presented.

### 7.1 Hypotheses Testing: ANOVA's

Analysis of variance (ANOVA) was used extensively in testing our hypotheses. ANOVA's test differences of means of one or more dependent variables across one or more samples (Howell, 1987). An ANOVA makes two major assumptions: firstly, that within each sample, there is a normal distribution for the dependent variable under consideration, and secondly, that the dependent variable showed the same variance in all the samples being compared; this is also known as homogeneity of variance (Howell, 1987). However, Howell (1987) states that the ANOVA is robust and these assumptions may be violated to an extent without affecting results. In particular, if the dependent variables' distributions are not significantly skewed or significantly peaked or flat, an ANOVA may still be applied (Howell, 1987; Becker, 1999). A distribution's "peakness" is measured by its kurtosis value. A distribution which has a significantly tall peak is called a leptokurtic distribution and a significantly flat distribution is platykurtic (Howell, 1987).

Before conducting any ANOVA's, we tested the assumptions of normality and homogeneity of variances. The distributions of each dependent variable in each experimental condition under consideration were first tested for normality using the Shapiro-Wilks statistic (Becker, 1999). For those distributions reported as significantly non-normal, we further tested skew and kurtosis. Distributions whose skew lay outside the 95% confidence intervals for skewness were considered significantly skewed. Similarly, distributions whose kurtosis lay outside the 95% confidence intervals for kurtosis were considered significantly leptokurtic or platykurtic (Becker, 1999). Homogeneity of variances was tested using Levene's Test (Howell, 1987; Becker, 1999). Where either assumption was significantly violated, the nonparametric Kruskal-Wallis ANOVA was used to test differences of means. While less powerful than a standard ANOVA, this test does not assume normality or homogeneity of variance and is, thus, it is more likely to render a more accurate result in cases where the ANOVA's assumptions are significantly violated.

## 7.2 Study 1

In Study 1, 88 high-school learners were randomly divided into three groups. One group experienced the San story as a printed text (T), the second listened to the story told in a VE (VR+NI) and the third group listened to the story told in a VE preface by a hip-hop themed introductory VE (VR+I). There were 22 participants in the T group, 11 in the VR+NI group and 11 in the VR+I group.

### 7.2.1 Descriptive Statistics and Demographic Data

The descriptive statistics for Study 1 are presented in Table 7.1 below. Note that half of the 44 participants experienced one of the VR storytelling scenarios, thus there are 22 data points for presence (P). Each participant's grade, age and gender were recorded and their influence was analysed using general linear models; they were found to have no significant effect.

Variable	Valid N	Mean	-95% CI	+95% CI	Min	Max	Std. Dev.
HI	44	16.32	15.11	17.52	5.00	21.00	3.96
Ccloze	44	1.57	1.39	1.75	0.00	3.00	0.59
Cseq	44	2.27	1.95	2.60	0.00	3.00	1.07
Csvt	44	9.41	8.85	9.97	4.00	12.00	1.83
Cfact	44	2.57	2.05	3.08	0.00	6.00	1.69
C	44	15.82	14.70	16.94	6.00	23.00	3.69
tIB	44	9.43	8.56	10.30	3.00	14.00	2.86
sIB	44	11.72	10.87	12.58	2.00	14.00	2.81
INT	44	30.91	27.05	34.77	8.00	56.00	12.70
ENJ	44	9.07	7.95	10.19	2.00	14.00	3.68
CON	44	4.48	3.85	5.11	1.00	7.00	2.08
BOR	44	3.89	3.28	4.49	1.00	7.00	1.99
P	22	62.64	56.63	68.65	24.00	91.00	13.56

Table 7.1: Descriptive statistics for hip-hop interest (HI), cloze test (Ccloze), sequence test (Cseq), SVT test (Csvt), fact questions test (Cfact), overall story comprehension (C), interest tendency (tIB), existing San knowledge (sIB), interest (INT), enjoyment (ENJ), confusion (CON), boredom (BOR), and presence (P) in Study 1.

### 7.2.2 Correlations between the Dependant Variables

In Chapter 3, we proposed possible properties of an effective story experience and in Chapter 4 we defined a number of dependent variables corresponding to these properties. In order to test our assumptions on effective storytelling, we looked at the correlations between these dependent variables. Comprehension (C) did not correlate with any of the other variable we associated with story experience, although the sentence verification technique (SVT) test (Csvt) correlated significantly with enjoyment (ENJ) ( $r=-0.30$ ,  $n=44$ ). Interest (INT) correlated positively with ENJ while boredom (BOR) and confusion (CON) correlated significantly with each other and negatively with both INT and ENJ (see Table 7.2).

Variable	C	INT	ENJ	CON	BOR
C	1.00	-0.04	-0.13	-0.02	0.06
INT	-0.04	1.00	<b><i>0.69</i></b>	<b><i>-0.47</i></b>	<b><i>-0.63</i></b>
ENJ	-0.13	<b><i>0.69</i></b>	1.00	<b><i>-0.38</i></b>	<b><i>-0.83</i></b>
CON	-0.02	<b><i>-0.47</i></b>	<b><i>-0.38</i></b>	1.00	<b><i>0.48</i></b>
BOR	0.06	<b><i>-0.63</i></b>	<b><i>-0.83</i></b>	<b><i>0.48</i></b>	1.00

Table 7.2: Correlation matrix for dependent variables comprehension (C), interest (INT), enjoyment (ENJ), boredom (BOR) and confusion (CON) in Study 1. Significant correlations ( $p < 0.05$ ,  $n=44$ ) are shown in bold and italic.

### 7.2.3 The Effect of Storytelling Medium on Story Experience

To test for the effect of storytelling medium on the dependent variables, the T group was compared to the VR+NI and VR+I groups combined into one VR group. The VR+NI and VR+I groups were combined for this comparison since we found no significant differences between them for any of the dependent variables (this is presented in full detail later, in Section 7.2.4). One-way ANOVA's and Kruskal-Wallis ANOVA's were used to compare the T and VR groups.

Performance on each of the comprehension scales, the cloze test (Ccloze), sequence test (Cseq), SVT test (Csvt) and fact questions test (Cfact) was assessed as well as the total C score. Participants who read the story text achieved significantly higher scores on the Ccloze ( $H(1)=6.19$ ;  $p<0.01$ ), Cseq ( $H(1)=4.51$ ;  $p<0.03$ ) and Csvt ( $H(1)=10.63$ ;  $p<0.001$ ) scales. Overall the T group had significantly higher total C scores than the VR group ( $F(1)=14.80$ ;  $p<0.0004$ ), a means plot of this effect is shown in Figure 7.1 below. The average total comprehension score achieved in the VR group was 63% as opposed to 77% in the T group.

An opposite effect was observed for the INT variable: the VR group exhibited a significantly greater INT scores over the T group ( $F(1)=5.64$ ,  $p<0.02$ ). This effect is shown by the means plot in Figure 7.2. In order to gain a more accurate idea of the influence of storytelling medium on interest, the interest baseline data, namely tIB (tendency to show interest) and sIB (existing knowledge of the San), was also considered. A general linear model was built to test tIB, sIB and storytelling medium (VR/T) as predictors of INT. The model is shown in Table 7.3 below. There were two significant predictors of INT: tIB and VR/T. Even when taking into consideration tIB, a highly significant INT predictor, storytelling medium still proved a significant predictor, such that VR resulted in greater INT.

Storytelling medium also had significant effects on the ENJ, BOR and CON variables. A Kruskal-Wallis ANOVA showed that the VR group reported significantly greater ENJ levels ( $H(1)=13.69$ ,  $p<0.0002$ ) than the T group. One-way ANOVA's showed that the VR group reported significantly lower levels of both BOR ( $F(1)=15.54$ ,  $p<0.0003$ ) and CON ( $F(1)=7.44$ ,  $p<0.009$ ) than the T group. Means plots for these effects are shown in Figure 7.3 and Figure 7.4 respectively.

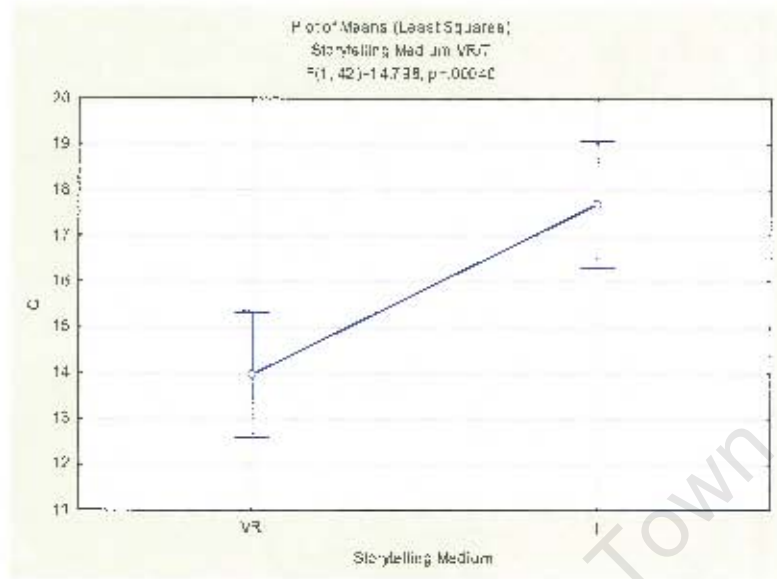


Figure 7.1: Means plot of the effect of Storytelling Medium (VR/T) on Comprehension (C) in Study 1. C was significantly higher in the text (T) condition than in the virtual reality (VR) condition.

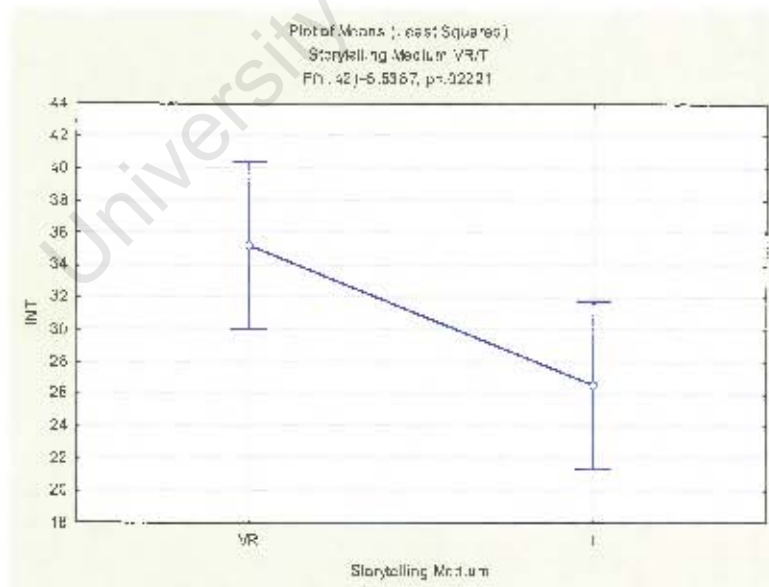


Figure 7.2: Means plot of the effect of Storytelling Medium (VR/T) on Interest (INT) in Study 1. INT was significantly higher in the virtual reality (VR) condition than in the text (T) condition.

Effect	df	F	P
<b>tIB</b>	<b>1</b>	<b><i>53.98</i></b>	<b><i>&lt;0.0001</i></b>
<b>sIB</b>	<b>1</b>	<b><i>0.27</i></b>	<b><i>&lt;0.609</i></b>
<b>VR/T</b>	<b>1</b>	<b><i>7.02</i></b>	<b><i>&lt;0.011</i></b>

Table 7.3: Summary of effects for a general linear model with interest (INT) as the dependent variable and tendency to show interest in folklore and South African cultures (tIB), existing knowledge of the San and San stories (sIB) and storytelling medium (VR/T) as predictors, in Study 1. Significant effects ( $p < 0.05$ ,  $n=44$ ) are shown in bold and italic.

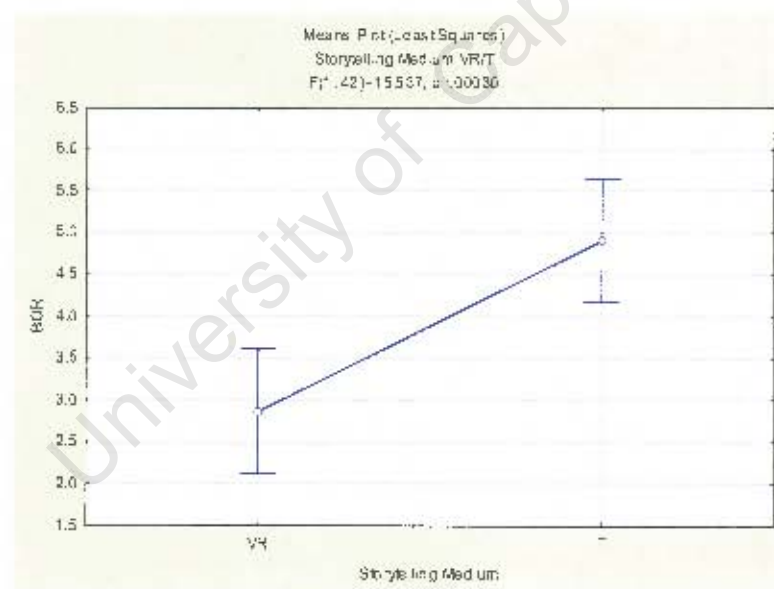


Figure 7.3: Means plot of the effect of Storytelling Medium (VR/T) on Boredom (BOR) in Study 1. BOR was significantly higher in the text (T) condition than in the virtual reality (VR) condition.

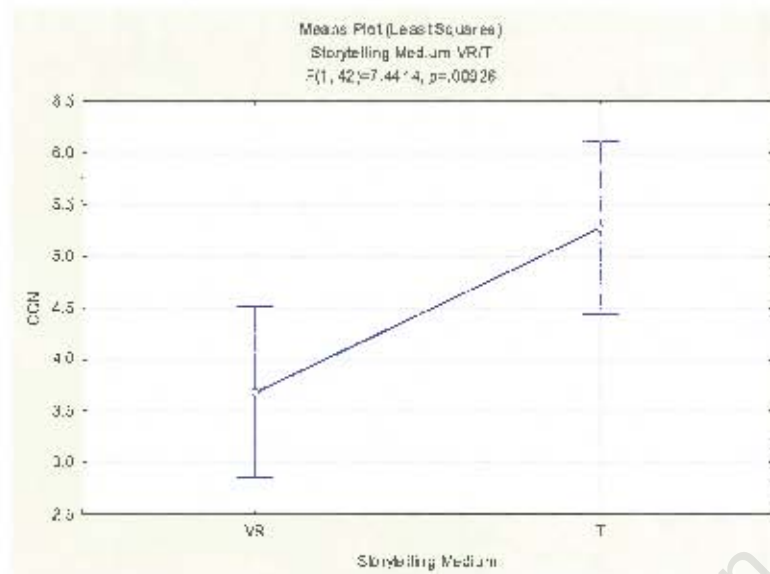


Figure 7.4: Means plot of the effect of Storytelling Medium (VR/T) on Confusion (CON) in Study 1. CON was significantly higher in the text (T) condition than in the virtual reality (VR) condition.

#### 7.2.4 The Effect of an Introductory VE on Story Experience

To test whether the inclusion of culturally familiar introductory VE influenced participants' experience of the virtual San storytelling, the VR+NI and VR+I groups were compared. No significant differences were noted between these two groups on any of the C scales or on the total C score. Additionally, the introductory VE was found to have no effect on INT. As in Study 1 above we tested the significance of the introductory VE as a predictor of INT along with tIB and sIB in a general linear model. Once again, tIB was identified as a significant INT predictor, while the introductory VE had no effect. The introductory VE also had no effect on the ENJ, BOR and CON variables.

We also tested how participants' hip-hop interest (HI) levels influenced their response to the hip-hop themed introductory VE. HI was measured by a multiple choice question (HI<sub>mc</sub>) and a number of items consisting of statements which participants were required to rate on a 7-point Likert-type scale (HI<sub>rate</sub>). General linear models were used to test for HI's role as a predictor of the dependent variables within the VR+NI and VR+I groups. Within the VR+I group, HI<sub>rate</sub> was a significant predictor of ENJ and these two variables correlated positively within this group ( $r=0.64, n=11$ ).

#### 7.2.5 The Relationship between Presence and Story Experience

Correlations were performed to establish the relationship between presence (P) and those variables associated with story experience, namely C, INT, ENJ, BOR and CON. However, P only correlated significantly with INT ( $r=0.44, n=22$ ).

### 7.3 Study Two

In Study 2, storytelling scenarios investigated in Study 1 were tested with a sample of 98 university students. Again, the students were randomly divided into three groups: one group experienced the San story as a printed text (T), the second listened to the story told in a VE (VR+NI) and the third group listened to the story told in a VE prefaced by a hip-hop themed introductory VE (VR+I). There were 30 participants in the T group, 30 in the VR+NI group and 28 in the VR+I group. Notably, two new variables, attention (ATT) and strangeness (STR), were added for consideration in Study 2.

#### 7.3.1 Descriptive Statistics and Demographic Data

The descriptive statistics for Study 2 are presented in Table 7.4 below. Note that, from a sample 88, there are 58 data points for presence (P); this is since P was measured for those participants who experienced one of the virtual storytelling scenarios. Additionally, there are only 87 data points for the comprehension scales. This is since one participant did not complete any of the comprehension questionnaire items, therefore this data point was excluded from analyses involving comprehension.

Variable	Valid N	Mean	-95% CI	+95% CI	Min	Max	Std. Dev.
HI	88	21.26	19.81	22.72	6.00	35.00	6.86
Ccloze	87	5.70	5.24	6.16	0.00	10.00	2.16
Cseq	87	4.11	3.77	4.46	0.00	6.00	1.61
Csvt	87	12.69	12.05	13.33	3.00	16.00	2.99
C	87	22.50	21.27	23.73	9.00	31.00	5.78
tIB	88	10.02	9.47	10.58	4.00	14.00	2.62
sIB	88	10.74	9.96	11.52	2.00	14.00	3.70
INT	88	35.31	33.16	37.45	9.00	56.00	10.12
ENJ	88	8.34	7.65	9.04	2.00	14.00	3.28
CON	88	3.27	2.88	3.66	1.00	7.00	1.83
BOR	88	13.10	12.11	14.09	3.00	21.00	4.68
ATT	88	4.22	3.82	4.61	1.00	7.00	1.85
STR	88	25.76	24.02	27.50	11.00	41.00	8.22
P	58	59.48	56.14	62.82	35.00	88.00	12.71

Table 7.4: Descriptive statistics for hip-hop interest (HI), cloze test (Ccloze), sequence test (Cseq), SVT test (Csvt), overall story comprehension (C), interest tendency (tIB), existing San knowledge (sIB), interest (INT), enjoyment (ENJ), confusion (CON), boredom (BOR), attention (ATT), strangeness (STR) and presence (P) in Study 2.

For each participant, age, gender and year of university study were recorded and we tested whether any of these demographics influenced any of the dependent variables using general linear models. We found that age was a significant predictor of ATT ( $F(1)=5.09$ ,  $p<0.027$ ) and a negative correlation was noted between the two ( $r=-0.14$ ,  $n=88$ ). Also, year of study was a significant predictor of both CON ( $F(1)=3.75$ ,  $p<0.014$ ) and STR ( $F(1)=5.022$ ,  $p<0.003$ ). Participants in this study ranged from 1<sup>st</sup> to 4<sup>th</sup> year students; therefore post-hoc tests were conducted to determine where exactly the significant differences lay. A Fisher LSD test showed significant CON differences between students in 1<sup>st</sup> and 3<sup>rd</sup> year ( $p<0.009$ ), 1<sup>st</sup> and 4<sup>th</sup> year ( $p<0.028$ ) and 2<sup>nd</sup> and 3<sup>rd</sup> year ( $p<0.039$ ). All these differences were such that CON was lower for the students with more years of study. For STR, a Fisher LSD test showed significant

differences between 1<sup>st</sup> and 2<sup>nd</sup> year ( $p < 0.007$ ), 1<sup>st</sup> and 3<sup>rd</sup> year ( $p < 0.003$ ) and 3<sup>rd</sup> and 4<sup>th</sup> year ( $p < 0.048$ ) students. In general, STR levels were significantly lower for students with more years of study, with the exception that 4<sup>th</sup> year students showed significantly higher STR than 3<sup>rd</sup> year students.

### 7.3.2 Correlations between Dependent Variables

As in Study 1, the correlations between the dependent variables related to story experience were investigated as a test of our story experience conceptualisation (See Section 3.1, Chapter 3). Additionally we wished to see how, ATT and STR, the variables introduced in Study 2, related to the other dependent variables.

The dependent variables were quite strongly related, as shown in Table 7.5 below. C correlated positively with INT, ENJ and ATT and negatively with BOR and CON. Similarly, INT correlated positively with ENJ and ATT and negatively with BOR, CON and STR. ENJ also correlated positively with ATT and negatively with BOR, CON and STR. Meanwhile, BOR, CON, and STR correlated positively with each other. ATT correlated negatively with BOR and CON. The only instances where these variables were unrelated was in the case of STR with both C and ATT.

Variable	C	INT	ENJ	CON	BOR	ATT	STR
C	1.00	<i>0.22</i>	<i>0.28</i>	<i>-0.42</i>	<i>-0.32</i>	<i>0.41</i>	0.13
INT	<i>0.22</i>	1.00	<i>0.62</i>	<i>-0.38</i>	<i>-0.52</i>	<i>0.43</i>	<i>-0.40</i>
ENJ	<i>0.28</i>	<i>0.62</i>	1.00	<i>-0.56</i>	<i>-0.69</i>	<i>0.63</i>	<i>-0.35</i>
CON	<i>-0.42</i>	<i>-0.38</i>	<i>-0.56</i>	1.00	<i>0.50</i>	<i>-0.41</i>	<i>0.42</i>
BOR	<i>-0.32</i>	<i>-0.52</i>	<i>-0.69</i>	<i>0.50</i>	1.00	<i>-0.51</i>	<i>0.34</i>
ATT	<i>0.41</i>	<i>0.43</i>	<i>0.63</i>	<i>-0.41</i>	<i>-0.51</i>	1.00	0.07
STR	0.13	<i>-0.40</i>	<i>-0.35</i>	<i>0.42</i>	<i>0.34</i>	-0.07	1.00

Table 7.5: Correlation matrix for dependent variables comprehension (C), interest (INT), enjoyment (ENJ), confusion (CON), boredom (BOR), attention (ATT) and strangeness (STR) in Study 2. Significant correlations ( $p < 0.05$ ,  $n=87$ ) are shown in bold and italic.

### 7.3.3 The Effect of Storytelling Medium on Story Experience

As in Study 1 no significant differences were found between the VR+NI and VR+I groups (see Section 7.3.4 below) for any of the dependent variables. Therefore the VR+NI and VR+I groups were again combined into one VR group for comparison with the T group.

Kruskal-Wallis ANOVA's were used to examine differences in means between the VR and T groups for the individual C scales and the total C score. This was done because the data for all the C scales violated one or both of the ANOVA assumptions discussed in Section 7.1 above. In particular, the comprehension scores within the T group were all significantly negatively skewed. We found significant differences between the VR and T groups for all the comprehension scales: Ccloze ( $H(1)=36.09$ ,  $p < 0.00001$ ), Cseq ( $H(1)=30.87$ ,  $p < 0.00001$ ) and Csvt ( $H(1)=13.07$ ,  $p < 0.0003$ ). For each scale the T group consistently achieved significantly higher scores than the VR group. Consequently the T group achieved a significantly higher overall C score ( $H(1)=33.07$ ,  $p < 0.00001$ ) than the VR group. The average total comprehension score achieved in the VR group was 58% as contrasted with 82% in the T group.

Storytelling medium was found to have no effect on INT in a one-way ANOVA or in the general linear model, shown in Table 7.6 below. The only significant predictor of INT was a tendency to show interest in folklore and South African cultures (tIB), while storytelling medium (VR/T) had almost zero effect.

Effect	df	F	p
tIB	1	<b>115.54</b>	<b>&lt;0.0001</b>
sIB	1	0.38	<0.537
VR/T	1	0.06	<0.811

Table 7.6: Summary of effects for a general linear model with interest (INT) as the dependent variable and tendency to show interest in folklore and South African cultures (tIB), existing knowledge of the San and San stories (sIB) and storytelling medium (VR/T) as predictors, in Study 2. Significant effects ( $p < 0.05$ ,  $n=88$ ) are shown in bold and italic.

There were also no significant differences between the VR and T groups for the ENJ and BOR variables. One-way ANOVA's did show that the VR group reported significantly higher CON than the T group ( $F(1)=5.10$ ,  $p<0.026$ ) and significantly lower ATT than the T group ( $F(1)=8.13$ ,  $p<0.005$ ). Means plots for these effects are shown in Figure 7.5 and Figure 7.6, respectively. A Kruskal-Wallis ANOVA further showed that STR was significantly lower in the VR group than in the T group ( $H(1)=6.04$ ,  $p<0.014$ ).

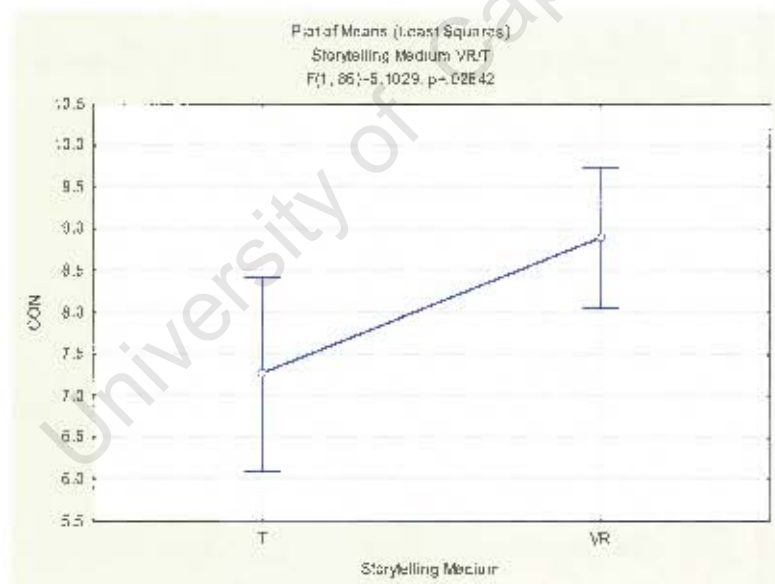


Figure 7.5: Means plot of the effect of Storytelling Medium (VR/T) on Confusion (CON) in Study 2. CON was significantly higher in the virtual reality (VR) condition than in the text (T) condition.

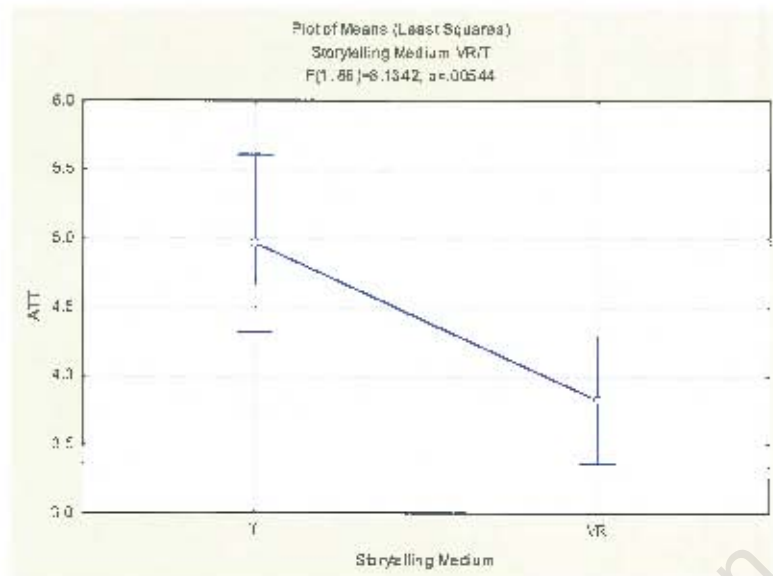


Figure 7.6: Means plot of the effect of Storytelling Medium (VR/T) on Attention (ATT) in Study 2. ATT was significantly higher in the text (T) condition than in the virtual reality (VR) condition.

#### 7.3.4 The Effect of an Introductory VE on Story Experience

In order to test the effect of the hip-hop themed introductory VE on story experience, a series of ANOVA's and general linear models were conducted to compare the VR+NI and VR+I groups. However, no significant differences were found for any of the dependent variables. The influence of participants' hip-hop interest (HI) was also tested using general linear models. Within the VR+I group, HI<sub>mc</sub> was a significant predictor of presence (P). More specifically, participants who experienced the introductory VE *and* identified hip-hop as their favorite music genre also exhibited significantly higher levels of P than those identified any other music genre as their favorite ( $F(1)=5.31, p<0.029$ ).

#### 7.3.5 The Relationship between Presence and Story Experience

In order to determine how presence (P) related to story experience, we looked at the correlations between P and the variables associated with story experience, namely C, INT, ENJ, CON, BOR, ATT, and STR. However, we found that P did not correlate significantly to any of these variables.

### 7.4 Study One and Two: Comparative Analyses

In our analyses on the effect of storytelling medium on story experience, a number of results were not consistent from Study 1 to 2. Specifically, significant differences were found between the VR and T groups for INT, ENJ and BOR in Study 1, but not in Study 2. We wished to investigate the possible role that the studies themselves might have played in these conflicting outcomes. Therefore Study 1 and 2's samples were combined and factorial ANOVA's were performed to test for the influence of both the study (1 or 2) and storytelling medium (VR or T) on INT, ENJ and BOR. Luckily, these cross-study comparisons were possible since INT, ENJ and BOR were measured using the same measures in both Study 1 and 2.

#### 7.4.1 The Effect of Study and Storytelling Medium on Interest

In Study 1 INT in the VR group was significantly higher than that of the T group, but, we did not find a significant INT difference between these two groups Study 2. This discrepancy was further investigated using a 2x2 factorial ANOVA testing the effect of storytelling medium (VR or T) and study (1 or 2) on INT. Main effects were found for both study ( $F(1)=4.57, p<0.034$ ) and storytelling medium ( $F(1)=4.77, p<0.031$ ) such that INT was significantly higher in Study 2's participants and in the VR groups across the two studies.

An interaction effect between storytelling medium and study was also observed for INT. A means plot for this effect is shown in Figure 7.7. The graph shows that INT in Study 1's T group is far lower than that of any of the other groups. Also, there is a large INT difference between the T groups of Study 1 and 2, while there was only a small difference in INT between the VR groups of Study 1 and 2. The significance of these differences was investigated using a Fisher LSD post-hoc test. The Fisher LSD test confirmed the significant INT difference, already presented in Section 7.2.3 above, between the VR and T groups in Study 1 ( $p<0.009$ ). It also showed that there was a significant difference in INT between Study 1 and 2's T groups ( $p<0.006$ ) and between Study 1's T group and Study 2's VR group ( $p<0.001$ ).

#### 7.4.2 The Effect of Study and Storytelling Medium on Enjoyment

In Study 1 ENJ was found to be significantly higher in the VR group than the T group, however there was no significant difference in ENJ between the T and VR groups in Study 2. A 2x2 factorial ANOVA showed that, across Study 1 and 2, storytelling medium had a significant main effect on ENJ in that participants in the VR groups reported higher ENJ levels than those in the T groups ( $F(1)=8.47, p<0.004$ ).

There was also an interaction effect between storytelling medium and study for ENJ. A Fisher LSD post-hoc test showed that Study 1's T group differed significantly in ENJ from all the other groups in the ANOVA, namely Study 1's VR group ( $p<0.00003$ ), Study 2's T group ( $p<0.004$ ) and Study 2's VR group ( $p<0.016$ ). The means plot in Figure 7.8 shows that Study 1's T group reported much lower ENJ levels than any other group. A significant difference between the VR groups from Study 1 and Study 2 ( $p<0.007$ ) was also noted, and Figure 7.8 shows that the VR group in Study 2 reported much lower ENJ than that of Study 1.

#### 7.4.3 The Effect Study and Storytelling Medium on Boredom

Similar to our previous two cases, BOR was significantly higher in the T group than the VR group in Study 1. But, no significant BOR differences were found for these groups in Study 2. The effect of the study and storytelling medium on BOR was tested in a 2x2 factorial ANOVA. We found main effects for both study and storytelling medium as well as an interaction effect between the two. The BOR level in Study 2 was significantly less than in Study 1 ( $F(1)=4.60, p<0.034$ ) and significantly greater for the T groups than the VR groups ( $F(1)=4.23, p<0.042$ ).

A means plot of the interaction effect between study and storytelling medium is shown in Figure 7.9 below which shows that the BOR of Study 1's T group was lower than all of the other groups under consideration. A Fisher LSD post-hoc test showed that BOR levels in Study 1's T group differed significantly from the VR groups in both Study 1 ( $p<0.0002$ ) and Study 2 ( $p<0.002$ ). The Fisher LSD test also showed a significant difference in BOR between T groups of Study 1 and Study 2 ( $p<0.00006$ ).

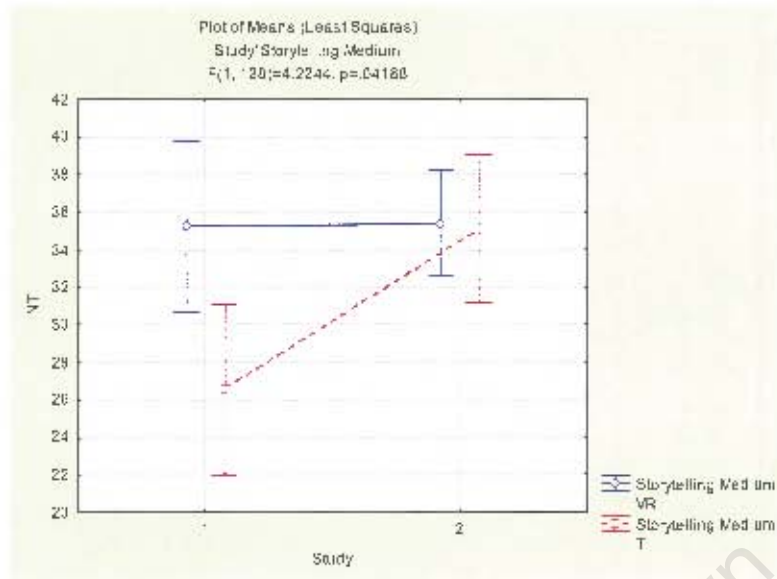


Figure 7.7: Means plot of the interaction effect between Storytelling Medium (VR/T) and Study on Interest (INT). Fisher LSD post-hoc test showed significant differences in INT between Study 1's text (T) and virtual reality (VR) groups ( $p<0.009$ ), between Study 1 and 2's T groups ( $p<0.006$ ) and between Study 1's T group and Study 2 VR group ( $p<0.001$ ).

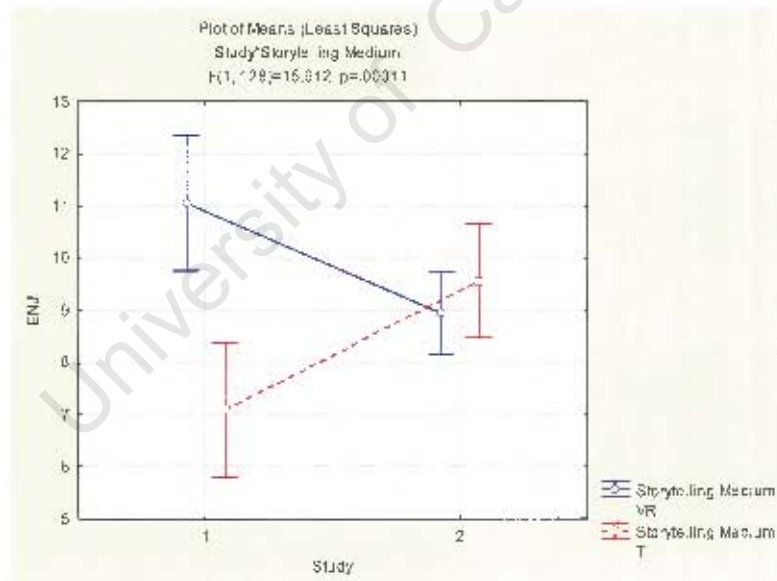


Figure 7.8: Means plot of the interaction effect between Storytelling Medium and Study on Enjoyment (ENJ). Fisher LSD post-hoc test showed significant differences in ENJ between Study 1's text (T) and virtual reality (VR) groups ( $p<0.00003$ ), between Study 1 and 2's T groups ( $p<0.004$ ), between Study 1's T groups and Study 2's VR group ( $p<0.016$ ) and between Study 1 and 2's VR groups ( $p<0.007$ ).

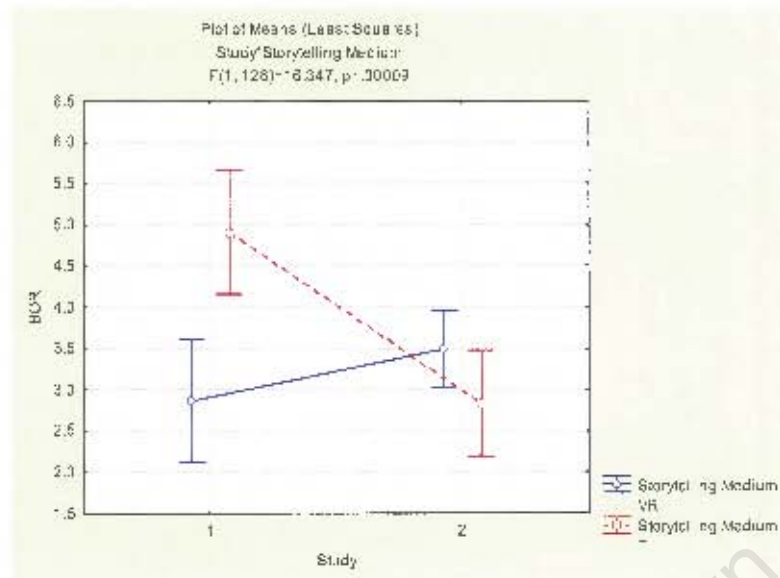


Figure 7.9: Means plot of the interaction effect between Storytelling Medium and Study on Boredom (BOR). Fisher LSD post-hoc test showed significant differences in BOR between Study 1's text (T) and virtual reality (VR) groups ( $p < 0.0002$ ), between Study 1 and 2's T groups ( $p < 0.00006$ ) and between Study 1's T group and Study 2's VR group ( $p < 0.002$ ).

## 7.5 Summary of Results

### 7.5.1 Story Experience

Correlations between comprehension, interest, enjoyment, boredom and confusion were examined to test our conceptualisation of an effective story experience. In Study 1 the following significant correlations were noted:

- Interest and enjoyment: correlated positively.
- Boredom and confusion correlated positively.
- Interest and enjoyment both correlated negatively with boredom and confusion.

In Study 2 the same set of correlations found in Study 1 was repeated, along with the following:

- Comprehension correlated positively with both interest and enjoyment.
- Comprehension correlated negatively with both boredom and confusion.

Significant correlations were also found for attention and strangeness, variables considered only in Study 2:

- Attention correlated positively with comprehension, interest and enjoyment and negatively with boredom and confusion.
- Strangeness correlated negatively with interest and enjoyment and positively with boredom and confusion.

### 7.5.2 The Effect of Storytelling Medium on Story Experience

In order to evaluate VR as a storytelling medium, we intended to compare the text (T) and virtual storytelling with no introductory VE (VR+NI) conditions since both conveyed the same story content using different media. However, in both studies, there was no statistical difference between the VR+NI and virtual storytelling with introductory VE (VR+I) conditions for story experience or presence. Therefore, the VR+NI and VR+I conditions were combined into one VR condition for comparison with the T condition.

The following results were noted in Study 1:

- Comprehension, boredom and confusion were significantly higher in the T condition.
- Interest and enjoyment were significantly higher in the VR condition.

The following results were noted in Study 2:

- Comprehension was significantly higher in the T condition.
- There was no significant difference between the T and VR conditions for interest, enjoyment and boredom.
- Confusion was significantly higher in the VR condition.
- Attention and strangeness were significantly lower in the VR condition.

Interest, enjoyment and boredom (all measured using the same questionnaire items in Study 1 and 2), were also compared across Study 1 and 2 revealing the following effects:

- Interest was significantly higher in Study 2 (main effect).
- Interest was significantly higher in the VR conditions (main effect).
- Interest was significantly lower in Study 1's T condition in comparison with Study 1's VR condition and Study 2's T and VR conditions.
- Enjoyment was significantly higher in the VR conditions (main effect).
- Enjoyment was significantly lower in Study 1's T condition in comparison with Study 1's VR group and Study 2's T and VR conditions.
- Enjoyment in the VR condition was significantly lower in Study 2 than in Study 1.
- Boredom was significantly higher in Study 1 (main effect).
- Boredom was significantly higher in the T conditions (main effect).
- Boredom was significantly lower in Study 1's T condition in comparison with Study 1's VR condition and Study 2's T and VR conditions.

### 7.5.3 The Effect of an Introductory VE on Story Experience

Story experience and presence in the VR+NI and VR+I conditions were compared in order to judge the effect of using a hip-hop themed introductory VE to preface a virtual San storytelling environment. The introductory VE was found to have no effect on story experience or presence in Study 1 or 2. But hip-hop interest (familiarity and preference) played a role for those participants who experience the introductory VE (the VR+I condition):

- In Study 1, hip-hop interest score was a significant predictor of enjoyment within the VR+I condition.
- In Study 2, those who identified hip-hop as a favourite music genre showed significantly higher presence within the VR+I the condition.

#### 7.5.4 The Relationship between Presence and Story Experience

The relationship between presence and story experience was assessed via the correlations between presence and the properties of story experience (comprehension, interest, enjoyment, boredom and confusion):

- In Study 1 presence correlated only with interest.
- In Study 2 presence did not correlate with any of the variables associated with story experience.

## Chapter 8

### Discussion of Results

In this chapter, the results for Study 1 and Study 2, presented in Chapter 7, are discussed. Recall that these studies aimed to investigate story experience in virtual storytelling. Study 1 was conducted with a sample of high-school learners while Study 2 was conducted with a sample of undergraduate university students. We will begin by discussing the influence of the sample demographics in our studies and the results regarding our conceptualisation of an effective story experience. Thereafter, we will discuss the outcomes of our hypotheses testing, namely the experimental comparison of text and VR as storytelling media, the effect of using an introductory VE to prime users before a virtual storytelling experience and the relationship between presence and story experience. Rather than present the results of Study 1 and 2 separately for each of these, the results from both studies are, generally, considered in conjunction. This way the results of both studies are used to inform overall conclusions regarding our research questions. Finally, we present a recap of our research hypotheses together with a summary of how our empirical findings either confirmed or contradicted them.

#### 8.1 Demographics

Demographics played no role in Study 1, but a number of the demographic factors measured in Study 2 significantly influenced dependent variables. Firstly, age emerged as a significant predictor of attention and the negative correlation between these two indicated that younger participants tended to pay more attention to the story. This result is difficult to explain theoretically and may be a sampling artefact; it is revisited later, in Section 8.3.1.

Secondly, year of study of the university students who participated in Study 2 arose as a significant predictor of both confusion and strangeness. For confusion, 3<sup>rd</sup> and 4<sup>th</sup> year students showed significantly less confusion than 1<sup>st</sup> year students and 3<sup>rd</sup> year students showed significantly less confusion than 2<sup>nd</sup> year students. For strangeness, 2<sup>nd</sup> and 3<sup>rd</sup> year students found the story significantly less strange than 1<sup>st</sup> year students. Thus, more years of tertiary study seemed to coincide with lower confusion and perceived strangeness of the story. Perhaps study experience enabled the students to process an unfamiliar narrative with less confusion. It is also possible that during the course of university study some students, might have been exposed to indigenous narratives and texts, and so did not find the San story as strange as those experiencing an indigenous story for the first time. Against this trend, however, we found that 4<sup>th</sup> year students reported higher level of strangeness than 3<sup>rd</sup> year students. But since there were only two 4<sup>th</sup> year students in the Study 2 sample, this result is most likely spurious.

## 8.2 An Effective Story Experience

### 8.2.1 Comprehension, Interest, Enjoyment, Boredom and Confusion

In Section 3.1, Chapter 3 a number of properties of an effective story experience were proposed. We speculated that an effective story experience, particularly in the case of an indigenous cultural story, was one in which story comprehension was achieved, an interest in the story's cultural context was engendered and the story was enjoyed. Additionally, we speculated that boredom and confusion in the story would be undesirable for conveying a story effectively. These properties were used as a basis for assessing text *vs.* VR as storytelling media and the benefits of using an introductory VE as priming in virtual storytelling. First however, we wished to examine whether our assumptions regarding story experience were accurate. Therefore, in both studies, the relationships between the story experience properties we had conceptualised were assessed to see if they related to each other as we had anticipated.

The results of Study 1 almost completely supported our conceptualisation of an effective story experience. Interest and enjoyment were related to each other while confusion and boredom were related to each other. Furthermore, interest and enjoyment were negatively related with both confusion and boredom. This means that high levels of interest and enjoyment were likely to occur in conjunction with low levels confusion and boredom. The only property which did not come into play was comprehension. While there were some scales in Study 1's comprehension questionnaire which were valid and/or reliable, the questionnaire as a whole was not reliable (see Section 6.5.2, Chapter 6). Therefore, no solid conclusions could be made regarding comprehension in Study 1.

Of the three scales used in Study 2's comprehension questionnaire, one was neither valid nor reliable, one was only valid and one was both valid and reliable. However, the three scales showed concurrent validity with each other and the comprehension questionnaire proved reliable overall (see Section 6.5.2, Chapter 6). The same set of relationships observed in Study 1 between interest, enjoyment, confusion and boredom also emerged in Study 2. In addition, in Study 2 comprehension was positively related to interest and enjoyment and negatively related to confusion and boredom. Thus those participants who reported high interest and enjoyment of the story were likely to also have achieved high comprehension scores. Also, those who reported high boredom and confusion were also likely to obtain low comprehension scores. This matched our assumptions on effective story experiences. Because all of the questionnaires used in Study 2 were valid and reliable, we were able to place more reliance on results obtained from this study, especially regarding comprehension.

In summary, the story experience variables in Study 1, with the exception of comprehension, correlated as we had expected. However, in Study 2 *all* the story experience variables correlated as we had expected. And in particular comprehension, measured using a valid and reliable questionnaire in Study 2, proved to relate to the other story experience variables in the way we had anticipated. Thus, correlations which emerged amongst those variables associated with story experience in our studies supported our conceptualisation of an effective story experience.

### 8.2.2 Attention and Strangeness

Two additional variables, in addition to those considered in Study 1, were measured in Study 2. We wished to measure attention since we observed a number of participants experiencing the virtual storytelling scenarios in Study 1 exploring the VE rather listening to the story. Strangeness was considered since we wished to distinguish between participant's confusion in the story and the extent to which they perceived the story as strange or unusual. The reasoning

behind adding these for consideration is discussed in more detail later, in Sections 8.3.1 and 8.3.3, respectively.

Attention related positively to comprehension, interest and enjoyment, all three of which were considered desirable for an effective story experience. Furthermore, attention also correlated negatively with confusion and boredom, both deemed undesirable in a story experience. Thus it seems that attention to a story is also part of an effective story experience. Although causality cannot be judged from a correlation between two factors, we can speculate that paying more attention to the story allowed the story content to be absorbed, resulting in higher story comprehension. Similarly, paying more attention to the story may have allowed participants a greater opportunity to become interested in the story's cultural context. The correlation between attention and enjoyment makes sense since enjoyment has been shown to indicate a focus of attention (Csikszentmihalyi, 1991). It is also possible that participants did not pay attention to the story because they found it boring or confusing or that, participants who paid little attention to the story missed details of its content, and thus found the parts they did attend to boring and/or confusing.

Strangeness related differently to story experience in that it correlated negatively with interest and enjoyment and positively with boredom and confusion. Thus, it follows that those participants who found the story very strange were also likely to show a low interest in the San, a low enjoyment of the story and high levels of boredom and confusion. Interestingly, strangeness showed no relationship with comprehension, which seemed to imply that finding a story strange need not impact on how well it is understood. This bodes well for conveying San stories, which may easily be construed as bizarre by modern audiences. However strangeness was related to confusion and boredom and might indirectly relate to comprehension through these.

Additionally, attention and strangeness also showed no relation to each other. Perhaps this means that the perceived strangeness of a story was not influenced by the amount of attention paid it. Whatever our speculation on the specific roles of attention and strangeness, it is clear that attention correlated with those factors we considered positive in a story experience and strangeness, mostly, with the factors we considered negative in a story experience.

### 8.3 The Effect of Storytelling Medium on Story Experience

The first question of this research dealt with the effectiveness with which VR can convey a story, as opposed to the more traditional and ubiquitous medium of text. We hypothesised that virtual storytelling would result in a more effective story experience than reading a story text, particularly for telling a San story (see Section 4.4, Chapter 4). Therefore, we expected that study participants who experienced the San story in a VE would achieve higher story comprehension scores, show a greater interest in the San culture and greater enjoyment of the story. We also expected that virtual storytelling would result in less boredom and confusion during the story experience. It was with regards to testing the effectiveness of text *vs.* VR as storytelling media that we observed the majority of our significant results. We will first discuss the comprehension results, and secondly the results for interest, enjoyment and boredom. Lastly we will discuss some unexpected findings regarding comprehension, confusion and strangeness.

#### 8.3.1 Comprehension

The most consistent result across Study 1 and 2 was that of a significantly higher comprehension for participants who read the story over those who experienced it in a VE. In Study 1 the text group scored higher than the VR group for three out of the four scales used to measure comprehension: the cloze, sequence and sentence verification technique (SVT) tests

(Ladeira & Blake, 2004). Note, however, that in Study 1, only the sequence test was valid and reliable (see Section 6.3.2, Chapter 6). The sequence test scores indicate that text participants understood the narrative flow of events better than those in the VR condition. Due to the low validity and reliability of the other comprehension scales, we can not draw conclusions from the scores obtained on them. We also cannot draw conclusions from the total comprehension scores since the comprehension questionnaire was not valid and reliable as a whole. In Study 2, the cloze, sequence and SVT scales were amended, but, only the SVT scale proved both valid and reliable. Overall, however, Study 2's comprehension questionnaire was valid and reliable (see Section 6.3.2, Chapter 6). Text participants in Study 2 obtained significantly higher scores for the cloze, sequence and SVT tests. Since the cloze and sequence tests were not valid and reliable, we will not draw conclusions from them. Scores on the SVT test indicate that the text group in Study 2 were better able to distinguish between events and details that did and did not appear in the story. The higher total comprehension scores in the text group indicate a better overall story comprehension than the VR group.

Thus it seemed that the VR groups in both studies performed poorly in comparison to the text groups. Looking only at the percentage of correct answers in the comprehension questionnaires, we notice that the VR group did not perform too poorly on the comprehension test though. The VR group obtained 63.2% correct answers in Study 1 and 57.8% in Study 2, while the text group obtained 76.9% in Study 1 and 82.2% in Study 2. However, we cannot say that the comprehension achieved by the VR groups was acceptable since the comprehension questionnaires had a very low level of difficulty in both studies (see Section 6.5.2, Chapter 6). Thus comprehension scores were most likely inflated for all participants.

There are a number of possible reasons for the higher comprehension noted in the text conditions as opposed to the VR conditions. Firstly, in Section 2.4, Chapter 2, we discussed Ricci & Beal's (2002) comparison of three storytelling modes: audio, audiovisual, and audiovisual with direct and passive interaction for storytelling. They found that the audio-only scenario consistently produced the poorest story comprehension (Ricci & Beal, 2002). Their finding, along with our results, suggests that reading may be better than hearing for achieving greater story comprehension.

Secondly, in designing our studies, it was our intention that all participants experience the story once only. Therefore, the storytelling VE was created such that the storyteller character would only tell the story once. Also, participants in the text groups were specifically instructed to read the story through once only and then place the text face down on their desks so that they could not read it again. Nonetheless, we observed some participants rereading parts of the text. Indeed, rereading sentences in this way is a common reading technique (Ebo & Stewart, 1985). Additionally, a number of participants who finished reading the text before the rest of the group would glance over it briefly, before placing it face down. In both these instances text participants were able to experience parts of the story more than once. An important distinction between the text and VR groups here is that the text groups had the entire story content available to them throughout their story experience, whereas the VR groups did not. The text groups were, therefore, able to control their experience of the story in that they could pace their reading and reread sentences if they wished. On the other hand, the VR groups had no control over their experience of the story, once the storyteller avatar had begun narrating. They had only one opportunity to hear the entire story and could not pause or alter the narration pace. The ability to control the pace of reading, allowed text participants to determine the amount of time they had to absorb the story. This, coupled with the opportunity of repeated exposure to parts of the story could, very likely, have increased the text groups' comprehension of the story (Ladeira & Blake, 2004). However, it is important to note that this is not necessarily a limitation of virtual storytelling in general but rather of the specific design of our storytelling VE in which the story was only narrated once. The interactivity of VR could very well allow VE authors to provide facilities for rehearing parts of a story, possibly even interacting with the storyteller (Silver *et al.*, 2003).

Thirdly, the VE contained information over and above the story content, such as the setting, characters and navigation. So, the text group had only the story content to process and attend to while the VR group had the visual and audio information of the VE itself. It has been argued that VE features intended to increase realism may also increase the cognitive load on users (see Section 2.2.1, Chapter 2) (Wickens & Baker, 1995). An added cognitive load on the VR participants, may have adversely affected their story comprehension.

The extra information presented in the storytelling VEs may also have provided distractions from the story. An important trend was observed in Study 1: we noted that participants would generally adopt one of two 'strategies' in the VE. Some would find a position in the VE from which they could see the storyteller clearly and stay there for the duration of the story, while others explored the cave environment during some or all of the storytelling. The fact that many participants explored the VE has implications for their story experience since they were not paying full attention to the story. Also, since the VE featured spatialised sound, the further away from the fire-side participants wandered, the softer the storyteller's voice became. Therefore, exploring the VE during the story narration most likely decreased attention to the story and caused participants to miss parts of the story which, as pointed out earlier, they could not rehear. This would certainly compromise the VR participants' ability to recall story information and understand the story as required by the comprehension questionnaire.

### *Attention*

Since the VR group's low attention had only been observed on an ad-hoc basis in Study 1, attention to the story was formally measured in Study 2, leading to two important findings. Firstly, comprehension and attention were related and, secondly, the VR group reported paying significantly less attention to the story than the text group. This decreased attention may, in part, be due to the instruction given to the VR groups before they experienced the storytelling VE's. They were told that they were free to navigate as they pleased in the VE's (see Section 4.7.2, Chapter 4). This might have prompted some participants to explore the VE rather than pay attention to the storyteller. Nonetheless, this result confirmed our speculation in Study 1 that the VR groups paid less attention. This is similar to the findings of de Jong & Bus (2002) and Murphy & Pitt (2001) where the interactivity offered by a digital book and virtual museum application, respectively, were found to distract from story content (see Sections 2.4 and 2.5, Chapter 2). We thus conclude that the decreased attention in the VR condition was a factor in decreasing story comprehension.

Since storytelling medium had such a strong effect on attention, we also tested whether it may have contributed to our finding that younger participants appeared to pay more attention to the story. In Section 8.1, we mentioned that this result may have been a sampling artefact. With general linear model which considered age as a predictor of attention while controlling for the effect of storytelling medium, we found that age was no longer a predictor of attention ( $F(1)=0.71$ ,  $p<0.4$ ) whereas storytelling medium was ( $F(1)=6.87$ ,  $p<0.01$ ). Thus the effect of age most likely occurred because there were a greater number of older participants in the VR condition.

### **8.3.2 Interest, Enjoyment and Boredom**

Apart from, comprehension, we found very different results in Study 1 and 2 for the properties of story experience. Interest in the San and enjoyment of the story was higher for the VR condition in Study 1. Even when controlling for tendencies to show interest in folklore and South African cultures, VR was found to generate a greater interest in the San than text. The text group of Study 1 also reported finding the story significantly more boring than the VR group (Ladeira & Blake, 2004). On the contrary, in Study 2, storytelling medium had no effect on interest, enjoyment or boredom. These results, along with the correlations between these

variables suggest that they are inter-related; hence we will discuss them together. We will first tackle the results of Study 1 and then consider the implications of Study 2's results.

### *Study 1*

We believe that the reasons behind the higher interest and enjoyment and the lower boredom of Study 1's VR condition are likely related. For the high-school learners who took part in Study 1, reading text is probably a common experience at school, whereas experiencing a story told by a San storyteller in a VE was probably out of the ordinary. This novelty in itself may have piqued participants' interest more than reading the story and thus generated a greater overall interest in the story experience and, in turn, San culture and folklore. The engaging novelty of VR may also have resulted in a more enjoyable, less boring experience of the story in comparison to the text group. However, the novelty of VR will wear off eventually and thus the benefits it offers could fade with repeated exposure. Furthermore, we cannot be sure whether novelty really did play a role in our studies since previous computer or gaming experience was not measured.

We have already mentioned, in Section 8.3.1 above, that the story text presented only the story content whereas the storytelling VE presented the story plus additional information. Using VR we were able to present the story in a traditional San fireside milieu and give a visual and audio representation of San people telling and listening to stories. Thus the VE allowed the presentation of a cultural context with the story, giving VR participants a broader view of the San's storytelling tradition. This might have generated more interest in the San and their stories than the presentation of the story content alone. In Section 2.3.3, Chapter 2, we described three factors, proposed by Schell (2005), which may determine the interest value of an entertainment experience. One of these, termed 'poetry of presentation', describes the aesthetics of an experience (Schell, 2005). Presenting the San story in a visually and aurally appealing VE and avatars, as opposed to plain text, may be seen as a way of enhancing the poetry of presentation, thus creating a story experience which engages greater interest. The added VE information also offered more to experience in the VE, thus promoting enjoyment and minimising boredom.

Also, the use of the of a virtual storyteller and the involvement of the user in the storytelling VE might have made the story experience more personal and appealing than reading a text. Psychological proximity, another Schell (2005) interest factor, describes the extent to which users are able to place themselves into a story experience. Involving users in a personal way can increase their psychological proximity to a story experience and increase their interest in a story and, in our case, possibly the story's cultural context (Schell, 2005). Similarly, increased user involvement may likely have increased enjoyment and decreased boredom in the story. Of course, the only concrete way to test this theory would be to bring real life storytelling into our comparison. It would be ideal to compare the story experiences attained by reading, hearing the story told by a virtual storyteller and hearing the story told by a real storyteller.

### *Comparing Study 1 and Study 2*

Storytelling medium did not have a significant effect on interest, enjoyment or boredom in Study 2; this introduced uncertainty into our thinking on the differences between text and VR. In order to understand the discrepancy between the two studies better, we compared the interest, enjoyment and boredom for the text and VR groups across the two studies. These comparisons were possible since the same measures for all three variables had been used in both studies. We found a number of main effects in this cross-study comparison. The participants in Study 2 expressed a greater interest in the San than those in Study 1 and boredom was also significantly higher in Study 1. Additionally, interest and enjoyment were significantly higher, and boredom significantly lower, in the VR condition across both studies. This partially supported our hypothesis that virtual storytelling would result in a more effective story experience than reading a story text.

However, since Study 1 and 2 made use of different samples and slightly differing procedures, post-hoc tests were performed in order to understand the different outcomes of these two studies. These showed that enjoyment was significantly lower in Study 2's VR group when compared to Study 1's VR group. Also, a remarkably consistent pattern emerged: Study 1's text group showed significantly lower levels of interest and enjoyment and higher boredom than all the other groups. There are two possible reasons for these differences. They may have been a consequence of differences in the two study's procedures or reflect differences in the high-school sample of Study 1 and the university sample of Study 2.

The procedures for the two studies were largely identical but differed in a potentially important way. Study 1 was conducted with three classes during school time, thus it was necessary for each class to meet together, as they usually would, in their classroom. Each class, as a whole, was informed that some learners would be staying in the class while some would be leaving the classroom for part of the class period (see Section 4.7.2, Chapter 4). From there they were randomly divided into the text or VR conditions; the text participants stayed in the classroom while the VR participants were taken to the experimental computer room. While Study 1's participants were not explicitly told what students staying in, versus those leaving, the classroom would be doing, it is possible that they concluded that each group would be doing something different. On the other hand, Study 2's participants signed up to partake in the experiment at a scheduled time. Here the scheduled time participants chose determined whether they would experience text or virtual storytelling. Thus, Study 2's participants did not witness any different activities occurring or division into different conditions. In other words, Study 1's sample may have been aware of the existence of different experimental conditions, while Study 2's sample was not. Awareness of different experimental conditions may have influenced the response to the experiment in Study 1 (Orne, 1962). In particular, the text participants may have felt that the learners leaving the class were going to do something special or exciting whilst they had to stay behind and partake in the ordinary class time activity of reading. This might have lessened the enthusiasm of Study 1's text group, resulting in low interest in the San and low enjoyment and boredom during their story experience.

Similarly, the VR group may have experienced a sense of excitement at being selected (albeit randomly) to leave the classroom to do something different to most of the class and possibly out of the ordinary during school-time. This might explain the greater enjoyment observed in Study 1's VR group as opposed to Study 2's VR group. In order to eliminate these extraneous effects, it would have been better to run Study 1 such that there was no perception of different activities occurring. For instance, all the learners in one class would fall into one condition only. However, since only eight VR participants could be accommodated per class period, it was not possible for a whole class to experience the virtual storytelling. Thus, it was necessary to have text and VR participants in each class. Furthermore, a visible division of learners into groups was difficult to avoid since each class was required to meet together at the start of the experiment.

It is also possible that the different samples of Study 1 and 2 responded differently to the text and VR conditions. The text group in Study 2 expressed significantly more interest and enjoyment and less boredom than did Study 1's text group. One can argue that the university students in Study 2 were a highly selected sample in comparison with the high-school learners in Study 1. University students may have more highly developed reading skills and may even find reading more appealing. Thus, reading the text may have been easier for the university students allowing them to enjoy the story more and experience less boredom during their reading. Ease of reading may also have allowed them more of a chance to develop an interest in the story's cultural context. Furthermore, the university students in Study 2 partook voluntarily in a study advertised as a San storytelling experiment. Those students who signed up for the experiment may have done so out of an existing interest in San storytelling, although existing knowledge of the San was not found to play a role in interest. Alternatively, the kind of student likely to

volunteer for a study, albeit it for small cash reward, may, at least, have been more open to the story experience.

As for the lower enjoyment observed in Study 2's VR group over the Study 1's VR group, it is possible that the university students' greater computer and media experience played a role. It is likely that university students had more computer and media experience than high-school learners. This may be due to their simply being older and thus having more media exposure or due to the use of computers during tertiary education. Given that computers are not as novel and exciting to university students as they are to high-school learners, one might have expected that they would respond to virtual storytelling somewhat less positively. This may explain why the university students expressed a lower story enjoyment than the high-school learners in the VR condition.

Enjoyment aside though, there were not differences in interest and boredom in the VR conditions of Study 1 and 2. This suggests that these variables were not affected by computer or VR novelty or experience. This is a positive result for VR; if the only effects possible using VR were achieved by virtue of its novelty, then its potential benefits as a storytelling medium would likely not endure after its novelty had worn off. Our results suggest that, for interest and boredom, a virtual story experience is relatively constant across audiences of different age groups. On the other hand, the applicability of text as a storytelling medium for different age groups and reading skills is uncertain. The response to reading the story text was much worse in Study 1's high-school sample than in Study 2's university sample. But, given the differences in experimental procedures mentioned earlier, we cannot be sure of this result.

Overall, the most plausible explanation for the discrepancy in Study 1 and 2's results is that story experience in Study 1, especially in the text condition, was influenced by experimental procedure and lower reading ability and affinity. If we ignore Study 1's text group for a moment and consider only Study 2's text group and the Study 1 and 2's VR groups. Amongst these three groups, the only significant difference was between Study 1 and 2's VR groups enjoyment. Thus, it may be that enjoyment of a story is harder to achieve in virtual storytelling for older samples, but we cannot draw this conclusion confidently since enjoyment may have been inflated in Study 1's VR group. Further, there were no significant interest or boredom differences between the text and VR conditions. Therefore, the most conservative conclusion we can make is that text and VR were, at least, equally good for generating interest in the San story's cultural context and establishing enjoyment and low boredom in the story.

### 8.3.3 Comprehension, Confusion and Strangeness

#### *An Unexpected Finding in Study 1*

An unexpected result emerged in Study 1 where the text group reported significantly more confusion in the story than the VR group. On the one hand this made sense since boredom, which correlated with confusion, was also significantly higher for the text group. It also stands to reason that if a participant found the story confusing, they were likely to find it boring. But, this result was also conspicuously counter-intuitive in light of our comprehension results. One would expect that if participants found the story very confusing, then a high comprehension score would be difficult to achieve. Instead, the text participants reported higher levels of confusion and yet also achieved higher comprehension scores than the VR group! Interestingly, there was a zero correlation between comprehension and confusion ( $r=0.08$ ). We speculated that, in rating their confusion, participants might have actually been reporting how strange the story seemed to them, rather than how incomprehensible it was (Ladeira & Blake, 2004).

*Considering Strangeness in Study 2*

We attempted to resolve the counter-intuitive result of Study 1 by testing whether participants had been reporting on strangeness instead of confusion. Therefore, for Study 2, we added an extra questionnaire item for measuring confusion and added a number of items to measure how strange participants found the story. The text group, again, achieved higher comprehension scores than the VR group, but, this time they also reported significantly lower confusion. Comprehension and confusion also showed a negative correlation indicating that they were inversely related. Note that the measure used for confusion in Study 2 was found to be valid, whereas we were unable to test validity in Study 1 since there confusion was measured with only one item. In terms of comprehension and confusion, these findings make more sense than those of Study 1, and are more reliable given that the confusion measure proved valid in Study 2. Furthermore, it seems likely that the higher confusion in the VR condition contributed to the lower comprehension shown in comparison to the text condition.

The text group also reported significantly higher perceived strangeness than the VR group. Furthermore, there was no correlation between comprehension and strangeness. In fact, strangeness behaved almost exactly as confusion had in Study 1. This validated our suspicion that participants in Study 1 may have been reporting how strange, rather than how confusing, they found the story. We believe that adding extra items to measure confusion and strangeness made the questionnaire less ambiguous and measured confusion and strangeness more distinctly. Strangeness was also related to both confusion and boredom, which were negatively related to comprehension. Therefore, one might conclude that strangeness was, indirectly, negatively related to comprehension. However, the fact that the text group scored both high comprehension and high strangeness seems to indicate that they do not affect each other very strongly.

The finding that confusion was higher in the VR condition contradicted our hypothesis that confusion would be lower in virtual storyteller than in a story text, particular a San story text. The possible reasons for the higher confusion reported by the VR group are rather similar to those discussed in reference to the lower comprehension of the VR condition (see Section 8.3.1). Firstly, the VR participants were only able to hear the story once, at a set pace, whereas the text participants were observed rereading parts of the story and were able to pace their reading. Secondly, the text participants were only given the story content to process, whereas the VR participants were not only processing the story content but also the setting, characters and navigation in the VE. The additional VE information may have posed an additional cognitive load making it harder to focus on the storytelling and leading to greater confusion in the story content (Wickens & Baker, 1995). Thirdly, many participants in the VR groups were observed exploring the VE rather than attending to the story and attention to the story was found to be lower for the VR group in Study 2 (see Section 8.3.1). Not paying attention to the story almost surely means that the VR groups missed parts of the story during the narration, resulting in a fragmented story experience. The text participants were probably able to gain a more coherent interpretation of the story by having only the story content to attend to and process, all without missing parts of the story.

Our finding regarding strangeness is also important. The idea of strangeness is quite interesting in the context of San stories, which are different to the western folklore and fairytales many audiences are familiar with. The fact that those who read the story found it stranger than those who experienced the story in the VE indicate a potential advantage in using VR to tell indigenous, African stories. Firstly, one could infer that presenting the story in a VE with a San gathering made the story content seem less unusual. It may be that the VE contextualised the story by recreating a traditional San oral storytelling experience with an appropriate setting and characters. When placed in context like this, the story might have made more sense than when it was presented as text, without any cultural context. Here, VR offers the benefit of allowing users to experience a situation which would, otherwise, not be easily possible since so there are few traditional San living in southern Africa today (Jackson & Fagan, 2000; Pape *et al.*, 2001).

Secondly, it is also possible that hearing the story told by a San storyteller character, as opposed to reading it, made it seem more natural. Recall that English was not the original language of the San stories, including the one used for this research. The San stories available as texts today were mostly transcribed directly from the oral storytelling of the San people (see Section 2.6.1, Chapter 2). These stories have a grammar and diction which may seem unusual to English speakers and contain innate rhythms which may not come across easily when read. Unlike the text groups, the VR participants did not have to grapple with foreign-sounding words or character names or the unusual grammar and diction. The spoken narration in the VE may also have made the rhythms more apparent. Lastly, in order to simulate a live oral storytelling situation, the storyteller avatar was animated throughout the story narration, using hand gestures almost continually. In addition, the San gathering reacted to the story through gestures and vocal sounds. These probably provided cues to the VR participants as to which parts of the story were amusing, shocking or climatic, also making the story easier to relate to (Ladeira & Blake, 2004).

## 8.4 The Effect of an Introductory VE on Story Experience

Our second research question dealt with the use of priming as possible means of increasing the effectiveness of virtual storytelling (see Sections 2.2.2, Chapter 2). We tested the effects of using a hip-hop themed introductory VE to preface the more historical content of a San storytelling VE. We hypothesised that presenting priming information about the San in a contemporary, culturally familiar introductory VE would result in a more effective story experience in the San VE. We theorised that such an introductory VE might act as a hook, piquing user's interest at the outset of their VE experience and make the San VE more accessible. However, in both Study 1 and 2, the introductory VE had no effect on story experience or presence, except for participants who showed a pre-existing interest in hip-hop, which was the theme of the introductory VE. It may be that presenting the San story in VR was sufficient for piquing interest and needed no auxiliary features. Alternatively, this result may indicate that strongly themed priming material or introductory VEs do not offer much additional benefit to historical virtual storytelling. Interesting though, familiarity with and preference for hip-hop played a role in participants' reaction to the introductory VE in both Study 1 and 2.

### 8.4.1 The Role of Content Familiarity and Preference

Interest in hip-hop was measured in order to control for any influence that participants' personal interest or disinterest in hip-hop might have had on their response to the introductory VE. Two measures were used for hip-hop interest: first, a multiple choice question which required participants to choose their favourite music genre. Second, a number of statements which participants rated on a seven point Likert-type scale; these measured preference for and familiarity with hip-hop as a popular contemporary subculture (see Sections B.2 and C.2 in Appendix B and Appendix C for the hip-hop interest questionnaires of Study 1 and 2, respectively).

In Study 1 we found that high scores on the Likert-type scale predicted high levels of enjoyment for the group who experienced the introductory VE. In Study 2, we found that those who identified hip-hop as their favourite music genre in the multiple choice question, and who experienced the introductory VE, showed significantly higher presence. No similar effects were noted for any other music genres in the multiple choice question. In both studies, favourite music genres and familiarity with hip-hop had no effect for those who were not primed with the introductory VE. This clearly shows an interaction between the introductory VE and the participants' hip-hop familiarity and preference.

Study 1's result indicates that a pre-existing preference for and familiarity with hip-hop together with the introductory VE, served to increase the enjoyment of the San story. The Likert-type scales in Study 1 measured enjoyment of hip-hop and rap music as well as participants' perceptions of hip-hop as a popular, contemporary subculture in a more objective sense. Thus we cannot be sure whether it was familiarity or preference that played the more important role in increasing enjoyment. The outcome of Study 2 is more clear: having hip-hop as a favourite music genre together with the introductory VE appeared to increase participants' overall presence. Here it is clear that preference for hip-hop influenced presence. Bear in mind, no effects were observed where any of the other music genres (classical, alternative, rhythm and blues, rock or jazz) were selected as favourites. This strongly suggests that a match between participants' content preference and priming affected presence and where there was a mismatch, presence was not affected. It may be that the introductory VE caught the attention of those participants with an interest in hip-hop music, allowing them to become more engaged in the subsequent San VE. In Study 1 this worked to improve enjoyment of the story and in Study 2 it worked to increase presence.

One potential criticism of Study 2 is that the participants in the introductory VE condition may have confused the instruction of how to complete the presence questionnaire – rather than respond about the entire experience (introductory VE and San VE), they responded with regards to the introductory VE only, as it may have grabbed their attention initially. This is a small possibility though since that San VE was the last VE participants experienced before completing the presence questionnaire. However, if participants responded only about their experience in the introductory VE, it still shows that their interest in hip-hop interacted with the content of the introductory VE to increase their presence in the introductory VE.

So, although our studies did not show that introductory VEs are capable of improving story experience or presence, they showed, quite convincingly, some interaction between VE content and user preferences along with experience (familiarity). However, since this interaction occurred differently in Study 1 and 2, we can make no certain conclusions regarding the exact roles of content familiarity and preference.

## 8.5 The Relationship between Presence and Story Experience

Our final research question considered the relationship between presence and story experience in virtual storytelling. We hypothesised that there would be a positive relationship between presence and effective story experience. Therefore we expected presence to correlate positively with story comprehension, interest in the story's cultural context and enjoyment of the story, and negatively with boredom and confusion in the story. Only one of these expected relationships was noted in Study 1, where presence and interest correlated with each other. In Study 2, we found that presence did not relate to any of the story experience variables. Since presence and interest were related in Study 1, but not Study 2, we could say that, for younger users, a storytelling VE that creates a sense of presence also fosters an interest in the story's cultural context. However, let us consider this correlation more closely. Interest was included as a property of story experience because we were specifically looking at storytelling in the realm of cultural heritage. So, strictly speaking, it has more to do with cultural heritage than story experience. Thus, the correlation between presence and interest is not a strong indication of a presence-story experience link. In terms of the other story experience variables, there was no relationship with presence. Therefore, we conclude that presence and story experience are not related.

It was rather unexpected that presence and story experience should have no bearing on each other. Often user studies involving VR applications use presence as a metric of success (see Section 2.2.1, Chapter 2). But our study points out that presence should not necessarily be the sole goal for virtual storytelling applications. Virtual storytelling applications in which users

experience high levels of presence may not, in fact, convey stories effectively. For instance, we also found that participants in the VR condition paid significantly less attention to the story (see Section 8.3.1). So, while participants who explored the San VE extensively rather than focusing on the story may have felt a high sense of presence, they were not receiving the story content effectively. Our studies also did not show that presence detracts from story experience since there were no negative correlations between the two and there was no correlation between presence and attention. Rather presence and story experience seem to have very little to do with each other. So it seems that, as far as virtual storytelling is concerned, one should look to more than just presence to judge effectiveness.

## 8.6 Summary of Hypotheses and Empirical Outcomes

The following are our research hypotheses, along with a summary of the outcomes for each:

1. Virtual storytelling will result in a more effective story experience than reading a story text. This implies:
  - a. Virtual storytelling will result in greater story comprehension, interest and enjoyment than reading a story text.
  - b. Virtual storytelling will result in less boredom and confusion than reading a story text.

This hypothesis was contradicted by our findings. Comprehension was lower in the VR condition. Findings regarding interest, enjoyment and boredom differed in Study 1 and 2: there was higher interest and enjoyment and lower boredom in Study 1's VR condition, but no differences between text and VR in Study 2. Further, the younger, high-school sample in Study 1 did not respond well to reading the story text, evidencing markedly poor story experiences. Study 1's sample also enjoyed the virtual storytelling scenarios more than the older, university sample. Overall, however, we conclude that text and VR were equally good for generating an interest in a story's cultural context and creating high enjoyment, low boredom story experiences. Study 1 and 2's findings for confusion contradicted each other, but we conclude that confusion was higher in the VR condition..

2. A contemporary, culturally familiar introductory VE used to preface a VE presenting traditional storytelling will improve story experience. As above this implies:
  - a. The introductory VE will result in greater story comprehension, interest and enjoyment.
  - b. The introductory VE will result in less boredom and confusion.

Using a hip-hop themed introductory VE had no effect on story experience or presence, except where participants showed a pre-existing familiarity with or preference for hip-hop music and subculture. In Study 1 hip-hop familiarity and preference was significant predictor of enjoyment while those with a preference for hip-hop music showed significantly higher presence than those who indicated preferences for music genres other than hip-hop. Both of these results occurred only for participants who experienced the introductory VE. This indicates that priming material needs strong familiarity in order to work as a means of improving a subsequent story experience.

3. Presence will be related to an effective story experience. In other words:
  - a. Presence will relate positively to the variables to comprehension, interest and enjoyment.
  - b. Presence will relate negatively to boredom and confusion.

The only relationship found between presence and story experience was a positive correlation between presence and interest in Study 1. Therefore, we conclude that presence and story experience are not related.

In Study 2 two additional variables were also considered: attention to the story and perceived strangeness of the San story. We formulated the following hypotheses regarding these two variables:

3. Reading a story text will result in greater attention being paid to the story than experiencing the story in a VE.

This hypothesis was confirmed by our result that attention was significantly higher in the text condition.

4. Virtual storytelling will result in less perceived strangeness of the San story than reading the story text.

This hypothesis was confirmed by our result that strangeness was significantly lower in the VR condition.

## Chapter 9

# Conclusions and Future Work

Is virtual reality (VR) really capable of being a good storytelling medium? How can virtual storytelling be optimised, particularly when presenting traditional, indigenous folklore? And, is presence related to the quality of storytelling in a virtual environment (VE)? These were the questions posed at the outset of the research presented in this dissertation. We have presented our research on virtual storytelling, as applied to indigenous San storytelling, in which we aimed to investigate VR as a storytelling medium. In this final chapter our aims, experimental design and findings are summarised and we make conclusions regarding these findings. The novel contributions of this work are detailed along with suggestions for future work.

### 9.1 Summary of Aims and Experimental Design

Our main aims, as discussed in Chapter 3 and formalised in Chapter 4, were as follows:

1. *To investigate the strengths and/or weaknesses of VR as a storytelling medium.* This was done by comparing story experiences achieved by VR and text.
2. *To investigate the effectiveness of using a culturally familiar introductory VE to preface a VE presenting traditional storytelling.* This was done by comparing the story experience and presence achieved in a virtual storytelling scenario which included no introductory VE with one which made use of a contemporary-themed introductory VE. Hip-hop was chosen as a theme for the introductory VE since it is a popular, contemporary subculture with an easily-recognisable style and some interesting parallels with San culture.
3. *To investigate the relationship between presence and story experience in virtual storytelling.* This was done by examining the correlations between presence and a number of variables associated with story experience.

In this research, story experience was conceptualised in the context of using storytelling as a means of preserving cultural heritage, in particular the storytelling tradition of the San. We defined an effective story experience as one in which the story content was understood (i.e. comprehension), an interest in the story's cultural context was generated and the story was enjoyed. Additionally, boredom and confusion were considered undesirable in an effective story experience (see Section 3.1, Chapter 3). These properties, along with presence in a VE, comprised our dependent variables. Questionnaires were designed and validated for measuring these story experience properties, namely comprehension, interest, enjoyment, boredom and confusion. A questionnaire was also developed to measure interest in hip-hop, whose influence was considered when judging the effect of using a hip-hop themed introductory VE (see Section 4.5, Chapter 4).

Three storytelling scenarios, all conveying the traditional San story, entitled *How Kaggen the Mantis Created the Eland and the Moon* (Bleek, 1923), were created for these experiments. The design and implementation of these storytelling scenarios is described in Chapter 5. These scenarios were:

1. *Story Text (T)*: The story printed on a page.
2. *Virtual Storytelling with No Introductory VE (VR+NI)*: A visual and audio desktop VE in which a San storyteller avatar tells the story to a San gathering and the user around a fire in a cave. This VE has no introductory VE.
3. *Virtual Storytelling with Introductory VE (VR+I)*: Same as the VR+NI scenario described above, but is preceded by a hip-hop themed introductory VE which conveys information about the San and their storytelling tradition.

Two studies were conducted; both using a between-subjects design in which all participants experienced one of the above three storytelling scenarios (see Section 4.3, Chapter 4). Study 1 was conducted with a sample of 44 high-school learners and Study 2 with a sample of 98 undergraduate university students. Study 2 was a refined version of Study 1, taking into the account the effectiveness of Study 1's questionnaires and improving them for use in Study 2 and considering two additional, emergent variables, namely attention and strangeness.

## 9.2 Validation of Story Experience Conceptualisation

In Study 1, all the story experience related variables correlated with each other as predicted by our conceptualisation of an effective story experience, with the exception of comprehension. However, while there were some scales in Study 1's comprehension questionnaire which were valid and/or reliable, the questionnaire as a whole was not reliable. The questionnaire was consequently revised for use in Study 2, where it proved to be both valid and reliable. In Study 2, the same set of relationships found in Study 1 was repeated and comprehension, now measured using a valid and reliable questionnaire, related to all the other story experience variables, namely interest, enjoyment, boredom and confusion, as predicted by our story experience conceptualisation. Therefore, our conceptualisation of story experience was supported by our results.

Additionally, attention and strangeness, introduced as variables in Study 2, were also found to relate to story experience. As we suspected from our observation in Study 1, attention correlated positively with all the proposed desirable story experience properties and negatively with all the properties proposed undesirable in story experience. This suggested that attention to a story was also related to effective story experience. Strangeness, on the other hand, emerged as a negative aspect of story experience as it correlated positively with boredom and confusion and negatively with almost all the positive aspects of story experience, except comprehension and attention.

## 9.3 Text vs. VR

The most interesting and complex results in our research came from our comparison of text and VR as storytelling media. We hypothesised that virtual storytelling would result in a more effective story experience than reading a story text. Our conceptualisation of story experience consisted of a number of properties, so this was a multi-part hypothesis: mostly disproved by our results. Specifically, we hypothesised that virtual storytelling would result in greater story comprehension, generate a greater interest in finding out more about a story's cultural context and provide a more enjoyable experience of a story. We also predicted that the story would be

less boring and confusing when experienced in a storytelling VE. However, our results have led us to the following main conclusions: firstly, story comprehension is higher when experiencing a story as text, secondly, VR and text are equally good for generating an interest and providing high enjoyment, low boredom story experiences and, thirdly, confusion in a story is higher in a storytelling VE. Observations and results noted in Study 1 prompted us to also consider attention to and perceived strangeness of a story in Study 2. We hypothesised that listening to a story in a VE would result in lower attention to the story, but with less perceived strangeness of the story; both of these were confirmed by our results. In the rest of this section we will summarise the main results and reasoning which lead to our overall conclusions.

In Study 1 comprehension, boredom and confusion were significantly higher in the text condition while interest and enjoyment were significantly higher in the VR conditions. So, we initially speculated that neither text nor VR provided perfectly effective story experiences, but VR seemed to offer more benefits (Ladeira & Blake, 2004). However, when considering the results of Study 1 and 2 together, there was a challenging mix of consistent, contradictory and unexpected findings.

### 9.3.1 Comprehension and Attention

In both Study 1 and 2, comprehension of the San story was higher in the text condition (although it is important to note that only the questionnaire used in Study 2 was valid and reliable). This was contradictory to our hypothesis; we posit three possible reasons for this result (see Section 8.3.1, Chapter 8). First, reading may be a more effective mode than listening for achieving story comprehension (Ricci & Beal, 2002). Second, text participants were able to pace their reading and reread parts where necessary whereas the VR participants were only able to hear the story once, at a set pace. However, it is important to note that this is not necessarily a limitation of virtual storytelling in general but rather of the storytelling VE used in our experiments, which were created to present the story once only. The interactivity of VR can allow VE authors to provide facilities for rehearing parts of a story (Silver *et al.*, 2003). Third, text participants were only given the story content to process while the additional information contained in the three-dimensional setting of the storytelling VE may have posed an additional cognitive load and/or distraction for the VR participants (Wickens & Baker, 1995).

Some VR participants in Study 1 were observed exploring the VE rather than paying attention to the story. This prompted us to measure attention to the story in Study 2; we found attention to be lower in the VR condition. This confirmed the earlier findings of de Jong & Bus (2002) and Murphy & Pitt (2001). Therefore, we conclude that the setting and avatars in the storytelling VE distracted from the story, resulting in a fragmented experience of the San story. We believe that the decreased attention paid to the story in the VR condition was, very likely, a contributing factor to the lower comprehension in this condition. This is further supported by the positive correlation between story comprehension and attention.

### 9.3.2 Interest, Enjoyment and Boredom

In Study 1, we found significantly higher interest, enjoyment and significantly lower boredom in the VR condition; we put forward three possible reasons for these effects. Firstly, the novelty of VR, secondly, the storytelling VE presented a cultural context for the San story and gave the story experience a visual and aural appeal not present in the story text. Providing a cultural context may have provided a greater platform for generating an interest in the San culture. According to Schell (2005), the aesthetic appeal of an entertainment experience is a factor in improving the interest in and quality of that experience. And, thirdly, an increased personal aspect in the virtual storytelling achieved by using a virtual storyteller avatar may have involved users more in the story experience. This ties into another of Schell's (2005) factors for increasing interest levels during an entertainment experience, namely psychological proximity.

Psychological proximity refers to the extent to which someone feels personally involved in an entertainment experience. These three reasons emphasise aspects of the storytelling VE which may have caused Study 1's high-school sample to become more engaged with their story experience, resulting in more enjoyment and less boredom in the story and a greater, subsequent interest in the San culture.

However, in Study 2 we found no difference between text and VR for interest, enjoyment or boredom. This contradiction between Study 1 and 2's results made it difficult to draw firm conclusions regarding text *vs.* VR for these variables. However, comparisons of interest, enjoyment and boredom across Study 1 and 2 and the text and VR conditions made the picture clearer. These comparisons showed an important pattern, namely that Study 1's text group showed lower interest and enjoyment, and greater boredom than the other three groups (Study 1's VR group and Study 2's VR and text groups).

There are two possible reasons for the poor story experience evidenced in this group. This may have reflected a sampling artefact; perhaps, high-school learners do not enjoy reading as much as university students; the more advanced reading skills of university students may also have allowed for easier text reading. In other words, the university student sample may have over represented skilled, willing readers, resulting in a very positive story experience in Study 2's text condition. Another possibility is that awareness of different experimental conditions in Study 1 influenced the text group such that interest and enjoyment were deflated and boredom inflated (see Section 8.3.2, Chapter 8). When considering only Study 1's VR group and Study 2's VR and text groups, we noted that there were no significant differences in interest, enjoyment and boredom, except for a difference in enjoyment between Study 1 and 2's VR groups. Thus we concluded that text and VR were, at least, equally good for generating interest in a story's cultural context and providing enjoyment and low boredom in a story. Furthermore, there were no differences in interest and boredom between Study 1 and 2's VR groups. This suggested that the virtual storytelling was equally effective for both Study 1 and 2's samples for generating interest and providing a low boredom experience.

### 9.3.3 Comprehension, Confusion and Strangeness

An unexpected and puzzling finding emerged in Study 1: the text group reported significantly higher confusion in the story while also achieving significantly higher story comprehension. This seemed counter-intuitive and we speculated that participants may not have been reporting confusion at all but rather perceived strangeness of the story. So, confusion and strangeness were measured more distinctly in Study 2, where the text group showed significantly lower confusion and higher comprehension than the VR group. Also, strangeness behaved almost exactly as confusion had in Study 1: the text group reported significantly higher strangeness and there was no correlation between comprehension and strangeness. This validated our suspicion that Study 1's participants may have reported strangeness rather than confusion.

We proposed that the greater confusion observed in the VR condition was related to the reasons proposed in relation to the lower comprehension observed in the VR condition in both studies (see Section 9.3.1). The finding that perceived strangeness of the story was lower in the VR condition in comparison to the text condition is an important, albeit unexpected, finding. We believe that using a VE to depict the oral storytelling tradition of the San contextualised the story and made it seem less strange and more accessible. Additionally, the storyteller avatar's narration may have made the unusual grammar, diction and names of the story seem natural. The live narration may also have made the innate rhythms of the story more apparent. Lastly, storyteller's animations along with the visual and audio reactions of the San gathering to the narration provided cues as to the amusing, shocking and climatic parts of the story making the story more relatable.

The results for comprehension and confusion were contradictory to our hypothesis where we expected that both would be higher in the VR condition. In terms of grasping the story content, the well established medium of text certainly showed its superiority. But the VR showed an advantage in cultural storytelling which we did not anticipate at the outset of our research: a lower sense of strangeness in an unfamiliar narrative through the ability to provide cultural contextualisation, a virtual storyteller's narration and cues through a virtual audiences' reaction.

#### 9.4 Introductory VEs as Culturally Familiar Priming

The use of priming, in the form of an introductory VE, was explored as a means of improving virtual storytelling's effectiveness. We were also concerned that the historical nature of San storytelling might be too culturally remote for most users to relate to. We hypothesised that the use of a culturally familiar introductory VE used to preface a VE presenting traditional storytelling would improve story experience. Instead, a hip-hop themed introductory VE had no effect on story experience or presence, unless participants showed a pre-existing familiarity with and/or preference for hip-hop (Ladeira *et al.*, 2005). This suggests that strongly themed priming material or introductory VE's may not offer added benefit for historical virtual storytelling.

The fact that the introductory VE priming only had an effect for participants who showed an interest in hip-hop, suggests that users' existing interest play a role in how VE content is received. In Study 1, priming together with hip-hop familiarity and preference increased enjoyment, whilst, in Study 2, priming together with hip-hop preference increased presence. We believe that, for participants with a liking for hip-hop, the introductory VE acted as a hook, piquing their interest at the outset of their virtual experience and, increasing their overall engagement in the San storytelling VE. But, since the effects were different, in cause and outcome, for Study 1 and 2, we cannot draw concrete conclusions about the exact roles of content familiarity and preference.

#### 9.5 Presence and Story Experience

We hypothesised that presence and story experience would be related in virtual storytelling applications. Instead, we found only one significant correlation between presence and a property of effective story experience (interest) in only Study 1. Thus we conclude that presence and story experience are not necessarily related. If one bears in mind that a lower amount of attention to the story was observed in the VR condition (see Section 9.3.1), we might speculate that a high presence virtual experience may, in fact, detract from a story. However, this research shows no empirical evidence that presence detracts from story experience. Rather, presence and story experience appear to be unconnected, suggesting that presence is not the sole measure of virtual storytelling application's effectiveness.

#### 9.6 Contributions of this Work

This dissertation contains a number of novel contributions. The design and preparation for our experiments led to following theoretical and practical contributions:

- We set out to explore story experience in all our research questions. Thus, we proposed a number of properties of an effective story experience, with particular reference to preserving cultural narratives. We considered an effective story experience as one in which story comprehension was achieved, an interest in the story's cultural context was generated, and the story was enjoyed. Additionally, we considered boredom and

confusion in the story to be undesirable (see Section 3.1, Chapter 3). Our results show, generally strong support for our story experience conceptualisation (see Sections 9.2). We also found that attention paid to a story and perceived strangeness of a story, were related to story experience.

- Questionnaires were developed to measure the properties of our story experience conceptualisation as well as familiarity with and preference for hip-hop subculture. The validity and reliability of these were extensively assessed (see Chapter 6). These psychometric analyses were used to refine the questionnaires during our research. Ultimately valid and reliable questionnaires were created for measuring hip-hop interest, comprehension, interest, enjoyment, boredom, confusion, attention and strangeness. All questionnaires were also free of experimental bias; the only shortcoming was the low level of difficulty noted in the comprehension questionnaire.
- Two VEs were created, one to present a traditional San story, told by an elder storyteller to a San gathering in a cave, around a fire. And another, hip-hop themed, VE which presented information about the San and their storytelling tradition (see Chapter 5). Effort was made to create an authentic San VE which allows users to experience San storytelling tradition first-hand. This would not, otherwise, be easily possible since there are very few San practicing their traditional lifestyle. The San VE, prefaced by the introductory hip-hop VE was installed as an interactive display in the San exhibit of the IZIKO South African Museum, Cape Town for a number of months in 2004.

Two experiments were conducted, one with a sample of 44 high-school learners and another with 98 undergraduate university students, resulting in the following empirical contributions:

- A specific account of the advantages and disadvantages of VR as a storytelling medium in comparison to the more ubiquitous medium of text. We found that story comprehension was better with story text. While there were contradictory findings for interest, enjoyment and boredom, VR and text appeared, at least, equally good at generating an interest in a story's cultural content and achieving a high enjoyment, low boredom story experience. Findings for confusion were also contradictory in both studies but, we believe that a higher amount of confusion was experienced in the virtual storytelling. We also found that a VE may distract attention away from story content. And lastly, situating a San story within a virtual storytelling experience seemed to decrease the extent to which the story was perceived as strange.
- We found that a contemporary, culturally familiar introductory VE used to preface a VE presenting traditional storytelling had no effect on story experience or presence. This suggests that strongly themed introductory VEs may not be worthwhile additions to virtual storytelling.
- We found that content familiarity and preference interacted with the introductory VE to increase enjoyment in Study 1 and increase presence in Study 2.
- We found that presence and story experience, as defined for this research, were unrelated. This suggests that presence alone cannot be considered when creating virtual storytelling applications and evaluating their effectiveness.

## 9.7 Future Work

### 9.7.1 Story Experience

A well-established model of story experience would be very useful in the field of virtual storytelling. Especially, since presence may not be sufficient for measuring a virtual storytelling application's effectiveness (see Section 9.5 above). Our experiments produced strong empirical evidence supporting our story experience conceptualisation; further research toward testing this conceptualisation and proposing more story experience properties would strengthen and inform the idea of story experience. Future work could explore how story experience properties might influence each other. Also, more work on developing more extensive questionnaires for measuring story experience would serve to make its practical application more feasible in virtual storytelling research and evaluation.

### 9.7.2 Considering VR vs. Real Life Storytelling

In determining the strengths and weaknesses of VR as a storytelling medium, our research considered VR in comparison with text. This was appropriate as far as San stories are concerned since San stories are currently only available as texts. However, a more complete comparison of VR against traditional storytelling media might include live storytelling. One would probably not expect virtual storytelling to offer an improvement over real-life storytelling. But, it would be useful to know whether oral storytelling can be, at least, nearly as good in VR as it is in reality. It would be even more interesting to compare different kinds of real life storytelling with virtual storytelling, for instance by looking at the difference between experiencing a San story told by a traditional San storyteller and experiencing it told by a non-San person. But, a number of practical issues might hamper such a study since there are very few San people telling traditional stories today. Moreover, even if a traditional San storytelling experience could be arranged there might be issues around telling the story in a language that the audience can understand.

### 9.7.3 Exploring the Effect of Interactivity on a Virtual Story Experience

In our discussion we mention that text participants may have scored higher story comprehension than VR participants as a result of having the opportunity to reread parts of the story while VR participants could listen to the story only once (see Section 8.3.1, Chapter 8). However, we also note that this need not be the case in virtual storytelling since storytelling VE's can be designed such that users could, interactively, choose to re-experience parts of a story and, even, ask questions and influence the narrative. Virtual storytelling research has already been done using VE's which allow repetition of story chunks (Silver *et al.*, 2003). However, it would be useful to measure the quality of story experience in an interactive storytelling VE. It would be particularly interesting to see how story comprehension fares.

### 9.7.4 Generating Interest in Text Reading

The results of our VR *vs.* text comparison suggest that story comprehension is better achieved using text, while VR may be useful for generating an interest in a story's cultural context in younger audiences. Thus, virtual storytelling might be useful as a vehicle for encouraging story reading. Using San storytelling as an example: if virtual storytelling generates an interest in a San story and its cultural context but the story content is not fully grasped, users may still be encouraged find out more about the San and, possibly, go on to read more San folklore. It might be informative to run studies in which cultural stories are presented in VR and the story texts are subsequently made available to users. Such a study would test whether virtual

storytelling fosters enough interest to prompt subsequent reading, as this could provide the complement to our ideal story experience: comprehension of the narrative.

### 9.7.5 Boosting Attention in Virtual Storytelling

The finding that attention to the San story was significantly lower in a VE as opposed to text indicates an important shortcoming of virtual storytelling. Similar findings have also been noted in previous studies (Murphy & Pitt, 2001; de Jong & Bus, 2002). It has been proposed that, theoretically, VE user's attention may be indirectly controlled without curbing freedom in the VE (Schell, 2005). While we attempted to draw user's attention to the storytelling in the San VE by placing points of interest near the storyteller. This wasn't sufficient to focus all participants' attention exclusively on the story. Further research on innovative ways, direct or indirect, in which user's attention may be focused on VE's narrative content would be very valuable in resolving the problem of attention in virtual storytelling.

### 9.7.6 Determining the Roles of Content Familiarity and Preference

One of the outcomes of our research was the discovery that content familiarity and preference interacted with priming to affect story enjoyment and virtual presence. However the nature of this interaction varied in both studies and further research would be helpful in determining the precise roles of content familiarity and preference. Foremost, studies which distinguish between familiarity and preference and test for their effects separately would allow us to clarify which has the greater effect in combination with priming. It would also be helpful to measure familiarity and preference for the content of both a priming/introductory VE and main VE, then the effect of familiarity and preference to be tested over both VEs. Lastly, the finding of an interaction between priming and content familiarity and preference would be more generalisable if replicated with different types of content. For instance, it may be that individuals preferring classical music will not be affected by classically themed priming in the same way.

### 9.7.7 Tailoring Introductory VEs

Our studies showed that a culturally familiar introductory VE only had an effect together with familiarity and/or preference for the themed content of the introductory VE. This suggests that strongly themed introductory VEs may narrow their appeal to users and limit the benefit offered. Thus, if one were to then employ an introductory VE, its content should be carefully chosen to appeal as widely as possible in order to gain any benefits. On the other hand, one could also eliminate the effects of content familiarity and preference by ensuring that introductory VEs are not themed too strongly. But then the potential benefits of appealing to users' personal interests might be lost. Before discounting introductory VEs as a means of priming, it might be useful to consider tailoring introductory VEs to the user population. The content interests of a user population could be surveyed to ensure that an introductory VE presents content that is most familiar and popular. But, since it might not be possible to find a theme which appeals to everyone, a number of differently themed introductory VEs might be created and users could choose one based on their personal preferences. Testing the effectiveness of tailored introductory VEs could show whether attempting to appeal to user interests can improve story experience or presence in virtual storytelling.

### 9.7.8 Exploring Story Presence in Virtual Storytelling

In virtual storytelling there is the potential for a double-barrelled presence experience. Presence may be experienced in the VE in which a story is presented or narrated, but presence might also occur in the story or narrative itself. For example, if one considers the storytelling VE used in our research, presence could be experienced in the San VE, i.e. in the cave, at the fireside with

the San avatars, but one might also experience presence in the San story, i.e. in the world of Kaggen and the eland. Since our research has shown no connection between presence and story experience, it might be interesting to investigate the possibility that participants, rather than experiencing presence in a storytelling VE, might actually experience presence in the world painted by a narrative being conveyed in that VE. Perhaps there might be a link between story experience and this new kind of presence: story presence. We have investigated this notion briefly in past work, but not rigorously and not while also considering story experience (Brown *et al.*, 2001).

### 9.7.9 Considering a Greater Diversity of Users

In the two studies presented in this dissertation we attempted to consider a range of participants by considering high-school learners and university students. Our results show that there may be some differences in how each sample reacted to the different storytelling media of VR and text. This suggests that it would be useful to consider an even greater sample diversity in future virtual storytelling research to determine how story experiences differ from group to group.

University of Cape Town

## Appendix A

### The San Story

#### How Kaggen the Mantis Made the Eland and the Moon

Kaggen, the Mantis, is wise and he is gifted with special powers. We believe that he made the earth and the many animals that we hunt for food, but his favorite animal of all is the Eland. This is the story of how Kaggen, the Mantis, made the Eland and the Moon.

Kwammang-a, husband of the Mantis' daughter, the Porcupine, had taken off a part of his shoe and thrown it away - and Kaggen, the Mantis picked it up, this piece of Kwammang-a's shoe, and soaked it in the water down where reeds stand. Then Kaggen went away, and then came back again, and when he looked, he saw the Eland, who was still small. The Mantis called to the Eland:

“Kwammang-a's shoe's piece.”

And the Eland walked up to the Mantis, his father. Then the Mantis went to fetch some honey for the Eland. Then before the sun was up he came back to the water. He approached while the Eland was standing in the reeds. He called to it again: “Kwammang-a's shoe's piece.” The Eland walked up to his father, the Mantis. Kaggen, the Mantis, took honeycomb from his bag rubbed sweet honey on to the Eland's ribs, while he splashed them with water, making them grow very nice. Then the Mantis went away to find more honey. Once more he came back to the water and again rubbed honey into the Eland's ribs making him grow nice. Then the Mantis went way. Three nights passed before the Mantis visited the Eland again - and the Eland grew, becoming big like an ox.

The people did not know that it was the Eland to whom the Mantis was giving honey, for the Mantis used to come home and tell them that there was no honey. Then Kwammang-a said to his son, the young Ichneumon: “Ichneumon, you must find out why Grand-father does not bring honey home, you must lie down in the grass and cover your head with a kaross, while you look at what Grand-father does.”

The Ichneumon saw the Mantis go to the water and call the Eland. The Ichneumon saw the Mantis rub honey onto the Elands ribs. Then Ichneumon jumped up! And the Mantis drove the Eland back into the reeds. The Mantis said: “Ichneumon, let us go home!” Then the young Ichneumon told his father, Kwammang-a, about what he saw, and Kwammang-a said the young Ichneumon must guide him, take him and show him the Eland. Then the young Ichneumon took his father, Kwammang-a, to the Eland, while the Mantis was at another place. Ichneumon and Kwammang-a went up to the Eland at the water. Kwammang-a looked at the Eland and he knocked it down!

When the Mantis arrived, he saw Kwammang-a and others cutting up the Eland. The Mantis ran up to the people meaning to strike them with a knobkerrie. But a Mierkat snatched the knobkerrie from the Mantis's hand. The Mierkat beat the Mantis and told the Mantis to bring wood for a fire to cook the Eland. The Mantis brought wood, but then he saw the Eland's gall, on the bush.

Kaggen the Mantis whispered that he could prick the gall open; and it would cover him with darkness. And so the Mantis pricked the gall and sprang into the darkness, but he could not see the ground. The Mantis's thinking-strings quickly told him to take off his own shoe and throw it up into the sky. So he quickly snatched off the shoe from his foot - he quickly threw it up. And the Mantis' shoe became the moon that shone.

The Mantis said: "The sun was shining brightly when I grew angry, so I pricked open the Eland's gall, and the sun set behind the mountain; darkness covered the earth. Then I quickly snatched off my own shoe and spoke to it as I threw it up. I said: 'I am the Mantis and my shoe shall become the moon which shines in dark.'"

That is why the Moon shines at night. That is why the Moon is cold, because it is a shoe, it is leather. It is red because it has earth on it, the dust in which the Mantis had walked.

# Appendix B

## Study 1 Questionnaire

This questionnaire was used in the Study 1. All participants received the following set of questionnaires with the exception that participants experiencing a virtual storytelling scenario also completed the IGroup Presence Questionnaire (IPQ) (Igroup, 2000). The solutions to the comprehension questionnaire are also given.

### B.1 Questionnaire Cover Page

San Storytelling Questionnaire<sup>4</sup>

Please fill in your age and grade:

Age: \_\_\_\_\_

Grade: \_\_\_\_\_

Please circle your gender:

Gender: Male / Female

The following questionnaire relates your experience of the San story which has just been presented to you.

Please answer the questions in the order in which they appear. Do not to skip any questions or return to a previous question to change your answer. Your answers will not be used as a reflection of you or your abilities since all questionnaires in this study will be filled in anonymously.

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<sup>4</sup> The empty box on the top right of the cover page was used to mark the experimental condition of each participant's questionnaire.



### B.3 Comprehension

The following questions relate to the San story, try to answer them to the best of your ability.

Complete the following by filling in the blank spaces:<sup>10</sup>

The story was about how the Mantis made the \_\_\_\_\_ and the \_\_\_\_\_.

Please answer the following questions by circling one of the possible options a, b or c for each question.<sup>11</sup>

1. What happened first in the story?
  - a. The mantis went to find some honey.
  - b. The mantis rubbed sweet honey into the Elands ribs.
  - c. The mantis picked up a piece of Kwammang-a's shoe and soaked it in the water by the reeds.
  
2. What happened after the mantis rubbed sweet honey on the Elands ribs?
  - a. Kwammang-a ordered his son, Ichneumon, to spy on the Mantis
  - b. The Eland grew nice and big, becoming like an ox.
  - c. Kwammang-a knocked the Eland down.
  
3. What happened last in the story?
  - a. The Mantis threw up his shoe into the sky and it became the moon.
  - b. The Mantis pricked open the Eland's gall.
  - c. The Mantis saw Kwammang-a and others cutting up the Eland.
  
4. What happened before the Mantis threw his shoe up into the sky and it became the moon?
  - a. The Mantis saw Kwammang-a and the others cutting up the Eland.
  - b. The Mantis pricked open the Eland's gall and it covered him with darkness.
  - c. The Mantis went to find some honey.
  
5. What happened immediately after the Mantis saw Kwammang-a and the others cutting up the Eland?
  - a. The Mantis ran up to them meaning to strike them with his knobkerrie.
  - b. The mantis picked up a piece of Kwammang-a's shoe and soaked it in the water by the reeds.
  - c. The Mierkat snatched the Mantis' knobkerrie and beat the Mantis.

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<sup>10</sup> Cloze Test (Ccloze), consisting of one sentence with two blanks (labeled Cloze1 and Cloze2)

<sup>11</sup> Sequence Test (Cseq), consisting of five items (labeled Seq1-Seq5).

Please indicate whether the following sentences are true or false according to the San story. Answer by circling either TRUE or FALSE next to each sentence.<sup>12</sup>

1. Kaggen the Mantis whispered, "If I prick the gall open, it will cover me with darkness".  
TRUE / FALSE
2. Kaggen the Mantis whispered to himself that he could cover himself with darkness if he pricked open the Eland's gall.  
TRUE / FALSE
3. Kaggen the Mantis whispered, "If I prick the gall open, it will cover me with moonlight".  
TRUE / FALSE
4. Kaggen the Mantis whispered, "The Eland's gall is dark in colour".  
TRUE / FALSE
5. Ichneumon and Kwammang-a went up to the Eland at the water, Kwammang-a looked at the Eland and he gently patted it.  
TRUE / FALSE
6. Ichneumon and Kwammang-a went to the water to try and find some fish.  
TRUE / FALSE
7. Ichneumon and Kwammang-a went up to the Eland at the water, Kwammang-a looked at the Eland and he knocked it down!  
TRUE / FALSE
8. Kwammang-a struck the Eland to ground when he and Icheumon went to see the Eland at the water.  
TRUE / FALSE
9. The shining moon in the night sky was once the Mantis's shoe.  
TRUE / FALSE
10. The Mantis' shoe became the sun, that shone.  
TRUE / FALSE

---

<sup>12</sup> Sentence Verification Technique Test (Csvt), consisting of twelve items (labelled SVT1-SVT12)

11. The Mantis's shoe was broken and old.

TRUE / FALSE

12. The Mantis' shoe became the moon, that shone.

TRUE / FALSE

Please indicate whether the answers to the following sentences are yes or no. Answer by circling either YES or NO next to each question.<sup>13</sup>

1. Does the Mantis possess magical powers?

\_\_\_\_\_

YES / NO

2. Was the Mantis upset when he found Kwammang-a and the others cutting up the Eland?

\_\_\_\_\_

YES / NO

3. Were Kwammang-a and the Mierkat kind to the Mantis?

\_\_\_\_\_

YES / NO

Please answer the following questions in your words. Answers need not be detailed and should be a maximum of 1- 2 sentences long.<sup>14</sup>

1. What did the Mantis use to create the Eland?

\_\_\_\_\_  
\_\_\_\_\_

2. Why did Kwammang-a send his son, Ichneumon to spy on the Mantis?

\_\_\_\_\_  
\_\_\_\_\_

3. In the story Ichneumon lies under a kaross in order to spy on the Mantis and the Eland. How did the Mantis react when he saw Ichneumon jump out from under the kaross?

\_\_\_\_\_  
\_\_\_\_\_

<sup>13</sup> Inference Questions (Cinf), consisting of three items (labelled Inf1-Inf3); these were eliminated from Study 2's questionnaire.

<sup>14</sup> Fact Questions (Cfact), consisting of three items (labelled Fact1-Fact3); these were eliminated from Study 2's questionnaire.





## B.5 Comprehension Questionnaire Solutions

The following questions relate to the San story, try to answer them to the best of your ability.

Complete the following by filling in the blank spaces:

The story was about how the Mantis made the \_\_\_\_\_ and the \_\_\_\_\_.

Answer: eland; moon

Please answer the following questions by circling one of the possible options a, b or c for each question.

1. What happened first in the story?
  - a. The mantis went to find some honey.
  - b. The mantis rubbed sweet honey into the Elands ribs.
  - c. The mantis picked up a piece of Kwammang-a's shoe and soaked it in the water by the reeds.

Answer: c

2. What happened after the mantis rubbed sweet honey on the Elands ribs?
  - a. Kwammang-a ordered his son, Ichneumon, to spy on the Mantis
  - b. The Eland grew nice and big, becoming like an ox.
  - c. Kwammang-a knocked the Eland down.

Answer: b

3. What happened last in the story?
  - a. The Mantis threw up his shoe into the sky and it became the moon.
  - b. The Mantis pricked open the Eland's gall.
  - c. The Mantis saw Kwammang-a and others cutting up the Eland.

Answer: a

4. What happened before the Mantis threw his shoe up into the sky and it became the moon?
  - a. The Mantis saw Kwammang-a and the others cutting up the Eland.
  - b. The Mantis pricked open the Eland's gall and it covered him with darkness.
  - c. The Mantis went to find some honey.

Answer: b

5. What happened immediately after the Mantis saw Kwammang-a and the others cutting up the Eland?
  - a. The Mantis ran up to them meaning to strike them with his knobkerrie.
  - b. The mantis picked up a piece of Kwammang-a's shoe and soaked it in the water by the reeds.
  - c. The Mierkat snatched the Mantis' knobkerrie and beat the Mantis.

Answer: a

Please indicate whether the following sentences are true or false according to the San story. Answer by circling either TRUE or FALSE next to each sentence.

1. Kaggen the Mantis whispered, "If I prick the gall open, it will cover me with darkness".

TRUE / FALSE

Answer: TRUE (Original)

2. Kaggen the Mantis whispered to himself that he could cover himself with darkness if he pricked open the Eland's gall.

TRUE / FALSE

Answer: FALSE (Paraphrase)

3. Kaggen the Mantis whispered, "If I prick the gall open, it will cover me with moonlight".

TRUE / FALSE

Answer: TRUE (Meaning Change)

4. Kaggen the Mantis whispered, "The Eland's gall is dark in colour".

TRUE / FALSE

Answer: FALSE (Distractor)

5. Ichneumon and Kwammang-a went up to the Eland at the water, Kwammang-a looked at the Eland and he gently patted it.

TRUE / FALSE

Answer: FALSE (Meaning Change)

6. Ichneumon and Kwammang-a went to the water to try and find some fish.

TRUE / FALSE

Answer: FALSE (Distractor)

7. Ichneumon and Kwammang-a went up to the Eland at the water, Kwammang-a looked at the Eland and he knocked it down!

TRUE / FALSE

Answer: TRUE (Original)

8. Kwammang-a struck the Eland to ground when he and Icheumon went to see the Eland at the water.

TRUE / FALSE

Answer: TRUE (Paraphrase)

9. The shining moon in the night sky was once the Mantis's shoe.

TRUE / FALSE

Answer: TRUE (Paraphrase)

10. The Mantis' shoe became the sun, that shone.

Answer: FALSE (Meaning Change)

TRUE / FALSE

11. The Mantis's shoe was broken and old.

Answer: FALSE (Distractor)

TRUE / FALSE

12. The Mantis' shoe became the moon, that shone.

Answer: TRUE (Original)

TRUE / FALSE

Please indicate whether the answers to the following sentences are yes or no. Answer by circling either YES or NO next to each question.

1. Does the Mantis possess magical powers?

\_\_\_\_\_

Answer: YES

YES / NO

2. Was the Mantis upset when he found Kwammang-a and the others cutting up the Eland?

\_\_\_\_\_

Answer: YES

YES / NO

3. Were Kwammang-a and the Mierkat kind to the Mantis?

\_\_\_\_\_

Answer: NO

YES / NO

Please answer the following questions in your words. Answers need not be detailed and should be a maximum of 1- 2 sentences long.

1. What did the Mantis use to create the Eland?

\_\_\_\_\_  
\_\_\_\_\_

Possible answers: Kwammanga-a's shoe, honey, water.

2. Why did Kwammang-a send his son, Ichneumon to spy on the Mantis?

---

---

Answers: We wanted to know why the Mantis was not bringing honey home.

3. In the story Ichneumon lies under a kaross in order to spy on the Mantis and the Eland. How did the Mantis react when he saw Ichneumon jump out from under the kaross?

---

---

Answer: The Mantis drove the Eland back into the reeds and said "Ichneumon, let us go home!"

# Appendix C

## Study 2 Questionnaire

This questionnaire was used in the Study 2. All participants received the following set of questionnaires with the exception that participants experiencing a virtual storytelling scenario also completed the IGroup Presence Questionnaire (IPQ) (Igroup, 2000). The solutions to the comprehension questionnaire are also given.

### C.1 Questionnaire Cover Page

San Storytelling Questionnaire<sup>21</sup>

Please fill in your age, you year of study at UCT and your course major/s:

Age: \_\_\_\_\_

Year of Study: \_\_\_\_\_

Major/s: \_\_\_\_\_

Please circle your gender:

Gender: Male / Female

The following questionnaire relates your experience of the San story which has just been presented to you.

Please answer the questions independently and in the order in which they appear. Do not to skip any questions or return to a previous question to change your answer. Your answers will not be used as a reflection of you or your abilities since all questionnaires in this study will be filled in anonymously.

---

<sup>21</sup> The empty box on the top right of the cover page was used to mark the experimental condition of each participant's questionnaire.

## C.2 Hip-hop Interest

Please circle the music genre that is closest to your favourite type of music:<sup>22</sup>

- a) Classical
- b) Hip-hop
- c) Alternative
- d) Rhythm and Blues (RnB)
- e) Rock
- f) Jazz

In the following questions, please indicate the answer most applies to you by circling the appropriate number. Circling a 1 means that the statement fully applies to you and circling a 7 indicates that the statement fully does not apply to you.

Consider the entire scale when making your response since the numbers between 1 and 7 may also apply to you. For instance, if the statement applies to you only very slightly then you might want to choose a 2 or 3. If the statement applies to you but not fully you might choose a 5 or 6.<sup>23</sup>

1. I enjoy listening to rap music.  

1	2	3	4	5	6	7
FULLY DISAGREE						FULLY AGREE
  
2. Hip-hop culture is popular nowadays.  

1	2	3	4	5	6	7
FULLY DISAGREE						FULLY AGREE
  
3. I enjoy listening to hip-hop music.  

1	2	3	4	5	6	7
FULLY DISAGREE						FULLY AGREE
  
4. Most of my favourite music artists produce hip-hop or rap music.<sup>24</sup>  

1	2	3	4	5	6	7
FULLY DISAGREE						FULLY AGREE
  
5. Fashion inspired by hip-hop culture is cool and looks good.  

1	2	3	4	5	6	7
FULLY DISAGREE						FULLY AGREE
  
6. Classical music is outdated and irrelevant to today's youth.<sup>25</sup>  

1	2	3	4	5	6	7
FULLY DISAGREE						FULLY AGREE

<sup>22</sup> Hip-hop interest multiple choice item (HI<sub>mc</sub>)

<sup>23</sup> Likert-type scale (HI<sub>rate</sub>), consisting of six items: items 1, 2 and 3 were retained from Study 1's Hip-hop Interest questionnaire (these retained their original labelling of HI3-HI5); items 4, 5 and 6 were added in Study 2 (labelled HI6-HI8).

<sup>24</sup> Items 4 and 5 measured enjoyment of hip-hop music and fashion.

<sup>25</sup> Item 6 measured participants' opinion on classical music's relevance today.

### C.3 Comprehension

The following questions relate to the San story, try to answer them to the best of your ability.

Complete the following by filling in the blank spaces:<sup>26</sup>

1. The story was about how the Mantis made the \_\_\_\_\_ and the \_\_\_\_\_ using \_\_\_\_\_.<sup>27</sup>
2. Kaggen the \_\_\_\_\_ is wise and he is gifted with \_\_\_\_\_. The San believe that he created the \_\_\_\_\_ and the \_\_\_\_\_.<sup>28</sup>
3. The Mantis took the \_\_\_\_\_ from his bag and rubbed \_\_\_\_\_ onto the Eland's \_\_\_\_\_.
4. Ichneumon lay down in the grass under a \_\_\_\_\_ and spied on the Mantis.

Please answer the following questions by circling one of the possible options a, b or c for each question.<sup>29</sup>

1. What was the first thing to happen in the story?
  - a. The Mantis saw the Eland who was still small.
  - b. Ichneumon went to spy on the Mantis.
  - c. Kwammang-a threw away a part of his shoe.
2. Which of the following happened soonest after the mantis rubbed sweet honey on the Elands ribs?
  - a. The Mantis threw his shoe up into the sky.
  - b. The Eland grew nice and big, becoming like an ox.
  - c. The Mantis soaked a part of Kwammang-a's shoe in water.
3. Which of the following happened soonest after Inchneumon took Kwammang-a to the Eland?
  - a. Kwammang-a sent Inchuemon to spy on the Mantis.
  - b. Ichneumon hid lay down in the grass under a kaross.
  - c. Kwammang-a knocked the Eland down.
4. What happened last in the story?
  - a. The Mantis' shoe became the moon.
  - b. The Mantis pricked open the Eland's gall.
  - c. Everything was covered in darkness.

---

<sup>26</sup> Cloze Test (Ccloze), consisting of four sentences with eleven blanks (labelled according to sentence and blank: Cloze1a-1c, Cloze2a-2d, Cloze3a-3c and Cloze4).

<sup>27</sup> Cloze sentence 1 is an extended version of that used in Study 1.

<sup>28</sup> Cloze sentences 2, 3 and 4 were added in Study 2.

<sup>29</sup> Sequence Test (Cseq), consisting of six items: items 1, 2, 4, 5 and 6 are modified versions of the items used in Study 1 (these retained their original labelling of Seq1-Seq5); items 3 and 7 were added in Study 2 (labelled Seq6 and Seq7 respectively).

5. What happened right before the Mantis threw his shoe up into the sky and it became the moon?
  - a. The Mantis saw Kwammang-a and the others cutting up the Eland.
  - b. The Mantis pricked open the Eland's gall.
  - c. The Mantis went to find some honey.
  
6. Which of the following was the first thing to happened after the Mantis saw Kwammang-a and the others cutting up the Eland?
  - a. The Mantis ran up to them meaning to strike them with his knobkerrie.
  - b. The mantis picked up a piece of Kwammang-a's shoe.
  - c. The Mierkat snatched the Mantis' knobkerrie and beat the Mantis.
  
7. Which of the following was the first thing to happen after the Mantis pricked open the Eland's gall?
  - a. The Mantis's shoe became the moon that shone.
  - b. The Mantis rubbed honey onto the Eland's ribs.
  - c. Everything was covered in darkness.

Please indicate whether the following sentences are true or false, base your answers only on the information from the San story. Answer by circling either TRUE or FALSE next to each sentence.<sup>30</sup>

1. Ichneumon and Kwammang-a went up to the Eland at the water, Kwammang-a looked at the Eland and he gently patted it.<sup>31</sup>

TRUE / FALSE
  
2. Ichneumon and Kwammang-a went to the water to try and find some fish.

TRUE / FALSE
  
3. Ichneumon and Kwammang-a went up to the Eland at the water, Kwammang-a looked at the Eland and he knocked it down!

TRUE / FALSE
  
4. Kwammang-a struck the Eland to ground when he and Icheumon went to see the Eland at the water.

TRUE / FALSE
  
5. The Mantis was beaten up by the Mierkat, who then ordered him to fetch wood for a fire on which the Eland was to be roasted.<sup>32</sup>

TRUE / FALSE
  
6. The Mierkat ignored the Mantis and continued digging in the san.

TRUE / FALSE

---

<sup>30</sup> Sentence Verification Technique Test (Csvt), consisting of sixteen items: items 1-4, 9-16 were retained from Study 1's SVT Test (these retained their original labelling of SVT1-SVT12 ); the ordering of these items was altered.

<sup>31</sup> Items 1-4 correspond to items 5-8 in Study 1's SVT Test (SVT5-SVT8).

<sup>32</sup> Items 5-8 were added in Study 2.

7. The Mierkat beat the Mantis and told the Mantis to bring wood for a fire to cook the Eland.

TRUE / FALSE

8. The Mierkat embraced the Mantis and told the Mantis to bring wood for a fire to cook roots.

TRUE / FALSE

9. Kaggen the Mantis whispered, "If I prick the gall open, it will cover me with moonlight".<sup>33</sup>

TRUE / FALSE

10. Kaggen the Mantis whispered, "If I prick the gall open, it will cover me with darkness".

TRUE / FALSE

11. Kaggen the Mantis whispered to himself that he could cover himself with darkness if he pricked open the Eland's gall.

TRUE / FALSE

12. Kaggen the Mantis whispered, "The Eland's gall is dark in colour".

TRUE / FALSE

13. The shining moon in the night sky was once the Mantis's shoe.<sup>34</sup>

TRUE / FALSE

14. The Mantis' shoe became the sun, that shone.

TRUE / FALSE

15. The Mantis's put his shoes out to dry in sun.<sup>35</sup>

TRUE / FALSE

16. The Mantis' shoe became the moon, that shone.

TRUE / FALSE

---

<sup>33</sup> Items 9-12 correspond to items 1-4 in Study 1's SVT Test (SVT1-SVT4).

<sup>34</sup> Items 13-16 correspond to items 9-12 in Study 1's SVT Test (SVT9-SVT12).

<sup>35</sup> This distractor sentence was modified from Study 1 where it read: 'The Mantis' shoe was broken and old'. This was since participants might erroneously infer this sentence to be true even though it is not mentioned explicitly in the story. Indeed more participants incorrectly answered 'true' to this distractor than to any other in Study 1. We felt that the version used in Study 2 was much less likely to be erroneously inferred as true and more participants answered this modified item correctly.



8. At a library, I would look for a book with more information about the San.
- |                |   |   |   |   |   |             |
|----------------|---|---|---|---|---|-------------|
| 1              | 2 | 3 | 4 | 5 | 6 | 7           |
| FULLY DISAGREE |   |   |   |   |   | FULLY AGREE |
9. I have not heard / read any San stories before today.
- |                |   |   |   |   |   |             |
|----------------|---|---|---|---|---|-------------|
| 1              | 2 | 3 | 4 | 5 | 6 | 7           |
| FULLY DISAGREE |   |   |   |   |   | FULLY AGREE |
10. I enjoy learning new things about the cultures of South Africa.
- |                |   |   |   |   |   |             |
|----------------|---|---|---|---|---|-------------|
| 1              | 2 | 3 | 4 | 5 | 6 | 7           |
| FULLY DISAGREE |   |   |   |   |   | FULLY AGREE |
11. I think the San people are very interesting.
- |                |   |   |   |   |   |             |
|----------------|---|---|---|---|---|-------------|
| 1              | 2 | 3 | 4 | 5 | 6 | 7           |
| FULLY DISAGREE |   |   |   |   |   | FULLY AGREE |
12. I would not enjoy watching a video based on a San story.
- |                |   |   |   |   |   |             |
|----------------|---|---|---|---|---|-------------|
| 1              | 2 | 3 | 4 | 5 | 6 | 7           |
| FULLY DISAGREE |   |   |   |   |   | FULLY AGREE |
13. The San story was an ordinary fairy tale.<sup>39</sup>
- |                |   |   |   |   |   |             |
|----------------|---|---|---|---|---|-------------|
| 1              | 2 | 3 | 4 | 5 | 6 | 7           |
| FULLY DISAGREE |   |   |   |   |   | FULLY AGREE |
14. I found the San story confusing.<sup>40</sup>
- |                |   |   |   |   |   |             |
|----------------|---|---|---|---|---|-------------|
| 1              | 2 | 3 | 4 | 5 | 6 | 7           |
| FULLY DISAGREE |   |   |   |   |   | FULLY AGREE |
15. I enjoyed my experience of the San story.<sup>41</sup>
- |                |   |   |   |   |   |             |
|----------------|---|---|---|---|---|-------------|
| 1              | 2 | 3 | 4 | 5 | 6 | 7           |
| FULLY DISAGREE |   |   |   |   |   | FULLY AGREE |
16. The San story seemed strange to me.
- |                |   |   |   |   |   |             |
|----------------|---|---|---|---|---|-------------|
| 1              | 2 | 3 | 4 | 5 | 6 | 7           |
| FULLY DISAGREE |   |   |   |   |   | FULLY AGREE |

<sup>39</sup> Items 13, 16, 19 and 21 measured how strange the story seemed to participants; these items were added in Study 2 (labelled STR1-STR4).

<sup>40</sup> Items 14 (retained from Study 1's questionnaire) and 22 (new item) measured the extent to which the story was confusing (labelled CON1 and CON2 respectively).

<sup>41</sup> Items 15 and 18 measured the extent to which the story experience was enjoyable; these items were retained from Study 1's questionnaire (labelled ENJ1 and ENJ2 respectively).



2. Kaggen the \_\_\_\_\_ is wise and he is gifted with \_\_\_\_\_. The San believe that he created the \_\_\_\_\_ and the \_\_\_\_\_.

Answers: mantis; special powers or magic; the earth and the creatures or eland and the moon

3. The Mantis took the \_\_\_\_\_ from his bag and rubbed \_\_\_\_\_ onto the Eland's \_\_\_\_\_.

Answers: honeycomb; honey; ribs

4. Ichneumon lay down in the grass under a \_\_\_\_\_ and spied on the Mantis.

Answers: kaross

Please answer the following questions by circling one of the possible options a, b or c for each question.

1. What was the first thing to happen in the story?

- a. The Mantis saw the Eland who was still small.
- b. Ichneumon went to spy on the Mantis.
- c. Kwammang-a threw away a part of his shoe.

Answer: c

2. Which of the following happened soonest after the mantis rubbed sweet honey on the Elands ribs?

- a. The Mantis threw his shoe up into the sky.
- b. The Eland grew nice and big, becoming like an ox.
- c. The Mantis soaked a part of Kwammang-a's shoe in water.

Answer: b

3. Which of the following happened soonest after Ichneumon took Kwammang-a to the Eland?

- a. Kwammang-a sent Ichneumon to spy on the Mantis.
- b. Ichneumon hid lay down in the grass under a kaross.
- c. Kwammang-a knocked the Eland down.

Answer: c

4. What happened last in the story?

- a. The Mantis' shoe became the moon.
- b. The Mantis pricked open the Eland's gall.
- c. Everything was covered in darkness.

Answer: a

5. What happened right before the Mantis threw his shoe up into the sky and it became the moon?
- The Mantis saw Kwammang-a and the others cutting up the Eland.
  - The Mantis pricked open the Eland's gall.
  - The Mantis went to find some honey.

Answer: b

6. Which of the following was the first thing to happened after the Mantis saw Kwammang-a and the others cutting up the Eland?
- The Mantis ran up to them meaning to strike them with his knobkerrie.
  - The mantis picked up a piece of Kwammang-a's shoe.
  - The Mierkat snatched the Mantis' knobkerrie and beat the Mantis.

Answer: a

7. Which of the following was the first thing to happen after the Mantis pricked open the Eland's gall?
- The Mantis's shoe became the moon that shone.
  - The Mantis rubbed honey onto the Eland's ribs.
  - Everything was covered in darkness.

Answer: c

Please indicate whether the following sentences are true or false, base your answers only on the information from the San story. Answer by circling either TRUE or FALSE next to each sentence.

1. Ichneumon and Kwammang-a went up to the Eland at the water, Kwammang-a looked at the Eland and he gently patted it.

TRUE / FALSE

Answer: FALSE (Meaning Change)

2. Ichneumon and Kwammang-a went to the water to try and find some fish.

TRUE / FALSE

Answer: FALSE (Distractor)

3. Ichneumon and Kwammang-a went up to the Eland at the water, Kwammang-a looked at the Eland and he knocked it down!

TRUE / FALSE

Answer: TRUE (Original)

4. Kwammang-a struck the Eland to ground when he and Icheumon went to see the Eland at the water.

TRUE / FALSE

Answer: TRUE (Paraphrase)

5. The Mantis was beaten up by the Mierkat, who then ordered him to fetch wood for a fire on which the Eland was to be roasted.  
TRUE / FALSE  
Answer: TRUE (Paraphrase)
6. The Mierkat ignored the Mantis and continued digging in the san.  
TRUE / FALSE  
Answer: FALSE (Distractor)
7. The Mierkat beat the Mantis and told the Mantis to bring wood for a fire to cook the Eland.  
TRUE / FALSE  
Answer: TRUE (Original)
8. The Mierkat embraced the Mantis and told the Mantis to bring wood for a fire to cook roots.  
TRUE / FALSE  
Answer: FALSE (Meaning Change)
9. Kaggen the Mantis whispered, "If I prick the gall open, it will cover me with moonlight".  
TRUE / FALSE  
Answer: FALSE (Meaning Change)
10. Kaggen the Mantis whispered, "If I prick the gall open, it will cover me with darkness".  
TRUE / FALSE  
Answer: TRUE (Original)
11. Kaggen the Mantis whispered to himself that he could cover himself with darkness if he pricked open the Eland's gall.  
TRUE / FALSE  
Answer: TRUE (Paraphrase)
12. Kaggen the Mantis whispered, "The Eland's gall is dark in colour".  
TRUE / FALSE  
Answer: FALSE (Distractor)
13. The shining moon in the night sky was once the Mantis's shoe.  
TRUE / FALSE  
Answer: TRUE (Paraphrase)
14. The Mantis' shoe became the sun, that shone.  
TRUE / FALSE  
Answer: FALSE (Meaning Change)

15. The Mantis's put his shoes out to dry in sun.

TRUE / FALSE

Answer: FALSE (Distractor)

16. The Mantis' shoe became the moon, that shone.

TRUE / FALSE

Answer: TRUE (Original)

# Appendix D

## IGroup Presence Questionnaire

The IGroup Presence Questionnaire (IPQ) was used to measure the presence of those participants who experienced a virtual storytelling scenario in Study 1 and 2. In both studies this questionnaire was completed last.

The following questions relate to your experience of the virtual environment/world you saw on computer today. Please indicate the answer most applies to your experience in the virtual environment by circling the appropriate number on the seven point scale. Circling a 1 means that the statement fully applies to you and circling a 7 indicates that the statement fully does not apply to you. As before, consider the entire scale when making your response since the numbers between 1 and 7 may also apply to you.

Remember to answer the questions in the order in which they appear. Do not skip questions or return to a previous question to change your answer. There are no right or wrong answers, only your opinion counts.

You will notice that some questions are very similar to each other. This is necessary for statistical reasons.

1. How aware were you of the real world while navigating in the virtual world? (for example: sounds, room temperature, other people, etc. from the real world)?

1	2	3	4	5	6	7
EXTREMELY AWARE		MODERATELY AWARE			NOT AWARE AT ALL	

2. How real did the virtual world seem to you?

1	2	3	4	5	6	7
COMPLETELY REAL					NOT REAL AT ALL	

3. I had a sense of acting in the virtual environment, rather than operating it from the outside.

1	2	3	4	5	6	7
FULLY DISAGREE					FULLY AGREE	

4. How much did your experience in the virtual environment seem like a real world experience?

1	2	3	4	5	6	7
NOT AT ALL		MODERATELY			ALOT	

5. How real did the virtual world seem to you?

1	2	3	4	5	6	7
ABOUT AS REAL AS AN IMAGINED WORLD					INDISTINGUISHABLE FROM THE REAL WORLD	



# Appendix E

## Virtual Environment Storyboards

This Virtual Environment (VE) storyboard document consists of three parts:

- The storyboard template used for specifying the requirements of a VE (Section E.1).
- The storyboard for the San storytelling VE (Section E.2).
- The storyboard for the hip-hop themed introductory VE (Section E.3).

Two VEs will be developed from these storyboards:

- The San storytelling VE, represented by the frames S1 – S4 (Section E.2).
- The San storytelling VE with hip-hop themed introductory VE will consist of frames H1 - H3 (Section E.3), and the frames S1 – S4 (Section E.2).

### E.1 Virtual Environment Storyboard Template

The following template was used for the annotations accompanying each frame and should comprehensively cover the VE's specifications:

#### Interactions:

- This stipulates whether the storyboarded frame represents the typical state/appearance of the VE after a particular interaction or event. If this is the case, details of the interaction or event and its consequences should be given.
- Details of possible interactions.

#### Setting:

- Description of VE setting and required objects and elements in terms of appearance, placement and static or dynamic behaviour.

#### Avatars:

- Description of required avatars in terms of appearance, placement and static or dynamic behaviour.
- Requirements and labels for avatars that will forge interaction with the user.

#### Lighting:

- Type of lighting
- Position of individual lights if significant
- Details of any dynamic light behaviour

**Sound:**

- All required sound and their desired effects (such as which VE element or avatar the a sound clip is associated with)
- Position of sound clip if significant
- Any dialogue (whether between two avatars or directed at the user)

**User:**

- Specify whether user is constrained in any way in their navigation or point of view
- Position if significant
- Point of view if significant (for instance if the point of view is a result of a forced camera change or is otherwise constrained)

**Special Effects:**

- Any specific audio or visual effects required
- This category may also act as a 'miscellaneous' for anything that doesn't fit into any of the above categories.

## E.2 Storyboard for San Storytelling VE

Frame S1:



**Interaction:** - *San Trigger 1* is in front of the user and encloses the area containing the gathering, cave and hut.

**Setting:** - Dry, arid setting with night-time sky  
- Open cave (typical of those found in the Cederberg)  
- San family gathered around an animated fire at the mouth of the cave  
- There is a small hut just outside the cave

**Avatars:** - San man, elder woman (*storyteller*) and two children, they are sitting around the fire quietly talking amongst themselves (possibly gesturing to each other now and then)

**Lighting:** - Low ambient lighting to give the appearance of dusk  
- Dynamic firelight  
- Soft light positioned inside the moon

**Sound:** - Ambient night sounds  
- Muttering/ soft talking sounds to accompany gathering's chattering

**User:** - Free navigation and point of view

**Frame S2:**



**Interaction:** - *San Trigger 1* is crossed.

- *San Trigger 2* is still in front of the user, if it is not crossed in about 5 seconds, the gathering will look away and continue as they were or offer further encouragement.

**Setting:** - As in **S1**

**Avatars:** - The San family stops chattering and acknowledges the user's presence by greeting/gesturing/nodding

**Lighting:** - As in **S1**

- The ambient lighting slowly becomes darker and the light from the moon and fire become brighter (this is to simulate the falling of night-time)

**Sound:** - As in **S1**

- *San Man:* Come closer friend

**User:** - Free navigation and point of view within the area enclosed by *San Trigger 1*

Frame S3:



**Interaction:** - *San Trigger 2* is crossed.

**Setting:** - As in **S1**

**Avatars:** - The *storyteller* stands and greets the user

- The San children are looking in the direction of the user.
- The *storyteller* invites the user to listen to a San story.
- These actions should be possible from whether the gathering is chattering as in **S1** or acknowledging the user as in **S1**.

**Lighting:** - As in **S2**

**Sound:** - As in **S1**

- *San man and children:* hello
- *Storyteller:* I was just about to a story, the one about how the mantis made the eland. Please sit and listen with us.

Frame S4:



**Interaction:** - None

**Setting:** - As in S1

**Avatars:** - The *storyteller* sits down and begins narration.  
- The San family directs their attention to the *storyteller*.

**Lighting:** - As in S2  
- At the end of the narration there is very low ambient light and when the storyteller is finished all remaining light in the VE fades to black smoothly.

**Sound:** - As in S1  
- *Storyteller's* narration of *San Narrative: Mantis Prologue* is directed at the user and *The Mantis Makes Eland* is more generally directed.

**User:** - Free navigation and point of view within the area enclosed by *San Trigger 1* such that the narration is never too far out of 'earshot'

**Special Effects:** - Visual story-related mediation (either in the form of rock paintings or smoke formations)

### E.3 Storyboard for Hip-Hop Themed Introductory VE

Frame III:



**Interaction:** - *Hip-hop Trigger 1* is in front of the user who has been placed very close to the gathering such that crossing the trigger is inevitable

**Setting:** - Urban

- Pavement or open alley
- There is a large wall with hip-hop graffiti on it, it should also have a door textured with colourful neo-San art

**Avatars:** - 3-4 hip-hop avatars chatting/break-dancing/spraying graffiti/rapping

- The *hip-hop guide* is closest to the user as shown

**Lighting:** - Daylight approaching dusk (to match time of day in subsequent San VE)

**Sound:** - Ambient urban sound (such as traffic, walking etc)

- Sounds to accompany avatars' movement, rapping and spray painting etc
- One of the characters beat boxes

**User:** - Free navigation and point of view

**Frame H2:**



**Interaction:** - *Hip-hop Trigger 1* is crossed

**Setting:** - As in **H1**

**Avatars:** - The hip-hop avatars' activity ceases and they acknowledge the user by greeting/gesturing/nodding  
- The *hip-hop guide* is closest to and directly faces the user

**Lighting:** - As in **H1**

**Sound:** - As in **H1** minus the sound that accompanied the hip-hop avatars' activity  
- Sounds to accompany avatars' movement, rapping and spray painting etc  
- *Hip-hop guide*: Yo! Did you know dat way back in da day da San people used to live right here in southern Africa. They lived off the fat of the land, hunting and eating roots and berries. One of the things they loved to do was to tell stories, especially around a fire. Check it out!

**User:** - Free navigation and point of view

- At the end of the *hip-hop guide's* dialogue there is a smooth, but forced camera movement (may involve point of view and position change) to face the portal to the San VE as shown in **H3**

Frame H3:



- Interaction:** - The option to open the door is given to the user in the form of an onscreen HUD/menu; once the door is opened the *hip-hop guide* prompts the user to enter (perhaps by saying "Go on" and gesturing towards the doorway)
- If the user does not open the door within about 5 seconds, the door opens automatically.

**Setting:** - As in H1

**Avatars:** - The hip-hop avatars are all silent and looking at the door

**Lighting:** - As in H1

**Sound:** - As in H2

- *Hip-hop guide* (as the door first comes into view): Through that door you can meet a San family and hear a story dude!

**User:** - Navigation constrained by visible (realistic) or invisible bounding box to ensure the user can't move away from the wall or turn to face away from it.

## Appendix F

### San VE Setting and Reference Material

This appendix shows images of the content used in the setting of the San storytelling VE (Sections 1.1 and 1.2) along with reference sketches used in modelling artefacts and avatars (Section F.3).

#### F.1 Cave Setting



Figure F.1: A birds-eye view of the cave model used in the San storytelling VE.



Figure F.2: A ground level view of the cave model used in the San storytelling VE.



Figure F.3: The hearth area of the cave model, this is the area in which the San gathering and fire were situated.



Figure F.4: A bird-eye view of the cave model showing the boundaries beyond which users could not navigate in the VE. These boundaries were invisible to users.



Figure F.5: This birds-eye view of the cave model shows visualisations of the two proximity triggers used in the San storytelling VE. When the outer trigger is activated the San man in the San gathering stands up and looks in the general direction of the user. When the inner trigger is activated, the San man invites the user to join the gathering and sits down. A few seconds later the storyteller begins telling the story.

## F.2 San Rock Art Textures

The following are all the rock art pictures used to texture the walls of the cave model. These paintings were all related to the story told in the San VE. The original photographs were taken from Bassett, 2001 and Parkington, 2001.



Figure F.6: A painting of a hunter. This painting related to the San story since the storyteller mentions hunting at the start of the story.



Figure F.7: A painting of a young buck or eland. The San story mentions the young eland when it is first created by Kaggen, the mantis.

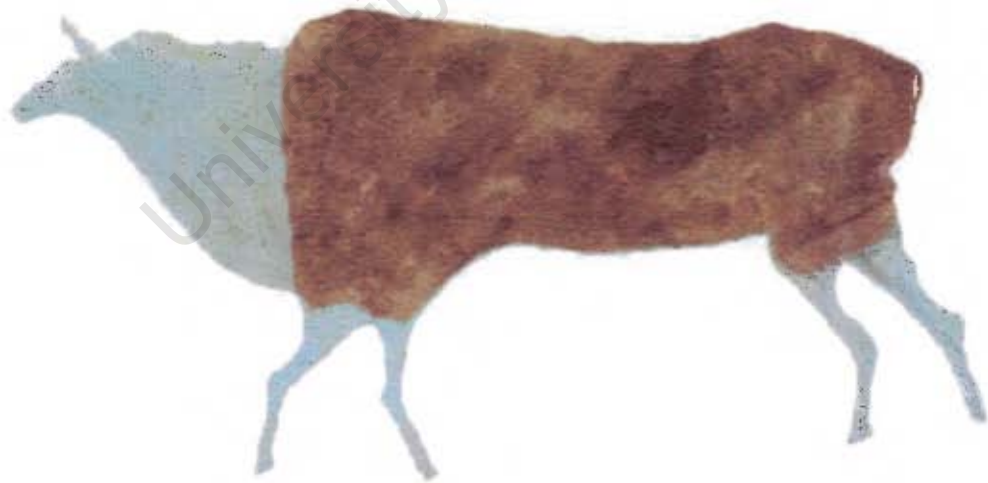


Figure F.8: A painting of a large eland. The painting was included since the San story deal largely with the first eland created by Kaggen, the mantis.



Figure F.9: A painting of a gathering of people. This painting was intended to relate to the part of the San story where a group of characters set out to find the eland which Kaggen has created.



Figure F.10: A painting of a group of eland and a group of people are attacking one of the eland. This painting was intended to correspond to the attacking of Kaggen's eland in the San story.

### F.3 Reference Sketches

The following reference sketches were created by an artist, Vera Vukovic, using various San books, photographs and in consultation with Prof. John Parkington. These sketches were used as reference for creating the models of the artefacts placed in the cave and the figures of the San gathering.

#### F.3.1 Artefacts



Figure F.11: A hanging bag.



Figure F.12: A grinding stone.



Figure F.13: A bow and quiver vessel.



Figure F.14: A bow and quiver vessel inside a hanging bag.

F.3.2 San Gathering



Figure F.15: Elder San storyteller reference sketch; front view.



Figure F.16: Elder San storyteller reference sketch; side view.



Figure F.17: Elder San storyteller reference sketch; back view.

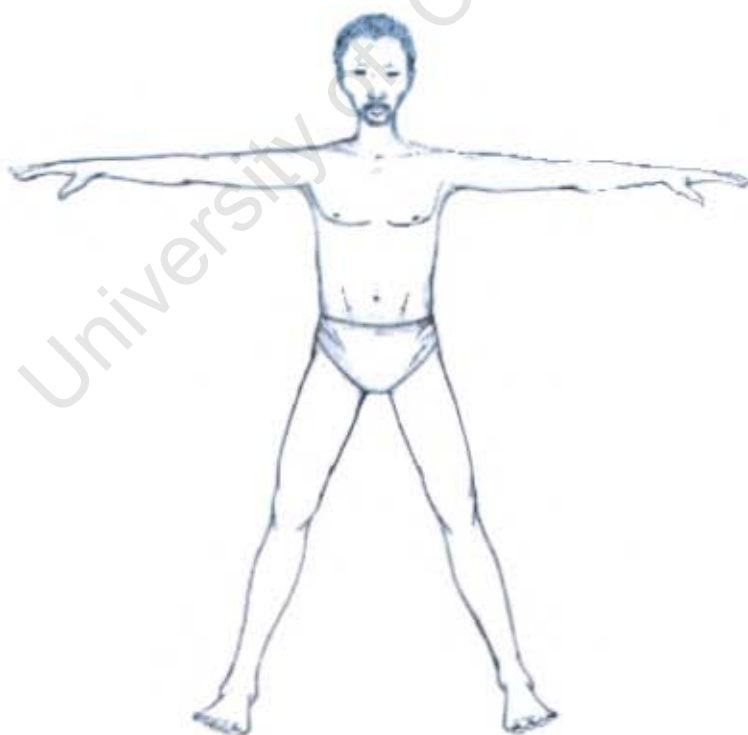


Figure F.18: San man reference sketch; front view.



Figure F.19: San man reference sketch; side view.



Figure F.20: San man reference sketch; back view.

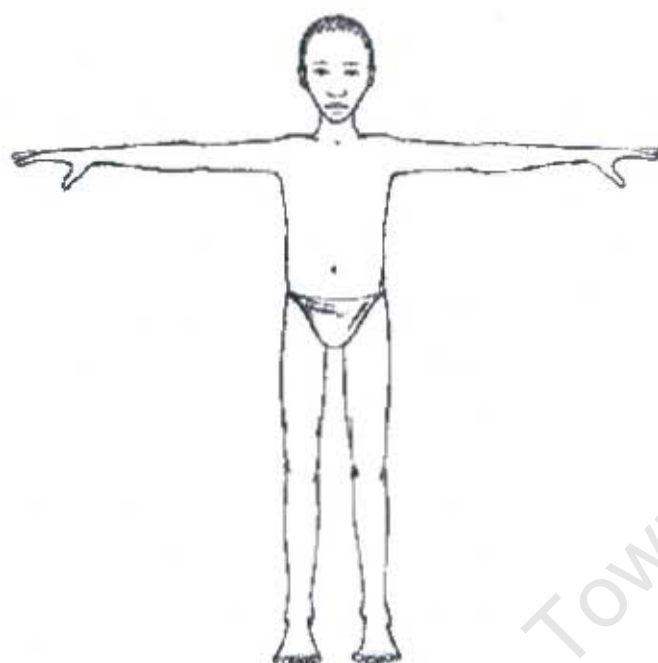


Figure F.21: San child reference sketch; front view.



Figure F.22: San child reference sketch; side view.

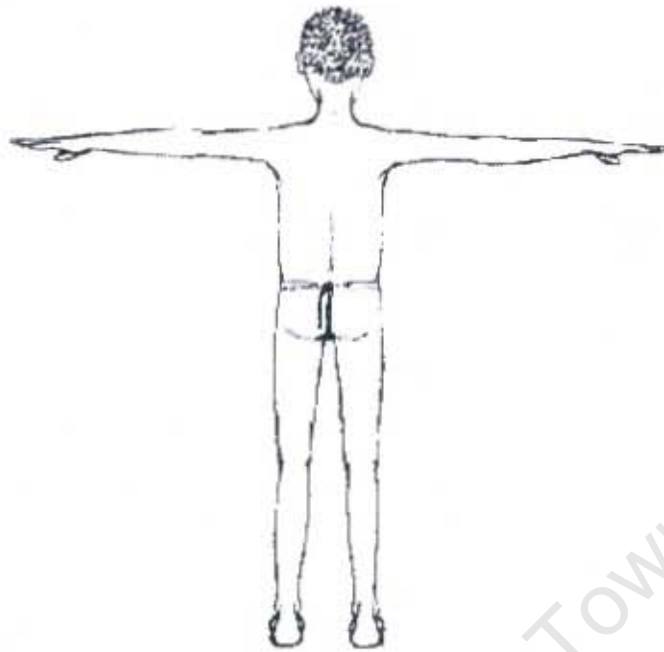


Figure F.23: San child reference sketch; back view.

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## Appendix G

### Introductory VE Setting

This appendix shows images of the 3D urban model used in hip-hop themed introductory VE.



Figure G.1: A birds-eye view of the urban model used in the hip-hop themed introductory VE. The user interacts with the hip-hop avatar within the fenced area.



Figure G.2: A ground level of the area in which the user interacts with the hip-hop avatar in the introductory VE. The graffiti-covered walls within this area are also visible.

## Appendix H

### Training VE Screenshots

This Appendix shows screenshots of the Training VE used in our experiments. All participants experiencing a virtual storytelling scenario were first briefed on the navigation principles and controls of our VEs. They then experienced the Training VE which was used to allow participants to become familiar with the navigation of a VE using a keyboard (for walking) and mouse (for changing viewpoint). The VE consists of a house and were participants would practice walking through doorways (required in the San storytelling VE). Text was used in the Training VE to reiterate the navigational controls.

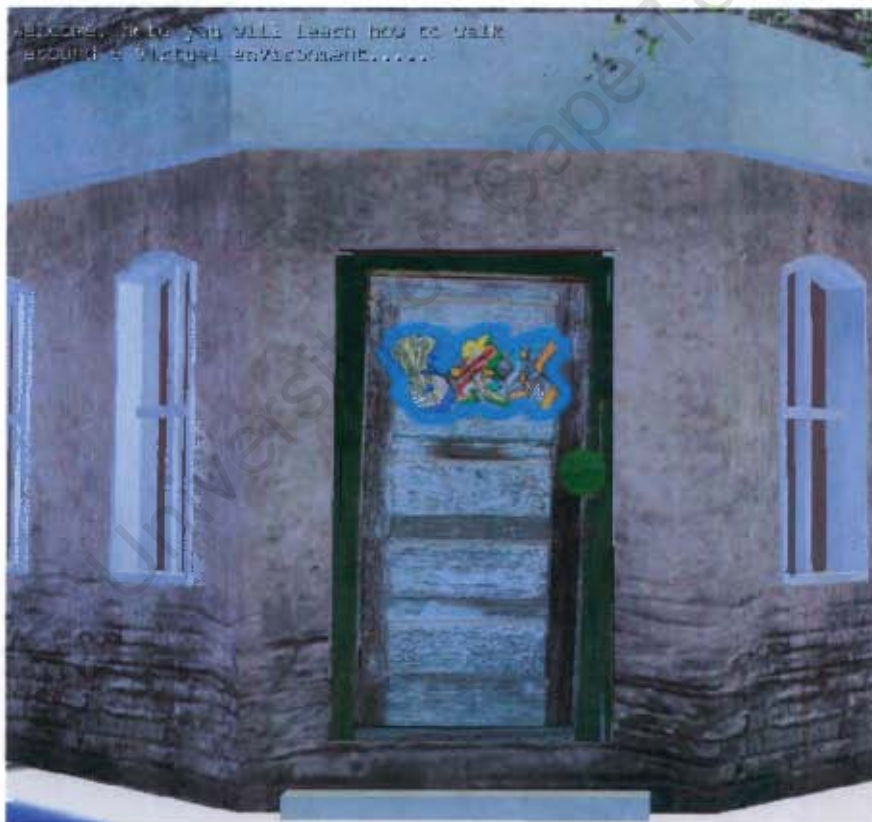


Figure H.1: The Training VE as it is first viewed by a user. The Training VE consisted of a house and participants were able to practice navigating both inside and outside the house using the keyboard and mouse.



Figure H.2: After a few seconds in the Training VE, the text changes to display the use of a mouse for changing viewpoint.



Figure H.3: The door in the Training VE opens and participants are encouraged to attempt walking through it. Walking through an open door is required in the introductory VE, thus participants were encouraged to practice this.



Figure H.4: A view from inside the house in the Training VE. The keyboard navigation controls are reiterated using text. At this point in the VE, participants were allowed to navigate until they felt comfortable with the controls. The text shown in this screenshot remained displayed until the VE was shut down by the experimenter.

## Appendix I

### Psychometrics: Inter-item correlation matrices

This Appendix gives the correlations matrices which were not included, referred to in Chapter 6.

#### I.1 Study 1

Item	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00	0.21	-0.17	0.15	0.06	-0.12	-0.07	0.02	-0.16	0.04	-0.08	-0.12
2	0.21	1.00	0.10	0.06	-0.04	0.07	0.04	-0.23	-0.02	<b><i>0.32</i></b>	-0.24	0.07
3	-0.17	0.10	1.00	0.01	0.26	0.16	0.11	-0.06	0.07	0.07	-0.28	-0.11
4	0.15	0.06	0.01	1.00	<b><i>0.36</i></b>	<b><i>0.62</i></b>	0.19	-0.24	0.04	0.24	0.29	-0.12
5	0.06	-0.04	0.26	<b><i>0.36</i></b>	1.00	0.28	0.15	-0.01	0.15	<b><i>0.32</i></b>	<b><i>0.30</i></b>	0.07
6	-0.12	0.07	0.16	<b><i>0.62</i></b>	0.28	1.00	0.17	-0.04	0.19	0.19	0.08	-0.07
7	-0.07	0.04	0.11	0.19	0.15	0.17	1.00	<b><i>0.33</i></b>	<b><i>0.47</i></b>	0.18	0.06	-0.02
8	0.02	-0.23	-0.06	-0.24	-0.01	-0.04	<b><i>0.33</i></b>	1.00	0.14	-0.01	-0.04	-0.04
9	-0.16	-0.02	0.07	0.04	0.15	0.19	<b><i>0.47</i></b>	0.14	1.00	<b><i>0.32</i></b>	0.06	0.19
10	0.04	<b><i>0.32</i></b>	0.07	0.24	<b><i>0.32</i></b>	0.19	0.18	-0.01	<b><i>0.32</i></b>	1.00	0.06	<b><i>0.47</i></b>
11	-0.08	-0.24	-0.28	0.29	<b><i>0.30</i></b>	0.08	0.06	-0.04	0.06	0.06	1.00	0.08
12	-0.12	0.07	-0.11	-0.12	0.07	-0.07	-0.02	-0.04	0.19	<b><i>0.47</i></b>	0.08	1.00

Table I.1: Correlation matrix for items SVT1-SVT12 of Csvt, the sentence verification test used to measure comprehension in Study 1. Significant correlations ( $p < 0.05$ ,  $n=44$ ) are shown in bold and italic.

Item	INT1	INT2	INT3	INT4	INT5	INT6	INT7	INT8
INT1	1.00	<b><i>0.64</i></b>	<b><i>0.50</i></b>	<b><i>0.82</i></b>	<b><i>0.75</i></b>	<b><i>0.83</i></b>	<b><i>0.65</i></b>	<b><i>0.52</i></b>
INT2	<b><i>0.64</i></b>	1.00	<b><i>0.31</i></b>	<b><i>0.55</i></b>	<b><i>0.51</i></b>	<b><i>0.61</i></b>	<b><i>0.52</i></b>	<b><i>0.47</i></b>
INT3	<b><i>0.50</i></b>	<b><i>0.31</i></b>	1.00	<b><i>0.48</i></b>	<b><i>0.46</i></b>	<b><i>0.53</i></b>	<b><i>0.48</i></b>	<b><i>0.38</i></b>
INT4	<b><i>0.82</i></b>	<b><i>0.55</i></b>	<b><i>0.48</i></b>	1.00	<b><i>0.87</i></b>	<b><i>0.81</i></b>	<b><i>0.60</i></b>	<b><i>0.48</i></b>
INT5	<b><i>0.75</i></b>	<b><i>0.51</i></b>	<b><i>0.46</i></b>	<b><i>0.87</i></b>	1.00	<b><i>0.77</i></b>	<b><i>0.65</i></b>	<b><i>0.52</i></b>
INT6	<b><i>0.83</i></b>	<b><i>0.61</i></b>	<b><i>0.53</i></b>	<b><i>0.81</i></b>	<b><i>0.77</i></b>	1.00	<b><i>0.66</i></b>	<b><i>0.58</i></b>
INT7	<b><i>0.65</i></b>	<b><i>0.52</i></b>	<b><i>0.48</i></b>	<b><i>0.60</i></b>	<b><i>0.65</i></b>	<b><i>0.66</i></b>	1.00	<b><i>0.39</i></b>
INT8	<b><i>0.52</i></b>	<b><i>0.47</i></b>	<b><i>0.38</i></b>	<b><i>0.48</i></b>	<b><i>0.52</i></b>	<b><i>0.58</i></b>	<b><i>0.39</i></b>	1.00

Table I.2: Correlation matrix for items INT1-INT8 of the interest questionnaire used to measure interest in Study 1. Significant correlations ( $p < 0.05$ ,  $n=44$ ) are shown in bold and italic.

I.2 Study 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1.00	<i>0.43</i>	<i>0.35</i>	0.09	0.16	<i>0.33</i>	<i>0.25</i>	<i>0.22</i>	- 0.06	<i>0.24</i>	0.15	<i>0.23</i>	<i>0.41</i>	<i>0.24</i>	<i>0.42</i>	<i>0.52</i>
2	<i>0.43</i>	1.00	0.19	0.03	0.09	<i>0.27</i>	<i>0.33</i>	<i>0.33</i>	0.10	<i>0.25</i>	- 0.01	0.04	0.17	0.02	0.12	<i>0.24</i>
3	<i>0.35</i>	0.19	1.00	0.07	- 0.01	0.19	<i>0.36</i>	<i>0.29</i>	0.17	0.10	0.09	0.19	<i>0.25</i>	- 0.07	<i>0.38</i>	<i>0.24</i>
4	0.09	0.03	0.07	1.00	0.20	0.11	0.02	0.14	0.03	0.16	- 0.04	0.14	0.05	0.00	0.02	0.17
5	0.16	0.09	- 0.01	<i>0.20</i>	1.00	0.10	<i>0.45</i>	0.18	- 0.06	0.07	0.16	<i>0.39</i>	<i>0.26</i>	<i>0.30</i>	0.06	<i>0.25</i>
6	<i>0.33</i>	<i>0.27</i>	0.19	0.11	0.10	1.00	0.11	<i>0.37</i>	- 0.00	<i>0.26</i>	<i>0.23</i>	<i>0.31</i>	0.18	0.10	0.16	0.02
7	<i>0.25</i>	<i>0.33</i>	<i>0.36</i>	0.02	<i>0.45</i>	0.11	1.00	- <i>0.44</i>	0.05	0.09	0.06	0.14	<i>0.34</i>	<i>0.26</i>	0.14	<i>0.26</i>
8	<i>0.22</i>	<i>0.33</i>	<i>0.29</i>	0.14	0.18	<i>0.37</i>	<i>0.44</i>	1.00	0.03	0.17	- 0.10	0.08	<i>0.22</i>	<i>0.24</i>	0.17	0.08
9	- 0.06	0.10	0.17	0.03	- 0.06	- 0.00	- 0.05	0.03	1.00	0.17	- 0.11	<i>0.25</i>	0.01	0.10	- 0.01	0.10
10	<i>0.24</i>	<i>0.25</i>	0.10	0.16	0.07	<i>0.26</i>	0.09	0.17	0.17	1.00	- 0.02	0.18	0.21	0.21	- 0.03	<i>0.23</i>
11	0.15	- 0.01	0.09	- 0.04	0.16	<i>0.23</i>	0.06	- 0.10	- 0.11	- 0.02	1.00	0.16	0.18	0.06	<i>0.24</i>	- 0.09
12	<i>0.23</i>	0.04	0.19	0.14	<i>0.39</i>	<i>0.31</i>	0.14	0.08	<i>0.25</i>	0.18	0.16	1.00	<i>0.30</i>	0.13	0.11	0.10
13	<i>0.41</i>	0.17	<i>0.25</i>	0.05	<i>0.26</i>	0.18	<i>0.34</i>	<i>0.22</i>	0.01	0.21	0.18	<i>0.30</i>	1.00	<i>0.43</i>	<i>0.63</i>	<i>0.39</i>
14	<i>0.24</i>	0.02	- 0.07	0.00	<i>0.30</i>	0.10	<i>0.26</i>	<i>0.24</i>	0.10	0.21	0.06	0.13	<i>0.43</i>	1.00	0.13	<i>0.25</i>
15	<i>0.42</i>	0.12	<i>0.38</i>	0.02	0.06	0.16	0.14	0.17	- 0.01	- 0.03	<i>0.24</i>	0.11	<i>0.63</i>	0.13	1.00	<i>0.38</i>
16	<i>0.52</i>	<i>0.24</i>	<i>0.24</i>	0.17	<i>0.25</i>	0.02	<i>0.26</i>	0.08	0.10	<i>0.23</i>	- 0.09	0.10	<i>0.39</i>	<i>0.25</i>	<i>0.38</i>	1.00

Table I.3: Correlation matrix for items SVT1-SVT12 of Csvt, the sentence verification test used to measure comprehension in Study 1. Significant correlations ( $p < 0.05$ ,  $n=44$ ) are shown in bold and italic.

Item	INT1	INT2	INT3	INT4	INT5	INT6	INT7	INT8
INT1	1.00	<i>0.39</i>	<i>0.38</i>	<i>0.49</i>	<i>0.54</i>	<i>0.51</i>	<i>0.45</i>	<i>0.30</i>
INT2	<i>0.39</i>	1.00	<i>0.24</i>	<i>0.36</i>	<i>0.37</i>	<i>0.33</i>	<i>0.40</i>	<i>0.37</i>
INT3	<i>0.38</i>	<i>0.24</i>	1.00	<i>0.45</i>	<i>0.50</i>	<i>0.32</i>	<i>0.41</i>	<i>0.35</i>
INT4	<i>0.49</i>	<i>0.36</i>	<i>0.45</i>	1.00	<i>0.61</i>	<i>0.52</i>	<i>0.53</i>	<i>0.37</i>
INT5	<i>0.54</i>	<i>0.37</i>	<i>0.50</i>	<i>0.61</i>	1.00	<i>0.51</i>	<i>0.61</i>	<i>0.41</i>
INT6	<i>0.51</i>	<i>0.33</i>	<i>0.32</i>	<i>0.52</i>	<i>0.51</i>	1.00	<i>0.45</i>	<i>0.31</i>
INT7	<i>0.45</i>	<i>0.40</i>	<i>0.41</i>	<i>0.53</i>	<i>0.61</i>	<i>0.45</i>	1.00	<i>0.49</i>
INT8	<i>0.30</i>	<i>0.37</i>	<i>0.35</i>	<i>0.37</i>	<i>0.41</i>	<i>0.31</i>	<i>0.49</i>	1.00

Table I.4: Correlation matrix for items INT1-INT8 of the interest questionnaire used to measure interest in Study 2. Significant correlations ( $p < 0.05$ ,  $n=44$ ) are shown in bold and italic.

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