INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

Bell & Howell Information and Learning
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
800-521-0600

UMI[®]

Voice and Text in Computer-Aided Instruction
an examination of the effects of a bimodal component
in a multimedia learning context

by

Devjani Sen, B. A. (Psychology, Carleton University)

A thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfillment of
the requirements for the degree of

Master of Arts

Carleton University, December 2000

National Library
of Canada

Acquisitions and
Bibliographic Services

395 Wellington Street
Ottawa ON K1A 0N4
Canada

Bibliothèque nationale
du Canada

Acquisitions et
services bibliographiques

395, rue Wellington
Ottawa ON K1A 0N4
Canada

Your file Votre référence

Our file Notre référence

The author has granted a non-exclusive licence allowing the National Library of Canada to reproduce, loan, distribute or sell copies of this thesis in microform, paper or electronic formats.

The author retains ownership of the copyright in this thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without the author's permission.

L'auteur a accordé une licence non exclusive permettant à la Bibliothèque nationale du Canada de reproduire, prêter, distribuer ou vendre des copies de cette thèse sous la forme de microfiche/film, de reproduction sur papier ou sur format électronique.

L'auteur conserve la propriété du droit d'auteur qui protège cette thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation.

0-612-57715-5

Canada

The undersigned recommend to the
Faculty of Graduate Studies and Research
Acceptance of the thesis:

"Voice and Text in Computer-Aided Instruction: An Exploration of the Effects of a
Bi-model Component in a Multimedia Learning Context"

submitted by

Devjani Sen

in Partial fulfillment of the requirements for
the degree of Master of Arts

Chair
Thesis Supervisor

Carleton University
December, 2000

Abstract

This study explores the effectiveness of adding voice narration (auditory adjuncts) to on-screen textual learning material in a computer-aided instruction (CAI) context. This is the first locatable test of dual-coding theory using non-pictorial information in a multimedia context. The effect of individual differences in attending to the narration as well as the manner of how the narration was used were also assessed.

Forty-eight first-year Psychology students participated in the study. These volunteers were categorized by gender, perception style and personality (introversion or extraversion). All participants were asked to learn three lessons regarding conflict resolution (game theory), Social Psychology and the Law and self-monitoring. Participants were asked to use each of three multimedia learning conditions: no voice (text-only format), text with voice added (bimodal format) and choice condition, which allowed participants to choose the presentation form they wished (no voice or text with voice added). Learning was measured with three tests of retention in each condition.

Expectations were not confirmed. The addition of voice narration was not found to have a facilitating effect on performance. The findings provide weak evidence for the mediating role of individual differences on performance as well as attitudes about and behaviour in bimodal multimedia learning context. Findings are considered in relation to current theoretical and empirical literature in multimedia.

Acknowledgements

I wish to thank the members of my committee. First, Dr. Jo Wood and Dr. Richard Dillon, both of the Department of Psychology. Second, Dr. George Pollard, office of the Dean of the Faculty of the Arts and Social Sciences, who assumed supervisory responsibility for this thesis. Third, the external examiner, Dr. Terry Nosanchuk, of the Department of Sociology and Anthropology, for his generous advise and comments.

I would also like to thank Karla for her emotional support and assistance throughout the writing of this thesis. Thanks also to Mike, Ron and Susan for coming through during so many 'pseudo-emergencies.' I wish also to express appreciation to my lab mates for making our years together so much fun and memorable. Special thanks to my dog Elmo for his many licks and hugs, and for 'just being there'.

Last, but not least, thanks to my Mother, Tapati Sen, for her encouragement and believing in me from the beginning. This thesis is dedicated to her.

List of Figures

Figure 1: A dual-coding model of multimedia learning	9
Figure 2. A proposed model of learning narrated text	85

List of Tables

Table	Description	Page
Table 1	List of Selected and Deleted Items from the VAP Principle	25
Table 2	Summary of Item Responses Designed to Assess Perceiver Style	31
Table 3	Order One: Presentation Mode x Topic	36
Table 4	Order Two: Presentation Mode x Topic	37
Table 5	Mean, Median and Standard Deviation (S.D.), for Performance in Text and Text-Voice Conditions	39
Table 6	Mean, Median and Standard Deviation (S.D.), for Expected Performance in Text and Text-Voice Conditions	41
Table 7	Mean, Median and Standard Deviation (S.D.), for Duration of Time Spent in Text and Text-Voice Conditions	43
Table 8	Mean, Median and Standard Deviation (S.D.), for Frequency of Time Spent in Text and Text-Voice Conditions	44
Table 9	Dichotomization of Participant Feedback on Voice Narration	46
Table 10	Means and Standard Deviations for Personality Across Performance in Text and Text-Voice Conditions	49
Table 11	Means and Standard Deviations for Personality Across Expected Performance in Text and Text-Voice Conditions	50
Table 12	Means and Standard Deviations for Personality Across Duration of Time Spent in Text and Text-Voice Conditions	51
Table 13	Means and Standard Deviations for Personality Across Frequency of Time Spent in Text and Text-Voice Conditions	52
Table 14	Means and Standard Deviations for Perception Style Across Performance in Text and Text-Voice Conditions	54
Table 15	Means and Standard Deviations for Perception Style Across Expected Performance in Text and Text-Voice Conditions	55

Table	Description	Page
Table 16	Means and Standard Deviations for Perception Style Across Duration of Time Spent in Text and Text-Voice Conditions	56
Table 17	Means and Standard Deviations for Perception Style Across Frequency of Time Spent in Text and Text-Voice Conditions	57
Table 18	Means and Standard Deviations for Gender Across Performance in Text and Text-Voice Conditions	59
Table 19	Means and Standard Deviations for Gender Across Expected Performance in Text and Text-Voice Conditions	60
Table 20	Means and Standard Deviations for Gender Across Duration of Time Spent in Text and Text-Voice Conditions	61
Table 21	Means and Standard Deviations for Gender Across Frequency of Time Spent in Text and Text-Voice Conditions	62
Table 22	Frequency Distribution for Personality (Extroverts and Introverts) Across Preference for Text-Voice	67
Table 23	Frequency Distribution for Perception Style (Visual and Auditory) Across Preference for Text-Voice	70
Table 24	Frequency Distribution for Gender Across Preference for Text-Voice	73
Table 25	Sequential Regression Analysis of Personality, Perception Style and Gender on Performance in Text-Voice	125
Table 26	Sequential Regression Analysis of Personality, Perception Style and Gender on Expected Performance in Text-Voice	126
Table 27	Sequential Regression Analysis of Personality, Perception Style and Gender on Duration of Time Spent in Text-Voice	127
Table 28	Sequential Regression Analysis of Personality, Perception Style and Gender on Frequency of Time Spent in Text-Voice	128
Table 29	Frequency Distribution of Perceiver Style, Gender, and Personality Across First Order	76

Table	Description	Page
Table 30	Frequency Distribution of Perceiver Style, Gender, and Personality Across Second Order	77

Table of Contents

<i>Abstract</i>		i
<i>Acknowledgements</i>		ii
<i>List of Figures</i>		iii
<i>List of Tables</i>		iv
<i>Chapter One:</i>	Introduction	1
<i>Chapter Two:</i>	Rationale	6
<i>Chapter Three:</i>	Methods	23
<i>Chapter Four:</i>	Results	38
<i>Chapter Five:</i>	Discussion	80
<i>References</i>		97
<i>Appendix A:</i>	Informed Consent	103
<i>Appendix B:</i>	Background Questionnaire	104
<i>Appendix C:</i>	Retention Tests	105
<i>Appendix D:</i>	Learning Material	111
<i>Appendix E:</i>	Debriefing Form	119
<i>Appendix F:</i>	Regression Analyses: Discussion and Tables	120

Chapter One

Introduction

The advent of computer-aided instruction (CAI) has transformed the field of education. It has encouraged integration of traditional methods of teaching with technological advances by introducing computers into the classroom. Computers have quickly become a preferred teaching tool for instructors; a recent study indicates more than 90% of all educational institutions in North America are now using computers (Yankus, 1995).

A principle benefit of CAI is enrichment of the learning experience by conveying material through a multimedia interface that facilitates enhanced sensory stimulation. As Wilson (1992:186) notes, multimedia learning environments,

allow for the electronically integrated display and user control of a variety of media formats and information types, including motion video and film, still photographs, text, graphics, animation, sound, numbers and data. The resulting interactive experience for the user is a multidimensional, multi-sensory interweave of self-directed reading, viewing, listening, and interacting, through activities such as exploring, searching, manipulating, writing, linking, creating, juxtaposing, and editing.

The promise of a multimedia approach leading to significant improvements in the breadth and depth of learning calls for an improved general understanding of its processes and a specific understanding of the performance variations across the human senses.

To date, however, it seems that the multimedia approach to learning has been developed more because of its technological capacity than because of pedagogical effects (Kozma, 1991). Few studies have contributed to the development of a theory of multimedia learning with little clarification and testing of cognitive principles of learning theory, which could provide further guidance on how this technology could be most effectively

implemented. As a result, instructional design of multimedia remains largely based on the intuitive beliefs of designers rather than on empirical evidence (cf. Park & Hannafin, 1994).

Essentially, it is the learner who creates the learning conditions within multimedia contexts through his or her interactivity with the system. There is an intricate relationship created between the learner and learning environment:

Control and initiative oscillate between the environment and the individual according to the latter's decisions, which in turn are conditioned by the adaptability and flexibility of the environment in relation to individual differences. Giardina (1992: 48).

Thus it seems, design principles for the development of multimedia support environments founded on cognitive theories of human learning are called-for. A cognitive theoretical basis is of particular importance in multimedia, as insight may be obtained on how sensory information is encoded and retrieved by the learner. This information in turn may assist in creating more effective technology for the end-user.

An exploration into the effectiveness of multimedia technology constitutes the overarching purpose of the current study. For the purpose of this study, the question of 'effectiveness' is operationally defined as follows: (1) does the technology work (i.e. facilitate learning)? and (2) is it used by the learner? An appreciation of one without the other is of little value. If a learning tool works but is not used, or conversely, is used but doesn't work, it is not effective. Both of these issues are thus addressed in the current study through the exploration of two corresponding themes.

The first theme concerns an assessment of the facilitative effects of voice narration on the retention of on-screen text instructional material. This evaluation is used to

clarify and test a fundamental cognitive principle of human learning: the dual-coding theory of working memory. The present study is the first known to examine modality effects in multimedia learning in which narration is compared to a text-only condition.

The second theme is a psychological exploration of how learners utilise multimedia learning environments. From an educational standpoint, the identification of the kinds of learners most likely to benefit from this technology is imperative. Such information would enable designers of CAI to more effectively design courseware to fit the individual needs of an increasingly diverse student population. Due to a paucity of locatable studies examining how learning decisions are made in a multimedia context, an analysis of the saliency of behaviour, motivation and the underlying mental processes should be undertaken. Thus, the moderating role of individual differences in selecting or using multimedia alternatives is explored in the current study in order to assist in the identification of users who are most likely to employ multimedia and benefit most from its use.¹

An increasing body of literature suggests that multimedia options may not be as widely implemented by users as was first anticipated (cf. Hadley & Scheingold, 1992; Kearsley & Lynch, 1992; Eubanks, 1988). Several studies suggest instructional material may be ineffective because it is ignored (Gardina 1992; Gayeski, 1989; Mevarech, 1989).² A critical question is thus raised: does multimedia promote cognitive engage-

¹ The primary focus of much of the multimedia literature has been the assessment of task performance. Task performance research examines how effectively instructional material is retained by the learner. The scope of these studies, however, is limited because they offer little insight into why media tools are employed by the learner, and in what way their use facilitates or impedes the learning process. Consequently, task performance assessments may tell us if multimedia works, but do not tell us why or why not.

² For instance, Mevarech (1989) reported students who were given control over whether or not they wished to view optional elements, such as hypertext, did not utilize this option significantly more often than students in a control condition, where a computer program controlled the amount of instruction presented. Thus, even when interactive multimedia is applied, it is often under-utilized (Gayeski, 1989). The reluctance of learners to employ multimedia technology significantly hinders demonstration of its potential and

ment, as it purports to do? If so, for which users is it most effective, which users choose to implement it, and why?

As user behaviour and aptitude in multimedia may be moderated by individual differences, these differences need to be explored through further research. Multimedia environments encourage users to learn through exploration and experimentation. In addition, the nature of multimedia is polysensory. It follows then, that individuals who are more discovery-oriented,³ and have higher aptitudes for learning through their senses should benefit more from this environment.

Cognitive theories emphasize the importance of attention in learning and focus on the effects of thought and mental processes in the learning process. Thus, a reasonable appreciation of user behaviour must involve an understanding of the learner. What, for example, are her or his preconceptions and expectations? Do users feel threatened by the technology? Do they find it distracting? Does it have or lack the power to cognitively engage? These are important questions that need to be addressed and are considered to an extent in this study.

To summarize, A system of teaching that is unable to interact with users in a flexible and effective way will be of little value. Therefore, the purposes of the study revolve around examination of the effectiveness and use of auditory media in the context of multimedia computer-aided instruction. It was determined that an examination of learner behaviour and the moderating effects of individual differences was essential. To this end, a number of propositions were derived to assess the effectiveness of the technology, as

facilitative benefits.

³ For this study, receptive or passive learning refers to that which is characterised by the presentation of instructional material in a predetermined format. Discovery learning, on the other hand, has a more 'active'

well as how and why it was utilised.

The implications of this study are twofold: for the first time, a single study will examine the effects of narrated instructional material on performance in CAI, while simultaneously examining how users relate to these auditory conditions. As is the case with much investigative research, it is hoped the results of this study will provide practical suggestions for understanding and improving the effectiveness of instructional courseware by lessening the ambiguity surrounding the use and effectiveness of multimedia technology.

Chapter Two explicates the theoretical basis of the study. Chapter Three outlines the experimental methods used to gather the data and considers reliability and validity issues. In Chapter Four, the experimental data is analyzed. Chapter Five discusses the results of the analysis and offers suggestions for future research.

style that involves exploration and experimentation by learners.

Chapter Two

Rationale

The purpose of this chapter is to develop a theoretical framework for the current study. To accomplish this task, I begin with an overview of research on multimedia learning, focusing on theories and studies that examine how the technology of CAI is employed by the learner. This review forms the foundation for both the dependent and independent variables employed in the present study. Following the operationalization of these variables, the propositions employed in the present study are detailed.

Cognitive Principles of Multimedia Learning

The contiguity principle and the dual-coding theory of working memory are the primary theoretical and methodological models of multimedia research. The contiguity principle was first proposed by Mayer and Anderson (1992). This principle states that the effectiveness of multimedia instruction increases when verbal and visual material are presented contiguously in time. A temporal-contiguity effect refers to learning enhancement when visual and spoken materials are presented simultaneously as opposed to concurrently.

Subsequent studies have tended to concede the existence of a contiguity effect when studying bimodal presentations in multimedia learning (Mayer & Moreno, 1998), even though there is evidence to suggest it is more predominant in higher order learning, such as reading comprehension (Sweller & Chandler, 1994), than in lower order learning, such as vocabulary acquisition (Allport, 1993). Mayer (1997) conducted a meta-analysis of studies of the effectiveness of multimedia instruction and concluded there was suffi-

cient reliable evidence to validate the importance of the contiguity effect: students generated over 50% more creative solutions to transfer problems when verbal and visual explanations were integrated than when these explanations were separate.

Similar patterns are reported in other studies (Sweller & Chandler, 1994; Chandler, & Sweller, 1991; Mayer & Anderson, 1991). Mayer and Anderson (1992), for example, presented participants with learning material that included a narrative given before or during an animated sequence. Their results indicated the words-with-pictures group outperformed the words-before-pictures group on tests of problem solving transfer.

Mayer and Anderson (1992) also had participants study animation with concurrent narration, successive animation and narration, animation only, narration only or no instruction. The temporal-contiguity effect was evident and extended to new materials. These studies have been cited as evidence for a 'temporal example of split attention' (Mousavi, Low & Sweller, 1995).

Contiguity theory thus posits that bimodal presentation styles are conducive to learning in multimedia conditions. This notion, however, does not explain *why* this is the case. In order to further understanding of how the contiguous presentation of visual and verbal information facilitates the learning process, I turn to the second model forming the basis for multimedia research, the dual-coding theory of working memory.

The "Dual-coding Theory" (DCT) model of visual and auditory perception, developed by Pavio (1986), offers a tripartite process-account of how visually and verbally presented material is integrated in the learner's working memory during the learning phase. This model emphasizes how a learner builds mental connections between visual and verbal representations. Meaningful learning involves more than building either a ver-

bal or a visual retrieval cue to memory. Rather, it involves the additional step of building referential connections between the two kinds of mental representations, which arguably facilitate the learning process.

Figure 1 was adopted for current purposes from Paivo's (1986) model of dual-coding theory. It diagrammatically summarizes the DCT theory of multimedia learning (cf. Mayer & Moreno, 1998). On the top left portion of the figure, a verbal explanation, such as an oral narration, is presented to the learner. Within working memory, the learner constructs a mental representation of the system described in the verbal explanation and encodes this information into verbal memory as indicated by the first arrow.

Figure 1. A dual-coding model of multimedia learning. The number 1 refers to building verbal representational connections; 2 refers to building visual representational connections; 3 refers to building referential connections; 4 refers to retrieval from long-term memory.

On the bottom left portion of the figure, a visual explanation, such as words on a screen, is presented to the learner. Within working memory, the learner constructs a mental representation of the visually presented system, which is encoded into visual memory as is indicated by the second arrow.

The third arrow depicts the construction of referential connections between visual and verbal memory, which is made possible by the presentation of information in both visual and verbal forms. The DCT model is based on the notion that presenting information in only one mode (visual or verbal) obviously only allows for the construction of only one retrieval cue to working memory (visual or verbal). When information is presented in both visual and verbal forms, a third type of retrieval cue (the referential connection between visual and verbal memory) is formed allowing for better retention in working memory.

Numerous studies have tested and found support for the dual-coding theory of working memory. Penney (1989), for example, reviewed research where the presentation material was a mixture of the auditory and visual modalities, and suggested that the effective capacity of working memory can be increased by using both visual and auditory channels. The higher recall of lists of items when presented in visual and auditory modalities rather than just in one modality is one of the most cited examples of modality effects in the literature (Frick, 1984).

These findings are also evident in examinations of modality effects in higher order learning. Early research on the effects of split-attention effects in paper-and-pencil environments, found evidence supporting the modality effect in the context of higher order learning. Mousavi, Low & Sweller (1995), for example, reported that dual-

presentation modalities increased working memory resources by activating both auditory and visual working memory. Their study consisted of two separate studies and involved the presentation of worked-out geometry examples under three different conditions. They reported participants learned better when an auditory narration was presented simultaneously with corresponding diagrams (different modality presentations), than when printed text was presented simultaneously with corresponding diagrams (same-modality presentations).

Learning was comparatively enhanced by the auditory mode of presentation in both experiments. The visual and verbal presentations were made sequentially in two further experiments, and still the mixed modality was found to be superior, in line with the prediction of dual-coding theory. The results of this study suggest dual-presentation modalities may increase working memory resources by activating both auditory and visual working memory rather than just one (Mousavi, et al. 1995).

Perhaps the most thorough investigation of the effects of dual-coding theory within the context of a computer-based multimedia environment, was conducted by Mayer and Moreno (1998). Their study consisted of two related studies, in which participants were required to learn animated instructional material. One group of students was presented with concurrent descriptive narration, whereas a second group was presented with concurrent on-screen text, for each of the two experiments. Across both studies, the first group outperformed the second group in a retention test, a matching test, and a transfer test. Thus, the robustness of the effect was evident across the three different measures across two different studies.

These studies provide evidence supporting dual-coding theory. When learners can

concurrently hold words in auditory working memory and pictures in visual working memory, they are better able to devote attentional resources to building connections between them.

Dual-coding theory predicts visual and verbal material presented simultaneously will lead to better retention than when presented separately. Separate presentation of visual and verbal information encourages the development of links 1 and 2 in Figure 1, whereas simultaneous presentation encourages the development of all three kinds of links. Thus, in the case of dual presentation, higher retention is attributed to the greater number of retrieval cues in memory.

These studies indicate that concurrent presentation of visual and verbal information in multimedia software may have a facilitative effect on learning. From a methodological perspective however, the generality of these studies may be questionable. Specifically, the display of information through illustrations or animation may act as a potential confound by providing additional visual cues that may have a crucial role, yet hitherto unnoticed, in enhancing retention during learning.

Consider a lesson in which a static diagram of lightning in the sky is followed by voice narration describing the image. Two kinds of information are encoded and stored in long term memory: first, physical characteristics such as shape, size and colour from the image itself; second, the verbal description of the picture. Any improvement of memory retention then, may be a result of more retrieval cues to long term memory rather than showing evidence of two separate visual and auditory channels to memory.

Instead, the simultaneous presentation of *identical* information, in visual and aural modalities should be a more productive means of testing modality theory. Non-pictorial

visual information (such as text) better meets this criterion. In this way, text might be considered a purer visual source than images.⁴ For this reason, printed text (visual modality) was thus narrated through voice (aural modality) in this study. In order to determine if voice narration had a facilitative effect on learning, the learning outcomes of users in unimodal conditions (visual-only) and bimodal conditions (visual-auditory) were compared. Comprehension of the instructional material was assessed through tests of retention in a multiple-choice format.

Individual differences in the cognitive abilities of multimedia users may cause variation in attention to and processing of verbal versus visual information. Individuals with a lower ability to process visual-verbal information may not benefit as much from multimedia options as will individuals with a higher ability and, consequently, may be less motivated to use them (Mayer & Sims, 1994). The question, however, is which cognitive abilities are the most relevant to multimedia learning?

The Role of Individual Differences in Multimedia Learning

Recent studies suggest arousability to external cues (Perlin, 1998), perceptual styles (Plass, Chun, Mayer & Leutner, 1989) and visual-spatial ability (Mayer & Sims, 1994) may all play important roles in influencing the degree to which visual and auditory stimuli are attended by learners. Accordingly, individual differences most closely related to each of these three criteria: introversion-extroversion (arousability to external cues), perception style, and gender (visual-spatial ability) were a central part of this study.

The moderating effects of arousal on performance have long been extent in the

⁴ It is interesting to note that studies testing for modality effects in multimedia have focused on pictorial information, given that the bulk of CAI is of a textual nature. A possible reason for this oversight may be that earlier CAI consisted of lessons with only short passages of text per screen, while the current trend is

literature (cf. Perlin, 1998). Introverts and extroverts may be characterized by their reactions to stimulation and level of arousal. Specifically, studies suggest that when introverts and extroverts are exposed to equal amounts of stimulation, arousal increases more for introverts than for extroverts and this has been shown to affect learning performance (Schmeck & Lockhart, 1983; Riding & Wicks, 1978).

Schmeck et al. (1983) found, for example, that simple and undemanding tasks with low levels of arousal are associated with linear increases in performance for introverts, while the opposite holds true in more complex and difficult tasks for extroverts. Several studies have found the arousability inherent in testing conditions to have a moderating effect on performance differences between introverts and extroverts (Perlin, 1998; Grigoryan & Agababyan, 1997; Mayer & Gallini, 1990). Consequently, variations in the performance of introverts and extroverts may be expected in a learning environment which is polysensory in nature.

Furthermore, evidence also suggests introverts have been found to benefit more from receptive learning, whereas extroverts benefit more from discovery learning (Leith, 1973). Thus, in the context of the present study, the greater attraction for stimulating learning environments which characterizes extroverts, may enhance their motivation by auditory adjuncts. In this way, introverts and extroverts may differ in their choice, preference for and ability to learn from, bimodal multimedia conditions.

In addition to variations in arousability, recent studies also suggest that individuals may differ in how they attend to visual and verbal information (Mayer, 1997). Indeed, differences in the realm of visual and verbal perception styles have been found to be a

an increasingly dense textual base.

good predictor of various task performances in learning with media (Plass, Chun & Mayer, 1989). This should significantly affect how information is processed and retained in memory.

A small body of literature exists on the identification of students' learning styles or learning preferences and the effectiveness of multimodal materials (Mayer, 1997; Keefe, 1989; Corno & Snow, 1986). Indeed, findings suggest that learning styles are a good predictor of variations in task performances in learning with media (Leutner & Plass, 1998; Kirby, Moore & Schofield, 1988). These studies highlight the significance of individual differences in attending to visual and auditory stimuli.

A model and questionnaire proposed by Lafontaine (1986) are pertinent to the conceptualization of this study. The model posits that individuals possess a perception profile (visual or auditory), which is inherent at birth. This visual-auditory perception (VAP) model is derived from neuropsychological data, which has identified specific behavioural traits to be associated with each of the perception styles (Meunier-Tardiff, 1989). In particular, differences in ability to recall visual versus auditory imagery was believed to affect how well narrated material would be encoded and subsequently stored in long term memory. Preferences for learning through textual formats was also important in a study which compares learning and behavioural outcomes between text-only and text with narration formats.⁵

More specifically, it should be expected that individuals with a typical mode of perceiving aurally should benefit more from multimedia learning environments in which an auditory element is added to the standard visual on-screen material. Compared to vis-

ual perceivers, such individuals who habitually perceive aurally, should be expected to encode, store and retrieve narrated material that has an auditory element with less difficulty. Consequently, the potentially moderating effects of visual and auditory perceptual styles on the retention of learning material presented bimodally (in an audiovisual format) were investigated in the current study. With regard to this study, it is expected that individuals with auditory perceptual styles should benefit more from narrated learning material due to their higher ability to process aural information

One area closely related to visual and auditory perception is that of visual-spatial ability. According to research, visual-spatial ability is believed to facilitate the processing of both visual and auditory information (Fastenau, Conant & Lauer, 1998). Although the evidence suggests visual-spatial ability speeds the processing of verbal information by effecting the phonological encoding of verbal information (Fastenau et al. 1998), the role of visual-spatial ability in positively affecting the processing of visual information has been more widely documented in the literature (Carroll, 1993; Corno & Snow, 1986; Underwood, 1981). According to these studies, visual-spatial abilities may have a conducive role when learning in bimodal multimedia conditions.

Following the work of Corno and Snow (1986), among others, Mayer and Sims (1994) have proposed that individuals with high visual-spatial ability may be expected to learn better when both visual and verbal information are presented simultaneously. According to Mayer & Sims (1994), this is because a high-spatial ability learner may be able to keep a visual image active in working memory for longer time periods than low-spatial ability learners. It is these visual images in memory that are believed to contribute to the

⁵ A questionnaire developed from Lafontaine (1986) for the purposes of the current study will be discussed

formation of referential connections between the visual images and verbally based aural information. Clearly, such expectations have important implications for the present study as individuals with high visual-spatial abilities should be expected to benefit more from bimodal learning conditions than individuals with low visual-spatial abilities.

In light of these speculations, gender differences in multimedia learning were examined in the present study as gender differences in visual-spatial ability have long been evidenced in the cognitive literature (Mevarech, 1989; Rosenberg, 1986). Relating these differences to multimedia learning, where the user is exposed to both visual and auditory media, it follows that males and females should differ in their ability to process visual and auditory information. With regards to the present study, males should be expected to perform better than females in bimodal learning conditions, given their higher levels of visual-spatial ability.

The furthering of our understanding of why multimedia has often been underutilised by the learner, was guided by the following question: if technology is administered in the form of learner-controlled options, will it be employed to facilitate learning or ignored by users? In an attempt to address this question, users were observed in a *choice* condition in which participants were given the option to incorporate voice into their lessons as many times and for as long as they desired.

Duration and frequency of sound-use thus constitute the two behavioural assessments of auditory media employed in the present study, each assessment having been designed to provide unique information. It is clear, for example, that the decision to terminate the option to add narration after limited exposure to auditory conditions, is a differ-

ent circumstance from the decision to refrain from using the voice option after prolonged exposure to it on multiple occasions. In this way, assessing both duration and frequency contributes to a more thorough understanding of the learner's employment of multimedia tools.

In order to acquire a better understanding of the effectiveness of multimedia in CAI, it is important to assess why it might be employed by the learner. It may be that social or motivational differences, yet to be discovered, are strong influences on the employment of media by users. In the present study, two mechanisms were used to assess motivation to implement technology in courseware. The first mechanism involved asking participants how they expected to perform in the aural condition; the same question was asked before and after each test. The second mechanism involved an open-ended question which asked each participant if they 'liked' or 'disliked' the narration and why they did so.

The purpose of these assessments was to gain a more thorough appreciation of why participants chose to employ multimedia options, specifically to determine if they expect it to have a positive effect on their performance. From an educational standpoint, such assessments of the underlying motivations behind multimedia use is critical in enabling a better fit between technology and the user.

To summarize. The current study adds voice narration to on-screen textual instructions as a means of assessing the effect of the combined presentation of instructional material. In an attempt to bridge the gap between theory and technology, the assessment of narrated media entails an examination of how the individual learner relates to his or her technology. Consequently, in order to understand if narration works, it was necessary to

examine the use of this multimedia instrument from the learner's perspective. An examination of technology without consideration to the user is of little importance in the dynamic paradigm of multimedia learning environments.

Thus, the principal purposes of the study are twofold. First, to assess whether narrated presentation of instructional material enhances learning performance in CAI. Second, to examine whether narration is utilised, and if so, how and why this feature is employed by the end-user in the learning process. This entailed an exploration of the role of individual differences in effecting learning performance in, and preference for, the addition of voice narration.

The dependent variables in the study are quiz performance (assessing accuracy of retention of the learning material), pre-test and post-test estimates of anticipated performance (assessing expectations) and sound measures (assessing duration, frequency and preference for sound). As it was believed that personality, perceiver style, and gender might constitute potential sources of variation in task performance in aural conditions, these subject characteristics served as the independent variables of this study.

As the central purpose of this study was to assess whether the addition of narration effects performance, the major proposition of this study was formulated to test for these effects. An additional set of propositions were developed in order to further explore the effects of individual differences on the various sound measures examined in this study. Finally, as it was expected that participant behaviour (use of narration) would be directly effected by their attitudes about this auditory adjunct, predictions relating preference for narration with duration and frequency of its use were also incorporated in these propositions.

To restate, central to the current research is the dual-coding theory (DCT) of working memory. DCT postulates that bimodal presentation will have a greater effect on facilitating the learning process than unimodal presentation formats. According to DCT, the learner uses two distinct information-processing systems – one that represents information verbally and one that represents information visually. For meaningful learning to take place, the learner must build an internal verbal representation from the presented verbal information, an internal visual representation from the presented visual information, and referential connections between these verbal and visual representations. DCT predicts that individuals will be better able to build referential connections when verbal and visual materials are presented contiguously rather than when they are presented separately as separate presentation of visual and verbal information encourages a greater number of retrieval cues in long term memory (Pavio, 1986).

Given the recent evidence that supports dual-coding theory (Moreno & Mayer, 2000; Moreno & Mayer 1999; Plass, Chun & Mayer, 1989; Mayer & Sims, 1994), a positive main effect for performance is anticipated for dual presentation of the learning material. Thus,

P1: Performance will be higher in bimodal conditions (text and voice) compared to unimodal (text only) conditions.

With regard to the specific effects of individual differences as a source of variability on performance in bimodal conditions, three further propositions were formulated. These propositions were based on the idea that individual differences pertaining to preferred styles of learning would effect how information is subsequently encoded, stored and retrieved from memory. Propositions were thus derived for personality, perception style and gender, respectively.

As previously noted, due to their lower threshold for monotonous activity, extroverts are more influenced by objects and events in the external world than introverts. According to arousal theory, the extrovert's increased level of arousal resulting from the cognitive engagement engendered by the polysensory nature of multimedia should result in improved learning performance. It is expected then, that extroverts should benefit more from bimodal learning conditions than introverts. Thus,

P2: Extroverts will perform better and feel more confident in, bimodal conditions than introverts. They will also report stronger preference for it, and incorporate it more frequently and for longer durations than introverts when given the option to do so.

As it follows from visual-auditory perception theory that auditory perceivers are predisposed to learn aurally, it is expected that they should perform better in learning conditions where an aural element is added, compared to visual perceivers. It should be further expected that this polarity will be even more pronounced in the case of higher order learning such as that being assessed in the current study. Unlike vocabulary acquisition, which involves verbal learning on a very low level, reading comprehension requires verbal learning on a higher level, including understanding words in context and constructing meaning. The effect of learning from verbal and visual presentation modes (by organizing texts and images into coherent mental representations and integrating these representations with one another) should be moderated by individual differences in learning preferences. Specifically, the unavailability of the preferred mode of information should be expected to limit the understanding of learning material and subsequently hinder storage in memory altogether (Plass, Chun & Mayer, 1998).

Consequently, a proposition was formulated based on the notion that individuals tend to rely on retrieval routes corresponding to their preferred learning styles, such that audi-

tory perceivers are more likely to benefit from information that has an auditory element in addition to a visual one. Thus,

P3: Auditory perceivers will perform better and feel more confident in, bimodal conditions than visual perceivers. They will also report a stronger preference for it, and incorporate it more frequently and for longer durations than visual perceivers when given the option to do so.

Given males' higher visual-spatial ability, which results in their enhanced phonological perception, it is expected that males should perform better than females in multimedia conditions where the learning environment is construed of both visual and verbal information. Studies suggest that males are substantially more confident than females in multimedia conditions (Passig, 1999) and more likely to approach multimedia features in an exploratory, less inhibited manner than females (Chan-Lin, 1999; Passig, 1999; Underwood & Underwood, 1998; Abouserie, 1992).

In light of these findings, it is expected that males should be more likely to incorporate and benefit from auditory adjuncts than females when given control over its implementation. Thus,

P4: Males will perform better and feel more confident in, bimodal conditions than females. They will also report a stronger preference for it, and incorporate it more frequently and for longer durations than females when given the option to do so.

These propositions form the conceptual basis of the present study. A test of these propositions however, requires further specification and operationalization of both the independent and dependent variables of this study. These are the issues addressed in the following chapter.

Chapter Three

Method

This chapter overviews the methodology employed in the present study. This includes a delineation of the participants sampled, followed by detailed descriptions of the materials and analytical procedure employed in this study. The chapter concludes with a consideration of various safeguards that were taken to ensure the validity and reliability of the data.

Participants. Forty-eight first-year psychology students consisting of eighteen males and thirty females participated in the experiment. All participants read and sign an informed consent form prior to their participation in the study (see Appendix A) and were treated in accordance with the "Ethical principles of Psychologists" (American Psychological Association, 1991). All participants reported having taken other tests in the past five years.

Materials and Apparatus. The paper-and-pencil materials consisted of a background questionnaire and three multiple-choice format tests of retention. The background questionnaire solicited information concerning participants' preferred perception style and predisposition towards introversion-extroversion.

Background questionnaire. Lafontaine (1986) developed a questionnaire that allows development of a visual and auditory perception index. Two items from the Lafontaine Index questionnaire were judged to have the highest face validity and thus eligible for use in this study. The retained items assess visual and aural memory for text and images and it is assumed these cognitive abilities effect retention of visual and aural information differently. Table 1 displays a condensed list of the retained and deleted items from the

original Lafontaine Index.

Table 1

List of Selected and Deleted Index Items from the VAP Principle

<u>Characteristics of Visual Perceivers</u>	<u>Characteristics of Auditory Perceivers</u>
<u>Deleted Personality Items</u>	
Pay attention to details	See the overall picture
Consider appearances important	Consider appearances unimportant
<u>Deleted Social Items</u>	
Like to be with other people	Enjoy own company
Use objects to communicate	Use logic to communicate
<u>Deleted Developmental Items</u>	
Problems in school appear at elementary level	Problems at school appear at secondary level
Prefer structured routine	Prefer unstructured routine
Need to see mother constantly	Satisfied to hear mother's voice
<u>Retained Cognitive Items</u>	
Remember visual images clearly	Remember auditory experiences clearly
Prefer to follow a drawing or diagram	Prefer to follow a technical form

As this study is the first locatable application of the Lafontaine Index questionnaire in the context of multimedia learning, four self report questions were appended to the questionnaire. This was done to solicit additional background characteristics believed relevant in an assessment of visual and aural perception styles (see items one to three and item five, Appendix B). First, as it was believed that exposure to aural environments (both childhood and current) might influence aural learning abilities, questions pertaining to these issues were included in the questionnaire. Hence, participant exposure to auditory material including books on cassettes, musical cassettes and CDs within the past year was calculated from their answers to questions one to three, which asked participants to provide a numerical estimate of their exposure to these materials. Childhood exposure to aural learning was assessed through a Likert item, which asked participants to rate how often they had been read to as children.

Second, in order to ensure convergent validity with the Lafontaine Index, two additional Likert items asked participants to provide self-reports of favoured perception style as well as artistic and musical abilities (see items four and seven, Appendix B). Finally, as mentioned, the remaining two questions, adapted from the original Lafontaine Index, (see item six, (i) (ii) and (iii), Appendix B) were designed to measure if participants were predisposed to a visual or auditory frame of reference when learning new material. The last item on the background questionnaire (see item eight, Appendix B) asked participants to rate their predispositions towards introversion-extroversion.

Retention tests. Three tests of retention were employed, each of which consisted of ten multiple-choice questions assessing the learning material in each of the three lessons. All quizzes were taken from the same textbook as the lessons (see Appendix C).

Two sets of questions were appended both prior to and at the end of each of the three retention tests. The first set of questions asked participants to estimate their anticipated performance prior to learning the material. The second set of questions asked participants to estimate how they believed they did upon completion of the test (see first and last questions on all topics in Appendix C). These questions required participants to provide numerical estimates of how they expected to perform on tests assessing the retention of the material to which they had just been exposed.

In this way, performance estimates in the unimodal condition (text-only) could be compared with performance estimates in the bimodal condition (text-voice) enabling speculations to be made about users' motivations for employing multimedia. If, for example, the anticipated performance estimates are significantly higher in the bimodal conditions, it may be expected that employment of multimedia features was motivated by the belief that it would facilitate subsequent performance.

Conversely, little difference between uni- and bimodal conditions may be indicative of less utilitarian and more exploratory (playful) reasons for employing one medium over another. In this situation, a lack of differences might suggest that participants did not expect the medium to be having any effect on their performance. Consequently their decision to employ it may be less utilitarian.

Learning Material. The computerized materials consisted of nine demonstration programs which were developed by the researcher using Toolbook software. These demonstrations consisted of three lessons on the topic of game theory, three lessons on Social Psychology and the Law, and three lessons on the topic of self-monitoring, taken from *Social Psychology* (Baron & Byrne, 1997) (see Appendix B) a standard undergraduate level so-

cial psychology text. Each of these lessons were presented in a text only, as well as a text with voice format, in addition to a choice condition where participants were given the choice of which format they wished the material to be presented. The lessons were implemented on an IBM PC computer. Information was presented in segments of approximately 150 words per screen. A multiple-choice quiz was employed at the end of all conditions to test participants' knowledge of the courseware material.

Experimental Conditions. In this study, a mixed factorial design was employed, with 4 participants per cell. Participants viewed three lessons in each of the three conditions: text only (T), text-voice (T-V) and choice (C).

Text condition. In this condition participants studied their material in plain text format; there was no voice. Participants had no control over presentation of the learning material except to turn to the next page. Participants were not able to click back once a page was turned.

Text-Voice condition. In this condition, the text was shown on the screen exactly as it was in the text-only condition, and it was also read by a human voice. The text format was again predetermined by the researcher (identical to the format of the text only condition) and the participant had no choice except to face the words displayed on the screen and listen to the material being presented. A built-in timer automatically flipped to the next page of material once each page was read by the voice.

Choice condition. Choice was defined as (1) allowing participants to have the option to choose which medium s/he wished to have the material to be presented in (e.g. text only, sound only, or both) and (2) having control over altering mode of presentation while the lessons were being studied. In this condition participants were given the option to turn the

sound on or off or turn the text on or off anytime they desired during the lesson. Those who chose either the text-only or text with voice condition were also allowed to change to a different presentation format at any point during the lesson.

In this choice condition, the computer was programmed by the researcher to record how many times users flipped across sound and no sound conditions. If users employed narration, the computer also recorded the length of time in minutes that the user spent with narration.

Procedure. Upon completion of the background questionnaire, each participant was randomly assigned to each of 3 conditions: text-only, text and sound, and the last condition in which the user had the option to view text, sound or both. Gender was recorded by the researcher as each participant arrived to begin the experiment. Each participant studied one of three different topics, in each condition (text, text-voice and choice) and was tested on their retention of the topic material with a multiple-choice quiz as soon as they completed studying each. There was no time limit for writing the quizzes.

Upon completing the study, each participant was asked how the auditory element influenced them when they were learning the lessons. The purpose of this question was to acquire more information about underlying cognitive processes influencing users' preference for auditory technology. The exploratory style of this question was designed to gather qualitative information about how narration focused, sustained, or distracted users' attention on information to be learned. By extending previous findings that multimedia technology is often 'misunderstood' by the user, this qualitative data was believed to shed valuable insight regarding the underlying motivations for the under-utilisation of multimedia features that has been found in previous research.

The study took approximately 45-60 minutes to complete for each participant. At the end of the experiment, participants were further informed about the purpose of the study, debriefed, and thanked for his or her participation, (see Appendix E).

Analysis. Scores for both perceiver style and personality were calculated from questionnaire data. A description of these calculations are detailed in the next two sections.

Perceiver Style. Answers to questions one through seven of the background questionnaire (see Appendix B) were used to calculate an overall perceiver style score for each participant. A summary of the means and standard deviations for each of these questions are presented in Table 2.

Table 2

Summary of Item Responses Designed to Assess Perceiver Style

Question	Mean	SD
Please estimate . . .		
(1) How many books did you read for pleasure last year?	6.52	9.59
(2) How many music cassettes or CDs did you buy last year?	11.38	24.51
(3) How many audio books/books on cassette did you listen to last year?	2.75	14.44
Please rate . . .		
(4) Are you a visual or auditory perceiver?	3.35	1.56
(5) Please rate approximately how often you were read to as a youngster.	4.58	2.05
(6) Please rate yourself on the following statements:		
(i) When learning something new, I prefer to follow a drawing or text.	5.15	1.37
(ii) I remember visual images very clearly.	4.77	1.17
(iii) I remember auditory images very clearly.	3.83	1.43
(7) Are you more artistic or musical?	4.35	1.71

In order for meaningful comparisons to be made among responses, scores for each question were transformed into z-scores. As the first set of questions were conceptually different from the second set (questions one to three asked for estimates of exposure to certain items, thus assuming accessibility to these items while questions four to seven asked for self-ratings on learning style) it was determined that one of three options could be employed when calculating an overall perceiver style score. These options included using (1) only questions one to three, (2) only questions four to seven, or (3) all questions (one through seven) could be used. Upon reflection it was decided that all questions would be employed to calculate an overall perceiver style score. This was decided for two reasons. Firstly, questions four through seven were employed since they were based largely on current theory concerning basic differences between auditory and visual perceivers (Lafontaine, 1986). Second, questions one to three, which assessed recent exposure to auditory stimuli were considered relevant, since recent history to sound media could act as a potential confound in predisposing participants to be more comfortable with or have a stronger preference for a voice element in CAI. Thus, the z-scores for all questions were added together for each participant to arrive at an overall perceiver score.

For the purposes of classifying each participant as either an auditory or a visual perceiver, a median split was performed on the overall perceiver score (Median = 42.13). Thus participants who responded below 42.13 were categorized as visual perceivers ($n = 24$), while participants who responded above 42.13 were categorized as auditory perceivers ($n = 24$).

Personality. Scores on introversion or extroversion were calculated from participants' answers to question 8 of the background questionnaire (see Appendix B). Responses for this

question were first converted into z-scores ($\underline{M} = 4.21$, $\underline{SD} = 1.86$). In order to categorize each participant as either an introvert or an extrovert, a median split was performed on the z-scores (Median = 3.72), so participants who responded below 3.72 were categorized as introverts, ($n = 24$), whereas participants who responded above 3.72 were categorized as extroverts ($n = 24$).

Intra-Sample Biases, Reliability and Validity. In order to control for extraneous variables, the reliability and validity of the current study was considered in detail. As a result, numerous corrective measures were employed to safeguard against possible confounds.

First, there was some concern about intra-sample biases regarding learning ability, that could create individual differences in performance on the tests of learning retention. As individual variation in age and recent exposure to taking tests were believed to constitute biases in learning ability, two items assessing these variables were appended to the background questionnaire (see items one and two, Appendix B). Responses revealed little intra-sample variation on these attributes: ninety-five percent (95%) of participants were between 18-29 years of age, the remaining five percent (5%) fell in the 30-39 year age category; all participants reported having taken a test within the past five years.

Reliability and validity were also considered for the background questionnaire, learning material and quizzes used in this study.

First, consideration was given to the reliability of the Lafontaine Index. Reliability refers to the consistency of a measure. If a study makes several attempts to measure the same thing and yields the same results, the study is said to be reliable. It may be argued then, that the widespread use of the Lafontaine principle is in itself, to some extent, indicative of its inherent reliability. Since its conception in 1978, based on twenty years

of longitudinal research, the theory of dual-cognitive perception has been used in business, education and in the workplace; its principles have been implemented in universities, hospitals and management fields (Meunier-Tardiff, 1989). Furthermore, the Lafontaine principle has inspired two books, one by a Paris schoolteacher, another by Lafontaine's former colleague. Both of these individuals extended the theory based on their own research and experiences (Meunier-Tardiff, 1989).

In contrast to reliability, which refers to internal consistency, validity refers to the degree a measuring instrument assesses what it intends to measure. An ideal test of the validity of the Lafontaine Index would be an inverse or an absence of a correlation between the sum of the visual perceiver and the auditory perceiver items. Unfortunately, such a correlation could not be determined, as the original data for the Lafontaine studies could not be obtained.

As the current study is the first known study to employ the Lafontaine Index, the attainment of validity checks was not of primary concern. Rather, the current study itself, was designed to serve as a measure of the validity of this index. Thus, a validity check was performed on the data. As only two questions could clearly be dichotomized as assessing visual or auditory perception styles (see items six (ii) and (iii) Appendix B) a Pearson Product Momentum Correlation Coefficient was calculated for the sum of the two items. A nonsignificant correlation between the sums of the two indices ($r = 0.06$, $p > 0.05$) suggests that the indices have reasonable internal validity.

Care was also taken in the selection of the learning material employed in the present study. In order to maximize external validity, and ensure an adequate assessment was made of higher-order learning, the lessons were directly taken from a standard un-

dergraduate text in social psychology. In addition, three different lessons were employed to ensure that the topic of the learning material did not confound potential significant effects on tests of learning performance.

A pilot study was conducted to calibrate the three quizzes used in the study. Fifteen participants were asked to take the tests without studying any material on the topic. A third of the participants were given the social psychology test on self-monitoring, a third were given the test on attitude change, and the remaining participants were given the test on impression formation. The mean marks for these tests were 25.9%, 33.1% and 21.9% respectively, suggesting that the tests were not overly easy and should not produce a ceiling effect.

Finally, due to the within-subjects nature of the study, controlling for potential order effects were also of particular concern. As each participant received three different lessons, which were presented in each of three different conditions (text-only, text-voice and choice) order effects for both topic and modality had to be carefully considered.

In order to safeguard against these confounds, participants were randomly assigned to each condition using counterbalancing techniques. Half the participants received the text-only condition first, while the remaining half received the text-voice condition first⁶. Within each of the two orders, complete counterbalancing was employed to balance the order of lessons across treatments (see Tables 3 and 4 below).

⁶ The user-choice condition was not counterbalanced, but was administered last for each participant. This was necessary as presenting the choice condition prior to the text and text-voice conditions would be rendered meaningless as participants would not fully understand what the choice option entailed without prior exposure to both unimodal and bimodal presentation formats.

Table 3

Order One: Presentation Mode x Topic

A = lesson on game theory

B = lesson on social psychology of the law

C = lesson on self-monitoring

Text-Only	Text-Voice	Choice
A	B	C
A	C	B
B	A	C
B	C	A
C	A	B
C	B	A

Table 4
Order Two: Presentation Mode x Topic

A = lesson on game theory

B = lesson on social psychology of the law

C = lesson on self-monitoring

Text-Voice	Text-Only	Choice
A	B	C
A	C	B
B	A	C
B	C	A
C	A	B
C	B	A

Chapter Four

Results

The results of this study are divided into two major sections: descriptive summary statistics and inferential statistics. The purpose of the first section is to provide a broad descriptive overview of the data. The purpose of the second section is to test the propositions of this study.

The following section delineates the descriptive statistics of this study. Considering the explorative nature of this work, detailed presentation of summary statistics was deemed relevant for purposes of identifying existing trends in the data. In the following sections, the data is described through two measures of central tendency,⁷ (mean ($\bar{X}$), median ($\underline{M}$)) and one measure of dispersion (standard deviation ($\underline{SD}$)). Dependent variables (performance, performance estimates, duration and frequency of sound use) are presented first, followed by consideration of the independent variables (gender, perception style and personality).

The first of the dependent variables to be considered is performance, which was assessed by means of scores on multiple-choice tests of retention, administered at the end of each lesson. Two within-subject conditions were employed: text with and without narration (text-only, text-voice). Contrary to expectations, mean subject responses were higher for the text-only condition ($\bar{X} = 58.75$, $\underline{M} = 60.00$, $\underline{SD} = 15.52$) than for the text-voice condition ($\bar{X} = 55.63$, $\underline{M} = 55.00$, $\underline{SD} = 13.98$) (see Table 5).

⁷ The exception is data relating to attitudes about sound. Since data for this measure were categorical in nature, statistics of central tendency would be meaningless. Thus, this data is dichotomized as 'liked', and 'disliked', and subsequently described through percentages.

Table 5

Mean, Median and Standard Deviation (S.D.), for Performance in Text and Text-Voice
Conditions.

	<u>Condition</u>	
	Text	Text-Voice
Mean	58.75	55.63
Median	60.00	55.00
S.D.	15.52	13.98

In order to investigate if participants believed the addition of narration would have a positive effect on their performance, both pre-test and post-test estimates of performance were collected for the text-only and text-voice conditions. Participants were requested to provide numerical estimates of anticipated test performance both prior to and after, viewing material in each condition.

Some differences between unimodal and bimodal conditions were apparent in pre-test estimates. Specifically, mean pre-test estimates were only slightly higher for the text-voice condition ($\bar{X} = 63.54$, $\underline{M} = 70$, $\underline{SD} = 15.50$) than for the text-only condition ($\bar{X} = 62.50$, $\underline{M} = 60$, $\underline{SD} = 15.09$) (see Table 6). This is not in line with expectations, which anticipated voice narration would make participants feel more confident toward subsequent test performance. A related finding is that performance estimates were highest in anticipation of the text-voice condition ($\bar{X} = 63.54$, $\underline{M} = 70$, $\underline{SD} = 15.50$) and lowest immediately following exposure to this condition ($\bar{X} = 58.96$, $\underline{M} = 60.00$, $\underline{SD} = 16.14$).

Table 6

Mean, Median and Standard Deviation (S.D.), for Expected Performance in Text and Text-Voice Conditions.

	<u>Condition</u>			
	Text (exp.)	Text (aft.)	T.V.(exp.)	T.V.(aft.)
Mean	62.50	60.21	63.54	58.96
Median	60.00	60.00	70.00	60.00
S.D.	15.09	16.04	15.50	16.14

Note: Text (exp.) = expected performance estimate prior to text only condition
 Text (aft.) = performance estimate after taking test in text only condition
 T.V. (exp.) = expected performance estimate prior to text-voice condition
 T.V. (aft.) = performance estimate after taking test in text-voice condition

After assessing participants' attitudes about aural media, the manner in which it was incorporated into the lessons was examined in detail. Two assessments of sound use were employed. The first, duration in sound, was operationalized as the total time in minutes sound was used. The second assessment employed was frequency of sound use, which was operationalized as the number of times participants selected voice within each lesson.

Only fifty-four percent (54%) of participants added narration to their lesson when given the option to do so. Of these participants, 56% used this feature only once, 19% used it partly, and 14% used it throughout their lessons. Contrary to expectations, participants spent little more than half the time in text with narration ($\bar{X} = 4.38$, $\underline{M} = 4.00$, $\underline{SD} = 4.45$) than they did in text-only ($\bar{X} = 7.04$, $\underline{M} = 7.5$, $\underline{SD} = 3.96$) (see Table 7). Participants also employed the text-voice format almost half as frequently ($\bar{X} = 2.85$, $\underline{M} = 2.00$, $\underline{SD} = 2.98$) as the text-only format ($\bar{X} = 5.15$, $\underline{M} = 6.00$, $\underline{SD} = 2.98$) (see Table 8). These findings indicate that the auditory component was not selected for as long or as frequently by participants as was originally expected.

Table 7

Mean, Median and Standard Deviation (S.D.), for Duration of Time Spent in Text and
Text-Voice Conditions.

	<u>Condition</u>	
	Text	Text-Voice
Mean	7.04	4.38
Median	7.50	4.00
S.D.	3.96	4.45

Table 8

Mean, Median and Standard Deviation (S.D.), for Frequency of Time Spent in Text and Text-Voice Conditions.

	<u>Condition</u>	
	Text	Text-Voice
Mean	5.15	2.85
Median	6.00	2.00
S.D.	2.98	2.98

On collecting performance measures in auditory conditions, it was of interest to examine participants' attitudes about the aural media to which they had been exposed. Fifty-six percent (56%) of participants reported that they "liked" the voice element in their lesson, compared with 44% who did not. Many participants who favoured the voice reported that they found it motivated them to learn the material by making the lessons more interesting. Among participants who disliked the voice element, most complained that they found the voice to be distracting, making it more difficult to concentrate. Participants' comments on voice-narration are presented in Table 9.

Table 9

Dichotomization of Participant Feedback on Voice Narration

Positive Comments	Negative Comments
"having the text and voice was good, sometimes I'd remember hearing something, I'd seen when taking you're the quiz" (9)	"the voice was very distracting, I would finish reading the text and would have to wait for the voice to finish before going on" (11)
"it made the lessons more clear, it helped to use it for difficult concepts (5)	"the voice was too fast, I couldn't keep up with it" to (8)
"the voice made the material more interesting (4)	"I had trouble concentrating with human voice, during pauses, I kept wondering what the speaker looked like" (2)
"it seemed 'friendlier' to have a voice" (4)	
"I went back later and added it to the difficult parts, I closed my eyes and just concentrated on the voice" (3)	
"it made the lessons more structured by giving it a pace" (2)	

Overall, these data are consistent with certain expectations of this study, but inconsistent with others. The major finding to this point is that the auditory component did not have as significant effect on performance as was originally anticipated. Notwithstanding, pre-test performance estimates in the bimodal condition suggest that although participants did not necessarily *perform better* with narration, they *expected to perform better* when voice was present. These expectations did not motivate more participants to chose narration when given the freedom to do so; only half of participants utilised the option to add the voice element. Moreover, when selected, narration was employed much less frequently and for shorter durations than was expected.

It was also of interest to investigate the potentially moderating effects of individual differences on auditory learning. Summary statistics suggest the existence of such differences (albeit in different areas, and magnitudes) between each of the groups examined in the present study.

Personality, perception style, and gender were all identified as potential sources of variability in learning with auditory media. Individual differences in personality were found for each of the dependent variables considered in this study. In line with previous research, mean performance⁸ was higher for extroverts in the text-voice condition ($\bar{X} = 57.92$, $\underline{SD} = 15.03$) than introverts ($\bar{X} = 53.33$, $\underline{SD} = 12.74$) (see Table 10). Consistent with expectations, extroverts did report higher estimates of performance in bimodal conditions ($\bar{X} = 65.41$, $\underline{SD} = 15.03$) than introverts ($\bar{X} = 61.67$, $\underline{SD} = 16.06$) (see Table 11).

Also consistent with predictions, extroverts chose to spend more time in bimodal conditions ($\bar{X} = 5.75$, $\underline{SD} = 4.78$) than introverts ($\bar{X} = 3.00$, $\underline{SD} = 3.68$) and employed the auditory mode more frequently ($\bar{X} = 3.58$, $\underline{SD} = 2.92$) than introverts ($\bar{X} = 2.13$, $\underline{SD} = 2.91$) (see Tables 12 and 13 respectively).

⁸ Although three measures of central tendency (mean, median and standard deviation) were given for the previous section, the present section reports only two measures (mean and standard deviation) which are the two traditional measures of central tendency reported when data is analysed through inferential statistics as is the case in this section.

Table 10

Means and Standard Deviations for Personality Across Performance in Text and Text-Voice Conditions.

	<u>Personality Style</u>	
	Extroverts	Introverts
<u>Performance In Text-Only</u>		
Mean	55.00	62.5
S.D.	16.82	13.59
<u>Performance In Text-Voice</u>		
Mean	57.92	53.33
S.D.	15.03	12.74

Table 11

Means and Standard Deviations for Personality Across Expected Performance in Text
and Text-Voice Conditions.

	<u>Personality Style</u>	
	Extroverts	Introverts
<hr/>		
Exp. Perf. In Text-Only		
Mean	59.58	58.33
S.D.	17.06	15.51
<hr/>		
Exp. Perf. In Text-Voice		
Mean	65.41	61.67
S.D.	15.03	16.06

Note: Exp. Perf. In Text = Expected performance estimates in text only conditions, Exp. Perf. In Text-Voice = Expected performance estimates in text-voice conditions.

Table 12

Means and Standard Deviations for Personality Across Duration of Time Spent in Text
and Text-Voice Conditions.

	<u>Personality Style</u>	
	Extroverts	Introverts
<hr/>		
Text-Only		
Mean	6.42	7.67
S.D.	3.96	3.94
<hr/>		
Text-Voice		
Mean	5.75	3.00
S.D.	4.78	3.68
<hr/>		

Table 13

Means and Standard Deviations for Personality Across Frequency of Time Spent in Text
and Text-Voice Conditions.

	<u>Personality Style</u>	
	Extroverts	Introverts
<hr/>		
Text-Only		
Mean	4.42	5.88
S.D.	2.92	2.91
<hr/>		
Text-Voice		
Mean	3.58	2.92
S.D.	2.13	2.91
<hr/>		

Some individual differences were also found between auditory and visual perceivers. Mean performance in the text-voice condition did not differ for auditory perceivers ($\bar{X} = 55.83$, $SD = 13.16$) and visual perceivers ($\bar{X} = 55.42$, $SD = 15.03$) (see Table 14) which was contrary to expectations. Auditory perceivers, however, were more confident about their performance in bimodal conditions ($\bar{X} = 66.25$, $SD = 12.79$) than visual perceivers ($\bar{X} = 60.83$, $SD = 17.67$) (see Table 15). Furthermore, auditory perceivers did not spend more time with narration ($\bar{X} = 3.87$, $SD = 4.03$) than visual perceivers ($\bar{X} = 4.87$, $SD = 4.89$), or employ narration more frequently ($\bar{X} = 2.92$, $SD = 3.13$) than visual perceivers ($\bar{X} = 2.79$, $SD = 2.87$) (see Tables 16 and 17 respectively). Again, with the exception of the confidence differences, and frequency of time in sound, these findings are inconsistent with the expectations of the present study.

Table 14

Means and Standard Deviations for Perception Style Across Performance in Text and Text-Voice Conditions.

	<u>Perception Style</u>	
	Visual	Auditory
<hr/>		
Text-Only		
Mean	57.50	60.00
S.D.	16.75	14.45
<hr/>		
Text-Voice		
Mean	55.42	55.83
S.D.	15.03	13.16
<hr/>		

Table 15

Means and Standard Deviations for Perception Style Across Expected Performance in
Text and Text-Voice Conditions.

	<u>Perception Style</u>	
	Visual	Auditory
<hr/>		
Exp. Perf. In Text-Only		
Mean	54.58	63.33
S.D.	16.93	14.35
<hr/>		
Exp. Perf. In Text-Voice		
Mean	60.83	66.25
S.D.	17.67	12.79
<hr/>		

Note: Exp. Perf. In Text = Expected performance estimates in text only conditions, Exp. Perf. In Text-Voice = Expected performance estimates in text-voice conditions.

Table 16

Means and Standard Deviations for Perception Style Across Duration of Time Spent in
Text and Text-Voice Conditions.

	<u>Perception Style</u>	
	Visual	Auditory
<hr/>		
Text-Only		
Mean	6.96	7.13
S.D.	3.76	4.23
<hr/>		
Text-Voice		
Mean	4.87	3.87
S.D.	4.89	4.03
<hr/>		

Table 17

Means and Standard Deviations for Perception Style Across Frequency of Time Spent in
Text and Text-Voice Conditions.

	<u>Perception Style</u>	
	Visual	Auditory
<hr/>		
Text-Only		
Mean	5.21	5.08
S.D.	2.88	3.13
<hr/>		
Text-Voice		
Mean	2.79	2.92
S.D.	2.87	3.13
<hr/>		

Finally, descriptive data for gender is as follows. The sample was comprised of 63% females and 37% males. Mean performance for text-only was higher for males ($\bar{X} = 61.67$, $\underline{SD} = 16.18$) than females ($\bar{X} = 57.00$, $\underline{SD} = 15.12$), although the opposite was true for the text-voice condition, in which females performed better ($\bar{X} = 57.00$, $\underline{SD} = 14.42$) than males ($\bar{X} = 53.33$, $\underline{SD} = 13.28$) (see Table 18). Overall performance estimates suggest that males were considerably more confident ($\bar{X} = 68.89$, $\underline{SD} = 10.23$) than females ($\bar{X} = 60.33$, $\underline{SD} = 17.32$) in bimodal conditions (see Table 19). Females also used it for longer periods ($\bar{X} = 5.20$, $\underline{SD} = 4.78$) than males ($\bar{X} = 3.00$, $\underline{SD} = 3.49$) and employed narration more frequently ($\bar{X} = 3.37$, $\underline{SD} = 3.08$) than males ($\bar{X} = 2.00$, $\underline{SD} = 2.66$), (see Tables 20 and 21, respectively).

Table 18

Means and Standard Deviations for Gender Across Performance in Text and Text-Voice
Conditions.

	<u>Gender</u>	
	Males	Females
<hr/>		
Text-Only		
Mean	61.67	57.00
S.D.	16.18	15.12
<hr/>		
Text-Voice		
Mean	53.33	57.00
S.D.	13.28	14.41
<hr/>		

Table 19

Means and Standard Deviations for Gender Across Expected Performance in Text and
Text-Voice Conditions.

	<u>Gender</u>	
	Males	Females
<hr/>		
Exp. Perf. In Text-Only		
Mean	65.00	55.33
S.D.	12.95	16.97
<hr/>		
Exp. Perf. In Text-Voice		
Mean	68.89	60.33
S.D.	10.23	17.32

Note: Exp. Perf. In Text = Expected performance estimates in text only conditions, Exp. Perf. In Text-Voice = Expected performance estimates in text-voice conditions.

Table 20

Means and Standard Deviations for Gender Across Duration of Time Spent in Text and
Text-Voice Conditions.

	<u>Gender</u>	
	Males	Females
<hr/>		
Text-Only		
Mean	8.22	6.33
S.D.	3.95	3.85
<hr/>		
Text-Voice		
Mean	3.00	5.20
S.D.	3.49	4.78
<hr/>		

Table 21

Means and Standard Deviations for Gender Across Frequency of Time Spent in Text and
Text-Voice Conditions.

	<u>Gender</u>	
	Males	Females
<hr/>		
Text-Only		
Mean	6.00	4.63
S.D.	2.66	3.08
<hr/>		
Text-Voice		
Mean	2.00	3.37
S.D.	2.66	3.08
<hr/>		

As previously noted, the purpose of the descriptive overview was to provide a thorough, solid foundation upon which to examine the propositions explored in the current study. As minimal differences were found between unimodal and bimodal presentation styles in proposition one for example, this proposition was dropped from subsequent analyses. As some noticeable group differences were found for all remaining propositions, however, these were further explored through bivariate analyses.

Four mixed 2 x 2 analyses of variance (ANOVA) and one chi-square goodness of fit tests were conducted to test each proposition. Specifically, two ANOVAs were performed for each of the performance measures (actual and expected performance) and two for each of the behavioural measures (time and frequency in sound). Data relating to attitudes about narration were analysed by means of chi-square analyses. Alpha was set at 0.05 throughout. The Mauchly Sphericity test was used throughout to ensure that the circularity assumption was satisfied. In cases where the assumption was violated, the Greenhouse-Geisser epsilon adjusted degrees of freedom were selected as an appropriate corrective measure. To ensure clarity, these analyses are detailed in the following section.

The first set of ANOVAs tested for a relationship between performance and the independent variable for each proposition. The dependent variable for each of these analyses was percentage of correct answers on the quizzes. Only quiz scores in text-only and text-voice conditions were compared. Quiz scores in the choice condition were not included in these analyses, as the value to the study of doing so was not altogether clear.

The second set of ANOVAs tested for a relationship between anticipated performance and the independent variable for each proposition. The dependent variable for

each of these analyses was estimated percentage of correct answers on the quizzes. Although data were gathered for both anticipated quiz performance and post hoc performance estimates, only the former were analysed, as descriptive statistics did not suggest sufficient evidence to warrant further investigation of the latter. Again, only quiz scores in text-only and text-voice conditions were compared in these analyses.

The next set of ANOVAs analyzed behaviour in bimodal conditions when participants were given choice over its implementation.

The third set of ANOVAs tested for a relationship between time spent with narration and the independent variable for each proposition. Time spent in sound was dichotomized as time in minutes spent in text-only and time spent in text-voice within the choice condition.⁹

The fourth set of ANOVAs tested for a relationship between frequency of sound use and the independent variable for each proposition. For this variable, frequency was treated as a continuous rather than a categorical variable, as this was believed to provide a more powerful analysis. Thus, frequency of participants' use of sound in these analyses was operationalized as the number of times it was selected within each lesson.¹⁰

Finally, qualitative data for preferences for bimodal learning conditions were ana-

⁹ As it was of interest to identify any variables that could be used to predict time in sound when users were given the choice to use it, correlations were calculated to answer the question: What factors can be used to predict how much time users would spend in sound when given the choice? Following from the expectation that both anticipated and actual performance in a given medium would be positively correlated to the amount of time users would spend in that medium, performance scores in text-voice (actual and anticipated) were regressed on percentage of time in text-voice. No significant correlations were obtained ($r = 0.08$ to 0.24), suggesting that how well users performed in or were confident in a particular medium had little relation to how long they chose to stay in that medium when given the option to do so.

¹⁰ Regression analyses were conducted to test for a possible relation between anticipated and actual performance in aural conditions with how frequently participants chose to employ these auditory conditions. Thus, the correlation analyses performed for length of time spent in sound, were replicated for frequency of sound use. Contrary to expectations, no significant differences were found (r ranged from 0.06 to 0.15).

lyzed through chi-square analyses. The purpose of these tests was to test for the existence of a relationship between preference for the sound medium and each of the independent variables explored in the propositions of this study. In these analyses responses to the question: 'How did you like the voice?' was classified as either: 'liked the voice' or 'didn't like the voice'.

Analyses of Propositions. As previously noted in the beginning of this section, the analysis of propositions commences with the second proposition as proposition one was dropped from bivariate analyses because minimal differences were found between unimodal and bimodal presentation styles in the univariate analyses.

Proposition two predicted that extroverts would perform better in, feel more confident in and report a stronger preference for bimodal conditions, incorporating it more frequently and for longer durations than introverts when given the option to do so. Support for this proposition was found in actual performance, as well as time spent in aural conditions.

In order to test for the existence of personality differences on performance, a mixed 2 x 2 ANOVA was computed on percentage of correct answers on the quizzes. This test, which consisted of one within subjects variable, quiz performance with two levels (in text and text-voice conditions), and personality (introversion, extroversion) as the between groups variable was significant ($F(1,46) = 4.79, p = 0.03$). As predicted, extroverts were found to perform significantly better in bimodal conditions ($\bar{X} = 62.50$) than introverts ($\bar{X} = 55.00$).

A second ANOVA was conducted to examine the effects of personality on expected performance with performance estimates as the within-subjects factor, and per-

sonality as the between subjects factor. Non-significant findings ($F(1,46) = 0.29$, $p = 0.60$) suggested that introverts and extroverts do not differ in how well they believe they will do in bimodal conditions.

In order to determine if personality differences had any effect on behaviour in auditory conditions, two additional ANOVAs were performed. In the first of these analyses, time spent in sound served as the within subjects condition, while personality served as the between groups variable. Significant findings ($F(1,46) = 4.37$, $p = 0.04$) suggested that extroverts spent more time in aural conditions ($\bar{X} = 5.75$) than introverts ($\bar{X} = 3.00$).

In the second ANOVA, frequency of sound use served as the dependent measure, while personality served as the between groups variable. Inconsistent with predictions, analyses of variance revealed no significant differences ($F(1,46) = 3.01$, $p = 0.09$), suggesting that personality differences did not mediate users' decisions to employ auditory components as an enhancement tool in multimedia learning.

Finally, a chi-square analysis was conducted to test for the existence of a relationship between personality and preference for the sound medium. No significant differences were found for personality $\chi^2(1) = 0.38$, $p > 0.05$, (see Table 22) suggesting that, contrary to expectations, personality differences did not effect participants' preferences for aural media.

Table 22

Frequency Distribution for Personality (Extroverts and Introverts) Across Preference for
Text-Voice.

Personality Style

	Extroverts	Introverts	Row Total
Liked	n = 14	n = 13	
Row Pct.	51.9%	48.1%	27
Col. Pct.	58.3%	54.2%	
Disliked	n = 10	n = 11	
Row Pct.	47.6%	52.4%	21
Col. Pct.	41.7%	45.8%	
Column	24	24	
Total			

Note: Row Pct. = Row Percentage; Col. Pct. = Column Percentage.

Proposition three predicted that auditory perceivers would perform better in, feel more confident in and report a stronger preference for bimodal conditions, incorporating it more frequently and for longer durations than visual perceivers when given the option to do so. Support for this proposition was only found in one area: preference for aural learning conditions.

In order to test for the existence of perceptual differences on performance, an ANOVA was conducted with quiz performance as the within-subjects variable, and perceptual style (visual and auditory) as the between groups variable. Inconsistent with predictions, auditory perceivers were not found to perform significantly better in bimodal conditions than visual perceivers, ($F(1,46) = 0.13, p = 0.72$)

An ANOVA was also performed to examine the effects of perceptual differences on expected performance with performance estimates as the within-subjects factor. Results were nonsignificant ($F(1,46) = 0.51, p = 0.48$) suggesting that auditory perceivers were not more confident in bimodal conditions than visual perceivers.

In order to determine if perceptual styles had any effect on time spent in auditory conditions an ANOVA was performed. In this test, time spent in sound served as the within subjects variable. Nonsignificant findings ($F(1,46) = 0.34, p = 0.56$) suggested that auditory perceivers did not perform better in aural conditions than visual perceivers.

A second ANOVA was conducted to test for the effects of perceptual preferences on frequency of sound use. Frequency of sound use served as the dependent measure, while perceptual style served as the between groups variable. Inconsistent with predictions, analyses of variance revealed no significant differences ($F(1,46) = 0.02, p = 0.89$), suggesting that personality differences did not mediate users' decisions to employ audi-

tory components as an enhancement tool in multimedia learning.

A chi-square analysis conducted to test for the existence of a relationship between perception style and preference for the sound medium was found to be significant $\chi^2(1) = 5.49$, $p < 0.05$ (see Table 23). Consistent with predictions, this suggests that auditory perceivers exhibited a stronger preference for aural media than visual perceivers.

Table 23

Frequency Distribution for Perception Style (Visual and Auditory) Across Preference for
Text-Voice.

<u>Perception Style</u>			
	Visual	Auditory	Row Total
Liked	n = 10	n = 17	
Row Pct.	37.0%	63.0%	27
Col. Pct.	41.7%	70.8%	
Disliked	n = 14	n = 7	
Row Pct.	66.7%	33.3%	21
Col. Pct.	58.3%	29.2%	
Column	24	24	
Total			

Note: Row Pct. = Row Percentage; Col. Pct. = Column Percentage.

Proposition four predicted males would perform better in, feel more confident in and report a stronger preference for bimodal conditions, incorporating it more frequently and for longer durations than females when given the option to do so. This proposition was only partially supported in the area of time spent in text-voice.

An ANOVA was conducted to determine if gender differences had any effect on performance in aural conditions. In this analysis, performance served as the within-subjects variable, while gender was the between groups variable. Nonsignificant results ($F(1,46) = 2.01, p = 0.16$) obtained, contrary to expectations, suggest that males did not perform significantly better in bimodal conditions than females.

An ANOVA designed to examine the effects of gender on expected performance with performance estimates as the within-subjects factor, was nonsignificant ($F(1,46) = 0.52, p = 0.82$). Inconsistent with predictions, this suggests that males were not more confident about anticipated performance in text-voice conditions than females.

An ANOVA was also performed to test for the existence of gender differences on time spent in auditory conditions. In this test, time spent in sound served as the dependant measure. Inconsistent with expectations, findings were significant ($F(1,46) = 4.27, p = 0.04$) suggesting that females willingly spend more time in aural learning environments ($\bar{X} = 5.20$) than males ($\bar{X} = 3.00$).

In order to determine if frequency of sound use was effected by gender, a second ANOVA was performed. Frequency of sound use served as the dependent measure, while gender served as the between groups variable. Inconsistent with predictions, analyses of variance revealed no significant differences ($F(1,46) = 2.48, p = 0.13$) suggesting that gender differences did not mediate users' decisions to employ auditory components as an

enhancement tool in multimedia learning.

Finally, the existence of a relationship between gender and preference for the sound medium by means of a chi-square analysis. Findings were again contrary to expectations $\chi^2(1) = 0.28$, $p > 0.05$, (see Table 24) suggesting that gender differences did not effect participants' preferences for aural media.

Table 24

Frequency Distribution for Gender Across Preference for TeXt-Voice.

	<u>Gender</u>		Row Total
	Males	Females	
Liked	n = 11	n = 16	
Row Pct.	40.7%	59.3%	27
Col. Pct.	61.1%	53.3%	
Disliked	n = 7	n = 14	
Row Pct.	33.3%	66.7%	21
Col. Pct.	38.9%	46.7%	
Column	18	30	
Total			

Note: Row Pct. = Row Percentage; Col. Pct. = Column Percentage.

Overall, the findings of this study presents weak evidence, at best, for the mediating role of individual differences on performance (actual and anticipated) as well as attitudes about, and behaviour in, aural conditions in multimedia learning. Inferential analyses revealed that only two of the four propositions were partially supported. Two of the three individual differences were found for the personality variable. Specifically, extroverts were found to outperform, and spend more time in aural conditions than introverts. Instructional implications of these findings are that multimedia instruction may be more effective for individuals with more extroverted personalities, possibly stemming from their greater comfort in stimulating learning environments.

Yet even these few significant findings should be interpreted with caution. Due to the problematic nature of the data, as an added measure, additional analyses (linear regression) were conducted to validate the results of the analyses of variance. Results of these analyses provide even less support for the existence of individual differences – all but one test (personality and duration in text-voice) were nonsignificant (please see discussion as well as Tables 25-28, Appendix F for a detailed overview of these analyses).

In addition to failing to find a significant effect of individual differences in bimodal learning, results of this study were also unable to identify a relationship between decisions to employ the auditory medium as a learning tool and positive anticipations and performance in narrated media. Subsequent regression analyses, for example, failed to identify a relationship between how well participants performed and expected to perform and their decision to employ voice as a tool to aid performance. Thus, no relationship was found between behaviour and performance in aural conditions, as was expected.

Due to the limitations of this study, some care should be exercised when generalizing the results. Perhaps the most serious shortcoming of this study is that the design was unbalanced with unequal sample sizes across cells. This has serious implications for the interpretation of the data. Recall that, stemming from a need to control for order effects, extensive counterbalancing measures were taken to ensure randomization of the order of treatments. Upon collection of the data, however, a new problem arose.

A consideration of order effects reveals that each of the individual differences examined (perceiver style, gender and personality) are distributed unequally across cells (see Tables 29 and 30 below). This, unfortunately, greatly undermines the ability to generalize the results. How meaningful are null results for example, when some cells have zero or only one participant in them?

Table 29

Frequency Distribution of Perceiver Style, Gender, and Personality Across First Order

Visual perceivers n = 8				Auditory perceivers n = 10			
Males n = 2		Females n = 6		Males n = 2		Females n = 8	
Ext. n = 0	Int. n = 2	Ext. n = 5	Int. n = 1	Ext. n = 1	Int. n = 1	Ext. n = 5	Int. n = 3

Note: Ext. = Extroverts, Int. = Introverts.

Table 30

Frequency Distribution of Perceiver Style, Gender, and Personality Across Second Order

Visual perceivers n = 19				Auditory perceivers n = 11			
Males n = 9		Females n = 10		Males n = 5		Females n = 6	
Int n = 5	Ext. n = 4	Int. n = 3	Ext. n = 7	Int. n = 3	Ext n = 2	Int. n = 2	Ext. n = 4

Note: Ext. = Extroverts, Int. = Introverts.

Indeed, the analysis and interpretation of the results in factorial designs with unequal, non-proportional sample sizes are much more complex and ambiguous than in designs with only one independent variable. This is because, when the frequencies in the cells of a factorial design are unequal, the treatment effects and their interactions are correlated, which causes the attribution of a portion of the sum of squares to each main effect and to the interaction to be ambiguous.

Unfortunately, there is no consensus regarding the most appropriate manner for analyzing nonorthogonal designs. Indeed, this area has generated much controversy among social scientists as is evidenced by numerous published arguments, counterarguments, comments and replies to comments (cf. Pedhazur, 1982). As Appelbaum and Cramer (1974: 335) observe,

The nonorthogonal multifactor analysis of variance is perhaps the most misunderstood analytic technique available to the behavioural scientist, save factor analysis.

The problem of shared variance in non-orthogonal designs has traditionally been handled by one of three methods: the hierarchical, unique-variance, and sequential approaches. For the purposes of this study, the sequential approach was favoured, and subsequently utilised, as a corrective measure in this study.

A consequence of the nature of the design, is that it limited the kinds of analyses that could be meaningfully performed on the data. This in turn indirectly affected assumptions of reliability and validity, as certain analyses traditionally employed to assess reliability and validity could not be performed. It may be argued, for example, that a principle components factor analysis could have provided a more powerful means of assessing the internal validity of the perceiver style index than the method employed by the

researcher. Furthermore, if the scale was found to have inherent validity as determined by factor analysis, then reliability analyses of the ensuing scale could have been conducted (e.g. Cronbach's alpha, for example).

Given the problematic nature of the data then, it is important to consider if anything could have been done to improve the nature of the design. Two possibilities include: (1) running a larger number of participants, in order to avoid having small numbers in each cells of the design¹¹ and (2) dropping one or more of the independent variables from the study altogether. Due to the time constraints of this study, the first option was not a serious possibility. Unfortunately, the second alternative was equally unfeasible, given that the assessment of individual differences on bimodal learning conditions was a central purpose of this study.

¹¹ It should be noted that the non-orthogonal nature of the design is of greater concern than the issue of unequal sample sizes. From a statistical perspective the problem of proportional, albeit unequal, sample sizes across cells are much easier to rectify than having non-proportional sample sizes within each treatment as is the case in the present study.

Chapter Five

Discussion

This study provides the first locatable test of dual-coding theory using non-pictorial information as the visual source within a multimedia context. The fundamental assumption of this study was that multimedia facilitates learning by holding the learner's interest and promoting cognitive engagement. This assumption is challenged by recent research which has found that multimedia features may not be effectively utilised by learners.

As a result, the present study was designed to enable exploration of the effects and use of a common multimedia tool (voice narration) on on-screen textual instruction. Two themes were addressed: first the effects of narrated technology on learning performance in CAI, and second, how the individual learner employs multimedia options. The second theme entailed an exploration of both behaviour and the decision making process of multimedia use from the learner's perspective, as well as an attempt to identify the kind of learner most likely to benefit from this technology. As evident from the results outlined in the previous section, the data failed-to-support any of these propositions entirely.

The sections to follow review these findings, focusing on the relationship to past theory and research. For ease of presentation, I begin with a discussion of the first proposition which entails a general overview of the nonsignificant effects of voice narration on learning performance found in this study. This is followed by a discussion of findings relating to propositions two through four on the effects of individual differences on bimodal learning performance. I conclude with an overview of the contributions and implications of this study to multimedia research.

Proposition one predicted a positive main effect for performance in bimodal learning conditions. The major finding of this study, that bimodal presentations (text with voice) had a hindering rather than a facilitative effect on learning performance, did not support this proposition. Inconsistent with expectations, this finding does not support the dual-coding theory of working memory upon which this proposition was founded.

Dual-coding theory (DCT) predicts that bimodal presentation will better facilitate the learning process than unimodal presentations. This expectation is based on the idea that learners can build three types of retrieval cues when words are presented in verbal and visual forms. In the case of unimodal formats, learners can only build one type of retrieval cue when they select words.

Why has this auditory adjunct hindered rather than facilitated the learning process? The results of this study suggest the addition of voice narration to on-screen text acts more as a distraction than an enhancement in multimedia learning. Research in the area of reading and cognition first began to accumulate during the mid-1970s. The primary focus of learning theories of this time was on the examination of the cognitive processing of textual information. One model, which specified the role of subvocalisation in the learning process may offer some insight to understanding the results of the current study.

According to learning theory, subvocalisation (i.e. saying to ourselves the words in the text as we read), is a crucial tool when learning new material. Most of us read by subvocalisation and although subvocalising can help us remember what is read, it limits how fast we can read. Since covert speech is not much faster than overt speech, subvocalisation limits reading speed to the rate of speaking.

It is more difficult to read complex or technical material, such as that used in the present study, without using subvocalisation. Experimental analysis of speech processing during reading suggests that although the meaning of the words read can be understood without subvocalisation, it is useful in the facilitation of detailed recall of a text.

Levy (1975), for example, attempted to suppress subvocalisations by requiring participants to count from ten (interference) as they read a short paragraph. Her results suggest suppressing subvocalisation did not interfere with performance when people listened to the sentence. But since the counting task did not interfere with performance, it was concluded that acoustic coding was not required to remember the less important ideas. Thus, when material is relatively simple and detailed recall is not required, people can recall the major ideas without subvocalisation. In contrast, subvocalisation facilitated the detection of more subtle changes, such as changing the order of two words or replacing a wrong word with a semantically similar word. Other studies on the effects of subvocalisation on learning have found similar results (Daneman & Newson, 1992; Pauk, 1981; Hardyck & Petrinovich, 1969).¹²

Considering the complex nature of the learning material¹³ in the present study, it is likely that participants were subvocalising during the learning process. Indeed, an examination of negative feedback regarding voice adjuncts provides ample evidence to suggest that a high proportion of participants were subvocalising while learning the material.

¹² Hardyck and Petrinovich (1969) for example, measured subvocalisation by recording the muscle activity of the larynx. Participants in the experimental group were trained to keep their muscle activity at non-reading levels. Any increase in activity during reading activated an audio signal to remind them to suppress subvocalisation. A control group read the same material but were allowed to subvocalise as they read. A comprehension test revealed that the two groups did not differ in recall of easy material, but the subvocalisation group recalled more for the difficult material than the suppression group.

¹³ The learning material was considered to be of a difficult level since the material was taken from a second year level undergraduate text and administered to participants who were first year undergraduates.

Consider, for example, comments such as the following: “the voice was very distracting, I would finish reading the text and would have to wait for the voice to finish before going on” and “the voice was too fast, I couldn’t keep up with it.”¹⁴ Since the voice reading the text was often at a different rate from readers’ subvocalisation, it may have had an adverse affect on performance by interfering with the natural subvocalisation of many participants. It may be concluded that the effect of narration may have had a distracting effect by making it more difficult to concentrate on the material presented.

The findings of the present study also point to the significance of the nature of the visual information source as a moderator of modality effects. Specifically, results suggest that although DCT may hold true when visual information is of a pictorial nature (i.e. animations and illustrations), it may not be supported when visual information is of a non-pictorial nature as in the case of printed text.

This may be because pictorial information, contrary to the theory outlined in Chapter Two, could be considered to be of a more purely visual nature than non-pictorial text, given the presence of subvocalisation in the encoding of the latter. This might classify text as more of a ‘visual-verbal’ information source. In the case of pictorial information, the learner receives a visual code combined with an acoustic code from narration (in bimodal presentations), allowing the formation of two sets of retrieval cues (one visual, the other verbal). In the case of printed text, however, the learner receives a visual code, an acoustic code (from the narration) and a second acoustic code (from subvocalisation) during the reading process. It may be that the two acoustic codes interfere with one an-

¹⁴ An argument could also be made that the following positive feedback “I went back later and added it to the difficult parts, I closed my eyes and just concentrated on the voice” may be indicative of the presence of subvocalisation.

other: that is, the redundant subvocalisation interferes with the acoustic code received from listening to the narration. As a result of this interference, learners may be unable to allocate resources needed to build a proper verbal retrieval cue to working memory. As learners must devote more cognitive resources to the construction of the verbal retrieval cue, they may have even less resources to build referential connections between visual and verbal memory. According to DCT theory, it is these referential connections that is crucial for meaningful learning to take place.

Based on the results of the present study, Figure 2 was developed. It proposes a model of how learning material, comprised of printed text simultaneously narrated by a human voice, may be integrated into working memory during the learning process. The top left portion of Figure 2 depicts the verbal presentation (narration) of the instructional material. The first arrow shows the encoding of the verbal information into verbal memory. The bottom left portion of the figure depicts the visual presentation (printed text) of the instructional material. The second arrow shows the encoding of the visual information into visual memory. The central portion of the figure depicts the second acoustic code caused by subvocalisation of the printed text. The intersection of the first arrow with the third arrow suggests the interference of the two acoustic codes with each other, conflicting with the formation of a proper acoustic code to working memory.¹⁵

¹⁵It should be noted that although the proposed model is based on the findings of this study, it nonetheless remains highly speculative in nature. Clearly, there is a need for much additional research to substantiate or refute the assertions of this model.

Figure 2. A proposed model of learning narrated text, adapted from the dual-coding model of working memory. The number 1 refers to building verbal representations; 2 refers to building visual representations connections; 3 refers to interference caused by subvocalization during the reading of the text; 4 refers to retrieval from long-term memory.

In addition to examining the effects of narrated media on learning performance in CAI, this study was also designed to increase awareness of how it might be utilised by the end-user during the learning process. The remaining propositions of this study (propositions two through four) guided analyses of this data.

Proposition two predicted extroverts would perform better in, feel more confident in, and report a stronger preference for bimodal conditions, incorporating it more frequently and for longer durations than introverts when given the option to do so. Support for this proposition was found in actual performance, as well as time spent in aural conditions

The finding that extroverts performed significantly better than introverts in the bimodal condition suggests introverts may have been more distracted by the voice when learning new material. This follows from other studies which have also found the stimulation of test conditions to be an influential factor in the differing performance between introverts and extroverts (Perlin, 1998; Grigoryan et al. 1997). In a study that assessed learning performance in the presence of background music, Perlin (1998) found introverts performed significantly less well on tests of recall than did extroverts. Thus, when participants were forced into a condition where they had to tolerate a distracting sound element in their lesson, extroverts may have naturally been more adept at 'tuning it out' than were extroverts.

The finding that extroverts spent significantly more time in the narrated lesson when given the choice is consistent with arousal theory, which suggests extroverts, in comparison with introverts, have a lower threshold for monotonous activity and may

have added sound to make their lessons more interesting. These results are also consistent with studies reporting introverts prefer receptive learning, in contrast to extroverts who favour discovery learning (Eyesenck & Eyesenck, 1979; Leith, 1973).

Proposition three predicted auditory perceivers would perform better in, feel more confident in and report a stronger preference for bimodal conditions, incorporating it more frequently and for longer durations than visual perceivers when given the option to do so. Support for this proposition was only found in an area relating to attitudes about bimodal learning: preference for aural learning conditions.

Despite auditory perceivers' greater preference for and use of sound, results suggest they did not perform significantly better in bimodal learning conditions than did visual perceivers. This, in turn, suggests auditory perceivers' preference for sound may be a preference more aesthetically than utilitarian based. Additional support for this argument is provided when these findings are considered together with the finding that auditory perceivers were no more likely than visual perceivers to chose to add sound to their lessons, when given the option to do so. It may be for example, that auditory perceivers, despite their preference for sound, did not add narration because they did not believe that it would effect their retention of the learning material.

Proposition four predicted that males would perform better in, feel more confident in and report a stronger preference for aural conditions, incorporating it more frequently and for longer durations than females when given the option to do so. This proposition was only partially supported in the area of time spent with narration. Inconsistent with expectations, females spent more time in bimodal conditions than males. The general absence of gender differences in learning is not consistent with previous studies, which re-

ported evidence for such differences in computer-assisted instruction (Small, 1992; Mevarech, 1989; Rosenberg, 1986). As these studies were conducted a decade or more ago, it may be that the picture is changing for males and females, and that as more females are now using and are consequently more familiar with computers, they are performing at more comparable levels with their male counterparts.

Overall, the findings of this study do not present strong evidence for the mediating role of individual differences on performance in multimedia learning.¹⁶ Given the very limited number of significant findings pertaining to individual differences (subsequent regression analyses identified only one) the most plausible explanation of these findings is that the significant findings may have occurred through random chance. In sum, this study was unable to identify individuals who are most likely to benefit from narrated computer-aided instruction as an aid to learning.

Despite this limitation, the present study was able to provide some insight to understanding how and why learners utilised the narration option. Some evidence was found to suggest that users' attitudes about voice media are, initially at least, open and exploratory in nature. Summary statistics on anticipated performance, for example, reveal that performance estimates were highest prior to exposure to aural conditions. Furthermore, data showing frequency of sound use indicate that although text with narration was not used as much as the text-only format, more than half of participants were willing to try it at least once.

Although these findings demonstrate participants were willing to try aural media, they do not provide evidence that the narration was employed strategically to facilitate

the learning process. Indeed, regression analyses found that neither behaviour nor anticipated performance was significantly correlated to sound use. Specifically, participants with higher expectations of its effect on their performance, as well as participants who actually performed better in narrated conditions were no more likely to incorporate it than participants who were detrimentally effected by the aural media.

These findings suggest participants did not employ the multimedia technology to full advantage. Specifically, it was used without purpose, not employed for the intent of facilitating the retention of material. This lack of a relationship between attitudes, expectations and behaviour in the employment of multimedia options challenge a basic assumption of this study: that multimedia would be employed as an educational tool by users. This sheds some light on earlier research that found that multimedia is often employed ineffectively by the end-user. One reason for this, the findings of the present study suggest, may be unfocused use by the learner, which is only compounded by the non-utilitarian motivation of the designers.

These findings may warrant a re-examination of the role of user control in multimedia. Specifically, if users do not employ multimedia options practically and judiciously, should they be given complete control over its use? The work of researchers in the area of sequencing control may provide some insight into the answer. According to these educators, when a technology is not used effectively, the issue of learner control should be reconsidered. Borsook and Higginbotham-Wheat (1991, 13), for example, caution that,

Although it may initially seem to be the case, increasing learner con-

¹⁶ In this study, the propositions were based on the assumption that both arousability to external cues and visual-spatial abilities would facilitate bimodal learning. Neither was substantiated by the findings.

trol is not commensurate with increasing the quality or quantity of interactivity offered by an instructional system.

Hannafin and Peck (1988:10) argue that while some learners may be best qualified to make decisions about their instruction, others might make ineffective choices. They continue,

As might be predicted, the student is not always basing decisions on a genuine belief that educational objectives have been met. When in doubt as to whether to grant the student control of the course of a lesson, let the objectives of the lesson be the determining factor.

As Marchionini (1988: 9) observes, a major problem with this type of material is that teachers and instructional designers have to learn how to,

shape this potential into quality learner control experiences. We want our students to learn to explore information freely and easily, but with purpose and discipline. The privilege of freedom demands responsibility; the responsibilities of using hyper-documents include knowing when and how to stay oriented and attentive to goals.

Given that participants did not expect the vocal component to facilitate learning, it seems reasonable to question why it was employed at all. Despite its distracting quality, why did almost half of all participants employ it at least once during their lessons? Would it not have made more sense to avoid a media option that was interfering with learning the material?

Some insight may be found from the qualitative data on feedback. An examination of positive feedback reveals that many participants found the voice was interesting, and added to the overall appeal of the lessons. Consequently, voice narration may have been employed, not because it would help users learn the material, but because it was

stimulating and promoted cognitive engagement.¹⁷

Educators have long contended that the primary advantage of multimedia is that its polysensory properties are conducive to increased stimulation of the senses, which in turn leads to greater interest and motivation to learn. It is this cognitive engagement that is believed to lead to higher overall retention of instructional material presented in multimedia format since the user's attention is more focused on it. The results of this study suggest that higher cognitive engagement does not necessarily lead to better understanding or cognitive processing of the learning material.

This challenges a basic assumption of multimedia design in CAI, which aims to make learning more stimulating in the belief that sensory stimulation is, without qualification, conducive to learning. Indeed, it may be that multimedia can make the learning environment too stimulating, thereby impeding the learning process. A reconsideration of the cognitive engagement seems to be in order: how much is optimal, can too much be detrimental? The latter is illustrated in the present study where the addition of aural media was found to cause interference, with two conflicting retrieval cues (sound of the voice and subvocalisation) competing for the cognitive resources needed to encode material.

The primary focus of multimedia research until now has been on technology—making it increasingly stimulating (i.e. more graphics, more animation, more variation and quality of sound). In the excitement to create engaging technology, educators may

¹⁷ It should be noted that other reasons for preferring narration were reported by participants in this study which have not been addressed to this point. Due to constraints of time and length, reasonable consideration of this data are beyond the scope of this paper, but may warrant further investigation through further

have sacrificed utility, overlooking the possibility that multimedia has a potential to impede rather than assist the learning process. The results of this study show that what in fact may be more useful than advancing the technological features of multimedia is a concentrated focus on creating media that answers to the needs of the end-user, thus producing a more effective tool for learning.

In sum, this study offers both theoretical and practical insights. It contributes to multimedia learning theory by testing the dual-coding theory of working memory. More specifically, the results provides the first opportunity to examine modality effects in multimedia learning, in which narration is compared to a text-only condition (without animation). The findings of this study also contribute to the multimedia learning literature by pointing to the significance of the nature of the visual source as a mediator of modality effects. The theoretical contribution of this study is an addition to the dual-coding theory of working memory that forms the basis of multimedia research.

On the practical side, the present study has direct implications for designers of computer-aided instruction. In the design of multimedia presentations, the designer is faced with the task of how to best integrate the multimedia features of instructional material. Previous work points to the advantage of integrating corresponding graphic and text materials as much as possible (Moreno & Mayer, 2000; Moreno & Mayer, 1999; Plass, Chun, Mayer & Leutner, 1989). The results of the current study, however, suggest that in the case of textual material it is not to the learner's interest to add voice narration.

Thus, courseware designers should be advised to limit the use of narrative adjuncts to enhance the learning of pictorial rather than textual information in multimedia

lessons. In this study, for example, the addition of an auditory component to text was shown to have a minimal effect on performance. It was also found that only approximately half of the users in this study utilised narration when given the option to do so. As a result, developers of CAI should give serious consideration regarding the feasibility of including an auditory component to their software, especially when considering the high cost of its implementation.

Care should be exercised when generalizing the results of the current study. Arguably, the greatest shortcoming of this study is that participants were not able to control the speed of the voice narration. Recall that all negative feedback concerning voice consisted of complaints about its speed. In light of this interference effect, it is plausible that significant differences in bimodal learning may have been found had users been able to adjust the speed of the narration to suit their own learning preferences. The ability to pause the computer voice may have been particularly helpful, as it would have allowed participants more time to reflect, and subsequently encode the instructional material into long-term memory. Moreover, it would have been easier to generalize the results of a study where users were given this added control option, as such control features are often typically found within actual multimedia contexts.

A second drawback of this study concerns the sample. Volunteer biases¹⁸ may have been present as the sample consisted entirely of first year psychology students who participated in order to accrue extra credits. One consequence of this is that participants may have initially employed and reported a higher preference for the auditory tool than would normally be expected in order to please the researcher. The inconsistency of high

reported aural preferences with a reluctance to employ aural adjuncts, provides some evidence for the speculation of such demand characteristics.

In addition, employing university students may have also posed a possible confound, as it is reasonable to expect that this population is more likely to exhibit higher levels of scholastic aptitudes than the norm. In light of evidence which suggest that less gifted students are helped more than average or better ones in CAI (Rosenburg, 1986), it is quite possible that significant bimodal effects may have been found had a different sample been employed in this study.

Finally, the sample employed may also have had direct implications for the findings regarding individual differences. In particular, the lack of gender differences should be interpreted with caution. First, as the sample consisted of a considerably higher proportion of females to males (sixty-three percent females, thirty-seven percent males) the low number of males (especially within a small overall sample size) may have effected the generalization of the results. Second, of these male participants, seventy-eight percent were included in the second half of the experiment. This in turn, may have resulted in two additional confounding effects: including volunteer biases and order effects (since the majority of males were exposed to the text-voice condition first).

Despite its limitations, the findings of this study offer important insights, and point to the need for future research in the area of narrated instructional media. In particular, the results suggest the necessity of exploring the role of subvocalisation in multimedia learning in further detail. Qualitative data on aural preferences suggest that while certain participants may have been subvocalising others were not. In addition to contributing

¹⁸ Volunteer biases, also known as demand characteristics, refers to participant reactivity. As perceived

to the theoretical literature on learning, research designed to distinguish these differences in learning styles may be helpful in identifying groups more likely to benefit from narrated instruction.

As it has been suggested that subvocalisation may be more prevalent in learning complex material, a second line of research might replicate the current study within the context of lower-order learning. In the case of vocabulary acquisition, which is a form of lower-order learning, decreased levels of subvocalisation may allow the building of referential connections between verbal and visual memory that were not found in the case of higher order learning. Such a finding may be of special relevance to computer-aided instruction, where the addition of voice adjuncts could facilitate the learning of supplemental instructional material such drill-and-practice style lessons.¹⁹

Another replication of this study could allow the speed of the narration to be controlled by the learner. Considering the distracting quality of the computer narration with participants' own subvocalisation in the present study, it seems plausible that potential interference could be minimized, if not eliminated in such a study, where the learner could pace the narration to suit his or her preferences. In addition to providing a less biased assessment of voice narration on learning performance, such a study could offer insight regarding how narration may be employed to facilitate the learning process.

In conclusion, this study begins to answer the questions: is narrated courseware effective and, if so, for whom is it effective? In the process of examining these issues,

roles may determine how participants respond, unnatural responding could occur and confound the results.

this study offers some insight regarding the under-utilisation of auditory adjuncts. It appears that users' reluctance to employ multimedia tools may stem more from beliefs that it will not facilitate their learning, rather than from a fear of the technology itself.

The exploratory nature of this study provides a framework for future research examining the effects of voice media in computer-aided instruction. The conduction of such research should be an exciting discovery for educators.

¹⁹ When considering that a positive feature of sound reported by participants was to make the lessons more interesting, developers of CAI might give consideration to the benefits of alternative uses of narration. One option includes using voice as a form of feedback (making the feedback more interesting, but not interfering with the lesson). Another alternative includes narrating supplemental learning material, since such material is likely less difficult than mainstream lessons.

References

- Abouserie, R. (1992). Cognitive style, gender: attitudes towards computer-assisted learning and academic achievement, Educational Studies, 18, 2, 151-160.
- Allport, A. (1993). Attention and control: Have we been asking the wrong questions? A review of 25 years. Attention & Performance, 14, 183-218.
- Applebaum, M. I., & Cramer, E. M. (1974). Some problems in the nonorthogonal analysis of variance, In Pedhazur, E. J. (1982). Multiple Regression in Behavioural Research: EXplanation and Prediction. New York: Rinehart and Winston.
- Baron, R. A., & Byrne, D. (1997). Social Psychology. Massachusetts: Allyn & Bacon.
- Borsook, T. K., & Higginbotham-Wheat, N. (1991). Interactivity: What is it and What can it do for computer-based instruction? Educational Technology, 31, 11-17.
- Carroll, J. B. (1993). Theory to practice: Self-Efficiency related to transfer of learning as an example of theory-based instructional design, Journal of Adult Education, 22, 1, 37-43.
- Chandler, P., & Sweller, J. (1991). Cognitive load theory and the format of instruction. Cognition and instruction, 8, 293-332.
- Chan-Lin, L. J. (1999). Gender differences and the need for visual control instruction Journal of Instructional Media, 26, 3, 329-335.
- Corno, L., & Snow, R. E. (1986). Adapting teaching to individual differences among learners, In M. Witroch (Ed.) Handbook of Research on Teaching (vol. 3 pp. 605-629). New York: MacMillan.

- Daneman, M. & Newson, M. (1992). Assessing the importance of subvocalisation during normal silent reading. Reading and Writing, An Interdisciplinary Journal, 4, 1, 55-57.
- Eubanks, C. L. (1988). A comparison of the performance on the New York State regents competency test in mathematics of remedial high school students receiving computer-assisted instruction. Journal of Graduate Research in Urban Education and Related Disciplines, 19, (12), 52-66.
- Eyesenck, M. W., & Eysenck, M C., (1979). Memory scanning, introversion-extroversion, and levels of processing. Journal of Research in Personality, 13, 3, 305-315.
- Fastenau, P. S., Conant, L. L., & Lauer, R. E. (1998). Working memory in young children: Evidence for modality-specificity and implications for cerebral reorganization in early childhood. Neuropsychologia, 36 (7), 643-652.
- Frick, R. W. (1984). Using both an auditory and a visual short-term store to increase digit span. Memory and Cognition, 12, 507-515.
- Gayeski, D. M. (1989). Why information technologies fail. Educational Psychology, 29, 2, 9-17.
- Giardina, M. (Ed.) (1992). Interactive Multimedia Learning Environments. Berlin: Springer-Verlag.
- Grigoryan, V. G., & Agababyan, A. R. (1997). Characteristics of evoked potential in extroverts and introverts in monotonous activity, Psikhologicheskyy-Zhurnal, 18(3), 121-125.
- Hadley, M. & Scheingold, K. (1992). Common abilities and distinctive patterns

- in teaching integration of computers, In Forster, C. (1991). Math Trek, Unpublished Manuscript.
- Hannafin, M. J., & Peck, K. L. (1988). The Design, Development & Evaluation of Instructional Software. MacMillan Publishing Company: New York.
- Hardyck, C. D. & Petrinoich, L. F. (1969). Treatment of subvocal speech during reading. Journal of Reading, 12, 5, 361-368.
- Kearsley, G. & Lynch, W. (1992). Educational leadership in the age of technology: The new skills, Journal of Research on Computing in Education, 25, (1), 50-60.
- Kozma, R. B. (1991). Learning with media. Review of Educational Research, 61, 179-211.
- Keefe, J. W. (1989). Learning Style Profile Handbook II: Accomodating Perceptual, Study and Instructional Preference. Reston, VA: National Association of Secondary School Principals.
- Kirby, J. R., Moore, P. J. & Schofield, N. J. (1988). Verbal and visual learning styles. Contemporary Educational Psychology, 13, 169-184.
- Kozma, R. B. (1991). Learning with media. Review of Educational Research, 61, 2, 179-211.
- Lafontaine, R. (1986). Visual and auditory perception profiles, In Meunier-Tardiff, G. (1989). Eye People, Ear People: Getting Along. Toronto: NC Press Ltd.
- Leith, G. (1973). The effects of extroversion and programmed methods of instruction on achievement. Educational Research, 15, 2, 150-153.
- Leutner, D., & Plass, J. L. (1998). Measuring learning styles with questionnaires versus direct observation of professional choice behavior in authentic learning

- situations: The visualizer-verbalizer behavior observation scale. Computers in Human Behavior, 14, 4, 543-557.
- Levy, B. A. (1975). Vocalization and suppression effects in sentence memory. Journal of Verbal Learning and Verbal Behavior, 14, 3, 304-316.
- Marchionini, G. (1988). Hypermedia and learning: Freedom and chaos. Educational Technology, 28, 8-12.
- Mayer, R. E. (1997). Multimedia Learning: Are we asking the right questions? Educational Psychologist, 32, 1-19.
- Mayer, R. E., & Anderson, R. B. (1991). Animations need narrations: An experimental test of a dual-coding hypothesis. Journal of Educational Psychology, 83, 484-490.
- Mayer, R. E., & Gallini, J. K. (1990). When is an illustration worth ten thousand words? Journal of Educational Psychology, 82, 715-726.
- Mayer, R. E., & Moreno, R. (1998). A split-attention effect in multimedia learning: Evidence for dual processing systems in working memory. Journal of Educational Psychology, 90, 312-320.
- Mayer, R. E., & Sims, V. K. (1994). For whom is a picture worth a thousand words? Journal of Educational Psychology, 82, 715-726.
- Meunier-Tardif, G. (1989). Eye People, Ear People: Getting Along. Toronto: NC Press Ltd.
- Mevarech, Z.R.(1989). Intrinsic orientation profiles and learning mathematics in CAI settings. Journal of Educational Research, 84 (4), 228-232.
- Moreno, R. & Mayer, R. E. (1999). Multimedia-Supported Metaphors for Meaning

- Making in Mathematics. Cognition and Instruction, 17, 3, 215-218.
- Moreno, R. & Mayer, R. E. (2000). Coherence effect in multimedia Learning: The case for minimizing irrelevant sounds in the design of multimedia instructional messages. Educational Psychology, 1, 117-125.
- Mousavi, S., Low, R., & Sweller, J. (1995). Reducing cognitive load by mixing auditory and visual presentation modes. Journal of Educational Psychology, 87, 319-334.
- Paivo, A. (1986). Mental representations: A dual-coding approach. Oxford, England: Oxford University Press.
- Park, L., & Hannafin, M. (1994). Empirically-based guidelines for the design of interactive multimedia. Educational Technology Research and Development, 41, 63-85.
- Passig, D., & Levin, H. (1999). Gender differences in multimedia learning interfaces. Computers in Human Behavior, 15, 2, 173-183.
- Pauk, W. (1981). You haf'ta vocalize to comprehend. Reading World, 20, 3, 225-226.
- Pedhazur, E. J. (1982). Multiple Regression in Behavioral Research: EXplanation and Prediction. New York: Hold, Rinehart and Winston.
- Penney, C. G. (1989). Modality effects and the structure of short-term verbal memory. Memory & Cognition, 17, 398-422.
- Perlin, T. R. (1998). Feedback, self-efficiency, arousal and performance of introverts and extroverts. Psychological Reports, 82(3), 706-716.
- Plass, J. L., Chun, D. M., Mayer, R. E., Leutner, D. (1989). Supporting visual and verbal learning: Preferences in a second-language multimedia environment. Journal of Educational Psychology, 90, 1, 25-36.

- Riding, R. J., & Wicks, B. J. (1978). The effects of extroversion and presentation order on learning from picture-commentary sequence by children. Educational Review, 30, 3, 255-257.
- Rosenberg, R. S. (1986). Computers and the Information Society. New York: John Wiley and Sons.
- Schmeck, R., & Lockhart, D. (1983). Introverts and extroverts require different learning environments. Educational Leadership, 40, 5, 54-55.
- Small, R. V., & Grabowski, B. L. (1992). An exploratory study of information-seeking behaviours and learning with hypermedia information systems. Journal of Educational Multimedia and Hypermedia, 4, 445-464.
- Sweller, J., & Chandler, P. (1994). Why some material is difficult to learn. Cognition and Instruction, 12, 185-233.
- Underwood, G. & Underwood, J. (1998). Children's interaction and learning outcomes with interactive talking books. Computers and Education, 30, 95-122.
- Weigel, R. H., & Newman, L. S. (1976). Increasing attitude behavior correspondence by broadening the scope of the behavioral measure. Journal of Personality and Social Psychology, 33, 793-802.
- Wilson, K. (1992). Discussion on two multimedia R & D projects: The Plaenque Project and the Interactive Video Project of the Museum Education Consortium. In M. Giardina (Ed.), Interactive Multimedia Learning Environments (pp.186-196). Berlin: Springer-Verlag.
- Yankus, M. (March,1995). New ways to learn. Byte. 50-70.

Appendix A

Informed Consent Form

The purpose of an informed consent is to insure that you understand the purpose of the study and the nature of your involvement. The informed consent must provide sufficient information such that you have the opportunity to determine whether you wish to participate in the study.

Research Personnel. The following people are involved in this research project and may be contacted at any time. Devjani Sen (Principal Investigator, 520-2600, ext. 8204), (Faculty Sponsor, 520-2600, ext. 2643).

Task Requirements. You will be shown three lessons in social psychology which will be presented on a computer screen. One lesson will consist of words on a computer screen. Another version will consist of text on the screen being read by a female voice. In the third lesson you will have the option to add voice to your lesson, or leave it as is (text only). At the end of each lesson, you will be asked to complete a short quiz designed to assess your comprehension of the learning material.

Anonymity/Confidentiality. The data collected in this experiment are confidential. All data are coded such that your name is not associated with the data. In addition, the coded data are made available only to the researchers associated with this project.

Right to withdraw. You have the right to not answer any specific questions if you feel uncomfortable to do so, and the right to withdraw from the experiment at any time without academic penalty.

Signatures

I have read the above description of this study on the effects of sound and user control in Computer-aided instruction and understand the conditions of my participation. My signature indicates that I agree to participate in the experiment.

Participant's name: _____
Signature: _____
Date: _____

Appendix B

Background Questionnaire

Please circle one:

I fall into the age category of:

- (a) 18-29 b) 30-39 c) 40-49 d) 50 or older

How many years has it been since the last time you took a test?

Please circle one of the following:

- a) less than 1 year b) 1-5 years c) more than 5 years

(1) How many books did you read for pleasure last year? _____

(2) How many music cassettes or CDs did you buy last year? _____

(3) How many audio books/books on cassette did you listen to last year? _____

(4) Are you a visual or auditory perceiver? Visual perceivers learn best from what they see, as visual cues in the environment are very important to them, in contrast to auditory perceivers, who are more in tune with auditory cues in the environment and attend more to what they hear. Please rate the type of perceiver you are on the following scale (1 indicates strong leanings towards being a visual perceiver, 7 indicates strong leanings towards being an auditory perceiver).

visual perceiver	1	2	3	4	5	6	7	auditory perceiver
------------------	---	---	---	---	---	---	---	--------------------

(5) When you were growing up, did someone often read you stories (for example during the day or at bedtime)? Please rate approximately how often you were read to as a youngster on the following scale (0 is never having been read to, 5 is being read to twice a week or more):

never read to	1	2	3	4	5	6	7	read to at least twice a week
---------------	---	---	---	---	---	---	---	-------------------------------

(6) Please rate yourself on the following statements (5 indicates that the statement is very true for you 0 indicates that the statement does not apply to you at all)

When learning something new, I prefer to follow a drawing or text

not at all	1	2	3	4	5	6	7	very much
------------	---	---	---	---	---	---	---	-----------

I remember visual images very clearly

not at all	1	2	3	4	5	6	7	very much
------------	---	---	---	---	---	---	---	-----------

I remember auditory images very clearly

not at all	1	2	3	4	5	6	7	very much
------------	---	---	---	---	---	---	---	-----------

(7) Are you more artistic or musical?

artistic	1	2	3	4	5	6	7	musical
----------	---	---	---	---	---	---	---	---------

(8) Are you an introvert or an extrovert?

introvert	1	2	3	4	5	6	7	extrovert
-----------	---	---	---	---	---	---	---	-----------

Appendix C

Please estimate how well you think you will do on the following quiz:
 Estimated quiz score _____%

QUIZ 1: CONFLICT RESOLUTION AND GAME THEORY

- (1) Game theory deals with:
 - (a) two or more interdependent parties who, according to rules, make decisions that affect each other
 - (b) two or more intradependent parties, who, according to rules, make decisions that affect each other
 - (c) motivations that are either competitive or cooperative
 - (d) b and c
- (2) In a Maximizing Difference Game (MDG), it was found that:
 - (a) same-sex female dyads were most competitive
 - (b) same-sex male dyads were most competitive
 - (c) males were more competitive in mixed-sex dyads
 - (d) females were more competitive in mixed-sex dyads
- (3) In the MDG, which group was found to be more exploitative?
 - (a) males more than females
 - (b) Canadians more than East Indians
 - (c) East Indians more than Canadians
 - (d) Flemish more than Americans
- (4) Who are most likely to use the 'tit-for-tat' strategy?
 - (a) East Indian females
 - (b) Canadian females
 - (c) East Indian males
 - (d) Canadian males
- (5) Which statement is false?
 - (a) there are two basic types of games, zero-sum and non-zero sum
 - (b) in game theory people act rationally in order to maximize their outcomes
 - (c) in a collective non-zero sum game, rational behaviour by individuals produces an outcome that is collectively desirable
 - (d) threats are often used to resolve conflicts
- (6) In the article, which of the following was not mentioned to have an effect on conflict behaviour?
 - (a) culture
 - (b) socioeconomic status
 - (c) personality traits
 - (d) age

- (7) For threats to be successful they must:
- (a) not have too high a cost
 - (b) be credible
 - (c) have negative consequences for both the threatened and the threatener
 - (d) all of the above
- (8) A mixed motive game is:
- (a) a non collective dilemma
 - (b) a zero sum game
 - (c) a non zero sum game
 - (d) when two parties reach h an agreement
- (9) When bargaining is employed in conflict situations, the most effective strategy:
- (a) involves two parties who are willing to compromise
 - (b) combines firm resistance to exploitation with responsiveness to cooperative overtures
 - (c) combines gentle resistance to exploitation with responsiveness to cooperative overtures
 - (d) none of the above
- (10) (GRIT) is:
- (a) a means of conciliation
 - (b) a type of bargaining
 - (c) graduated reciprocation initiative in tension-reducing acts
 - (d) all of the above

Please estimate how well you think you did on the quiz that you have just taken:
Estimated quiz score _____ %.

Please estimate how well you think you will do on the following quiz:
Estimated quiz score _____%

QUIZ 2: SOCIAL PSYCHOLOGY OF THE LAW

- (1) Like experimental subjects, eyewitnesses generally want to be useful and may react to subtle _____.
 - (a) environmental effects,
 - (b) response biases
 - (c) eyewitness characteristics
 - (d) all of the above
- (2) If a suspect is described as being bald, and there are two short bald people and three tall people in a lineup of ten, then the functional number in the lineup is:
 - (a) 2
 - (b) 3
 - (c) 5
 - (d) 7
- (3) When authoritarian subjects in the laboratory jury discussed in the article were contacted a week later, they recalled:
 - (a) less about the defendant's character and more about the evidence
 - (b) more about the defendant's character and less about the evidence
 - (c) the defendant's character and the evidence equally
 - (d) none of the above
- (4) Studies show high authoritarians are more likely to convict
 - (a) women
 - (b) authority figures
 - (c) people unlike themselves
 - (d) well-dressed people
- (5) Research shows that jurors are more likely to convict if they:
 - (a) are older
 - (b) of high socioeconomic status
 - (c) are highly educated
 - (d) none of the above

- (6) Which statement is true?
- (a) females are more likely to find the defendant guilty when the prosecutor is a man
 - (b) males are more likely to find the defendant guilty when the prosecutor is a man
 - (c) females are more likely to find the defendant guilty when the prosecutor is a woman
 - (d) males are more likely to find the defendant guilty when the prosecutor is a woman
- (7) Which statement is false?
- (a) male jurors have been found to express indirect sexism towards female prosecutors
 - (b) authoritarianism refers to individuals who display rigid thinking
 - (c) authoritarians and non-authoritarians have similar schemata when arriving at decisions, despite using information differently
 - (d) the similarity-attraction rule has been found to be effective in predicting how likely a juror is to convict
- (8) The lineup procedure is subject to:
- (a) police bias, and witness bias
 - (b) situational bias,
 - (c) response bias
 - (d) all of the above
- (9) In the Shatford case, the mistake that the eye-witness made was to:
- (a) be guilty of response bias
 - (b) identify the most attractive man in the line-up as the accused
 - (c) accept a bribe from one of the police officers present
 - (d) a and b
- (10) In rape cases, male jurors are more likely than women to:
- (a) favour harsher sentences and convict
 - (b) favour harsher sentences but not convict
 - (c) favour more lenient sentences but not convict
 - (d) there are no differences between male and female jurors in rape cases

Please estimate how well you think you did on the quiz that you have just taken:
Estimated quiz score _____ %.

Please estimate how well you think you will do on the following quiz:
 Estimated quiz score _____%

QUIZ 3: SELF-MONITORING

- (1) According to research:
 - (a) high self-monitors tend to respond more consistently across different situations
 - (b) low self-monitors tend to respond more consistently across different situations
 - (c) there is no difference in consistency across situations between high and low self-monitors
 - (d) none of the above
- (2) In the article, which of the following is *not* listed as a characteristic of high self-monitors?
 - (a) sensitivity
 - (b) affection
 - (c) honesty
 - (d) openness
- (3) The higher one's self-monitoring tendency:
 - (a) the less one relies another people's opinions
 - (b) the greater one's confidence in decision making
 - (c) the lesser one's confidence in decision making
 - (d) self-monitoring has no effect on confidence in decision making
- (4) Research indicates that greater maladjustment is characteristic of _____.
 - (a) those who score very high on self-monitoring behaviour
 - (b) those who score in the middle (who are neither high or low self-monitors)
 - (c) those who score very low on self-monitoring behaviour
 - (d) a and c
- (5) Which of the following is most typical of a low self-monitor?
 - (a) an introverted romantic swinger
 - (b) an extroverted romantic swinger
 - (c) an introvert who prefers to date exclusively
 - (d) an extrovert who prefers to date exclusively
- (6) Which statement is false?
 - (a) high self-monitors have generally been found to be more confident than low self-monitors
 - (b) high self-monitors use more 'he's' and 'she's' in their speech
 - (c) low self-monitors are more likely to buy a product advertised by Cindy Crawford
 - (d) low self-monitors exhibit more intrinsic dating motivations

- (7) Subjects in Jones' study of high and low self-monitors consisted of:
- (a) undergraduate men only
 - (b) graduate men and women
 - (c) undergraduate women only
 - (d) none of the above
- (8) Which statement is true?
- (a) high self-monitors have less positive personality characteristics than lows
 - (b) low self-monitors are less committed to their romantic partners
 - (c) high self-monitors are less sensitive to the opinions of others and have more social skills than low self-monitors
 - (d) low self-monitors make dating choices based on how much they like the other person
- (9) What is a 'sociometer'?
- (a) a term that measures how adept one is socially
 - (b) an element used in the monitoring of interpersonal relationships
 - (c) a branch of sociology
 - (d) none of the above
- (10) Which of the following was *not* found to be a difference between high and low self-monitors?
- (a) how one responds to advertisements
 - (b) level of confidence
 - (c) social ability
 - (d) talkativeness

Please estimate how well you think you did on the quiz that you have just taken:
Estimated quiz score _____ %.

Appendix D

Topic One: Conflict Resolution and Game Theory

In social psychology, game theory deals with two or more interdependent parties who, according to rules, make decisions that affect each other. There are two basic types of games, zero-sum and non-zero sum (or mixed-motive) games. The theory assumes that people act rationally in order to maximize their outcomes. Their motives may be individualistic, competitive or cooperative. A collective non-zero sum game, or dilemma, occurs when rational behaviour by individuals produces an outcome that is collectively undesirable.

Threats are often used in conflict situations. For a threat to be successful it must be credible. This means that the threatener must have behaved consistently in the past, that the threatened action will have negative consequences for the threatener as well as the person threatened, and that the threat does not have too high a cost. Threats often escalate as a result of a threat-counter-threat spiral.

Studies have found that culture, personality traits, age, and gender have some effect on conflict behaviour. Communication which clarifies the intentions of either side has also been found to be effective in reducing conflict.

When bargaining is employed in conflict situations, the most effective strategy combines firm resistance to exploitation with responsiveness to cooperative overtures. One means of conciliation is based on the graduated reciprocation initiative in tension-reducing acts (GRIT). Grit is essentially a strategy whereby each side in a conflict gives up something in turn until the tension is resolved.

Research has shown that, when interacting with another person of the same sex, Canadian females were likely to be more competitive than Canadian males. There is also

some evidence that the Flemish are more competitive than Americans.

In a Maximizing Difference Game (MDG) the only reason a person makes a competitive (D) choice is to get more than the other person, since a cooperative (C) choice has a larger individual payoff. In one experiment a MDG was used to observe competitive responding by East Indian males and females and Canadian males and females. The results indicated that females in both cultures were more competitive than males and that the Indians were more competitive than the Canadians. Competition was enhanced when the participants kept track of both their own and the other person's scores. An additional finding was that Indian males and females were more exploitative than the Canadians and the females in both cultures were more exploitative than the males.

A critical factor that may account for the different competitive propensities is the use of the 'tit-for-tat' strategy. Males were more likely than females to use this strategy and Canadian males used it more than any of the other subjects.

It is of interest to note that although this study was done some time ago, it is still not clear why women respond more competitively in these types of situations and are less likely to use a 'tit-for-tat' strategy. In other situations such as interpersonal bargaining, especially when communication is possible, women tend to be more accomodating than men.

Topic Two: Social Psychology of the Law

The Police Lineup Consider the police lineup, in which the suspect stands among a group, usually of five to nine persons, and a witness attempts to identify the guilty party. The lineup procedure is subject to its own biases, including police bias, witness bias, situational bias, and response bias. For example, some studies have found that the structure of a lineup can seriously bias the outcome as was found in one study, based on an actual case (Regina vs. Shatford). In the case of Regina vs. Shatford, conviction of the defendant was a direct result of the testimony of an eyewitness. Shatford had allegedly taken part in a holdup in which the cashier would later recall only that the robbers were 'very neatly dressed, and rather good looking and they looked enough alike to be brothers.' In spite of this vague description, she was able to pick Shatford out of a 12-person lineup nine days later. What she had done was simply select the best looking person in the lineup. If the police had inserted other, more attractive men into the lineup, the probability is that one of them might have been identified instead. The critical feature of a lineup is not the absolute number but the functional number of participants from which the witness may identify the culprit. For example, if the suspect is obese, and there is only one other obese person in the lineup, the total number of people in that lineup may be nine but the functional number is only two - and there is a 50 percent probability of one being identified by chance.

Like experimental subjects, eyewitnesses generally want to be useful and may react to subtle demand characteristics. For example, they may feel compelled to identify someone, although none of the people in the lineup may be guilty. Stereotypes regarding dress, ethnicity, age, hair style, and other physical features may reflect response biases,

particularly if the stereotypes are shared by the officers conducting the inquiry. Even lighting and noise levels in the room in which identification is being conducted may influence judgments, particularly if these conditions differ from those at the scene of the crime.

The Juror Research shows that jurors who are older, less educated, and of lower socioeconomic levels are more likely to vote to convict. Male and female jurors behave in a similar fashion, except in rape trials. Under these circumstances females are more likely to convict and to favour harsh sentences. Another predictor is the extent of similarity between jurors and the defendant: for example, a French-speaking female carpenter is more likely to receive a lenient judgment from jurors who also have one or more of these characteristics, an outcome consistent with the similarity-attraction rule.

One characteristic of jurors that has been studied extensively is authoritarianism, behaviour in which individuals display rigid thinking, submissiveness to authority, and a hostile punitive orientation towards those who deviate from social norms. For example studies have found that when mock-jury subjects were contacted one week after an experiment, high authoritarians recalled more about the defendant's character but less about the evidence. Authoritarians are more apt to convict and to recommend severe sentences, particularly if the defendant is not similar to themselves. However, authoritarians are less likely to convict if the defendant is perceived as representing authority, (e.g., a police officer). Apparently, authoritarians and non-authoritarians have different schemata and use different kinds of information in arriving at their decisions.

Jurors also differ in the important characteristics of prejudice, which may extend to witnesses or even officials of the court as well as the accused. In one study, subjects

acting in the role of jurors viewed an audio-visual presentation of a trial. The prosecuting lawyer, played by a male or female, was vigorously engaged in questioning a submissive male defendant. Male, but not female, subjects rated the defendant as less likely to be guilty when the prosecutor was female. Interestingly, the male jurors also rated the female prosecutor as more effective than did female jurors. Thus, the subjects expressed their sexism in an indirect or 'symbolic' manner, not by downgrading the female prosecutor who acted against stereotypical expectations, but by voting 'not guilty.

Topic Three: Self-Monitoring

Self-monitoring refers to the tendency of individuals to regulate their behavior on the basis of external events such as the reactions of others (high self-monitoring) or on the basis of internal factors such as their own beliefs, attitudes, and interests (low self-monitoring). According to research, low self-monitors tend to respond more consistently across differing situations than do high self-monitors.

Many behaviors have been identified that are different for high versus low self-monitors. Research suggests that when high self-monitors speak, they use the third person more often (he, she, his, her, their, etc.) while low self-monitors use the first person (I, me, my, mine, etc.). Studies have also found that highs respond best to advertising that is image-based ("Heineken - you're moving up") and lows to quality-based ads ("Heineken - you can taste the difference"). Because people who are confident about their decisions tend to be liked and respected, the higher the self-monitoring tendency, the greater the confidence in one's decisions, regardless of whether a decision was right or wrong.

High self-monitors choose friends on the basis of their external qualities (for example, selecting a tennis partner on the basis of how well he or she plays), while low self-monitors make choices based on how much they like the other person. Even in romantic relationships, low self-monitors are more committed to the other individual, while high self-monitors are more attuned to the situation and to a variety of partners.

Such findings led Jones (1993) to investigate motivational differences in the dating behavior of high and low self-monitors. She administered the self-monitoring scale and a test that assesses dating motivation to undergraduate men and women. Intrinsic motives for dating are indicated by such items as "We share the same interests and concerns"

and "We have the same attitudes and values." Intrinsic motivation means that an individual enjoys being with the partner in contrast to extrinsic motivation which means that the partner is selected on the basis of expected rewards beyond the relationship. Low self-monitors tend to emphasize intrinsic dating motivation more than highs, while high self-monitors stressed extrinsic dating motives more than lows. Once again, low self-monitors appear to be oriented toward the other person, while high self-monitors are more oriented toward satisfying their own broader needs.

A very different interpretation of the interpersonal relationships of those high and low in self-monitoring has been provided by Howells (1993). He found that high self-monitors had more positive personality characteristics than lows. Students scoring high on the self-monitoring scale were more sociable, affectionate, energetic, sensitive, intellectually curious, and open than students scoring low. Some of the previous interpersonal findings could simply indicate that low self-monitors are less socially competent and less confident about taking risks in social situations. It may be argued then, that self-esteem serves as a "sociometer" that is a necessary element in the monitoring of interpersonal relationships.

In thinking about the differences that have been found between high and low self-monitors, you may have concluded that lows are better adjusted than highs. That is, lows are consistent, honest in expressing their actual beliefs, and more committed to their romantic partners, while highs are inconsistent, eager to please others, and happy with multiple relationships. Yet the same findings, of course, could be described as showing that lows are self-centered, closed-minded, insensitive to the opinions of others, and lacking social skills, while highs are sensitive to the feelings of others, open-minded and so-

cially skillful. Research indicates, in fact, that greater maladjustment (neuroticism) is more characteristic of individuals falling at both extremes of the dimension than of those who score in the middle.

Appendix E

Debriefing

Thank you again for your participation. There was no deception used in this study. The purpose of this study was to examine the effects of narration and user choice on performance in computer-assisted instruction. Before you were given the lessons and the corresponding quizzes to test your retention of the material, you were given a background questionnaire which was designed to assess if you are an auditory or visual perceiver. It is expected that auditory perceivers will have a higher preference for and greater performance in lessons in which an auditory component is added. It is further expected that similar individual differences will also exist between males and females, as well as between introverts and extroverts. If you would like to know the results of the study I can forward them to you at any time.

If you have any further questions please do not hesitate to contact me at 520-2600 (ext. 8204) or (faculty sponsor) at 520-2600 (ext.2643).

Thank you again!

Appendix F

As previously discussed, the results of the analyses of variance were not as generally expected for a number of reasons. As a result, it was believed that a different analytical approach might provide more insight into the data. To this end, multiple regression seemed well-suited.

Initially, it was thought that analysis of variance would be the ideal method of analysing the data in this study. This was not the case. Instead, upon closer reflection, multiple regression, appeared to offer a number of advantages over this method of data analysis. One limitation of ANOVA, for example, was that it does not enable extrapolation of the nature of the relationship between the independent and dependent variables of concern. In contrast, the regression approach is designed to determine the nature this of the relationship, provided that significant results are obtained.

Two additional reasons favouring the employment of regression concerned the characteristics of the design employed in the present study. The use of an unbalanced design, for example, combined with a sample size and the number of empty cells may have weakened the capacity of the analysis of variance to detect significant differences. The application of ANOVA to a factorial design lacking in equality or proportionality of cases among cells can be misleading. This is because the tidy separation of variability due to different types of effects, possible for balanced factorial designs is not guaranteed when the data are unbalanced. In a design with two factors, for example, the sum of squares for the first factor may also contain information about the second factor and the interaction; the sum of squares for the second factor may contain information about the first factor and the interaction; and the sum of squares for the interaction may be contaminated to some extent by main effects of the first and second factors. In this way, the

possible correlation among the independent variables in such designs makes it very difficult to untangle and study the separate effects of each variable.

The number of empty cells within this design was also problematic. Considering that ANOVA is an analytical procedure founded on mean variability, the findings obtained from this method may be questioned (since certain cells had no data, the means could not be obtained for these cells). Again regression appears to be an attractive alternative.

A second, related reason, favouring the employment of a regression approach to data analysis in the present design is the complex nature of this study. As this study employed a large number of independent variables, the possibility existed that the independent variables may have been correlated and this correlation may have confounded the results of this study. It would appear that multiple regression analysis is better suited to explore the possible effects of this problem as it deals with both the separate and collective effects of two or more independent variables on a dependent variable.

This is because, in contrast to ANOVA, regression analysis offers the advantage of enabling a more detailed exploration of the variance in the dependent variable due to the effects of the independent variables. More specifically, multiple regression enables variance partitioning, so that it is possible to study the distinct effects of each independent variable as well as their joint effects on the dependent variable. As such a large number of nonsignificant findings were obtained in the present study, this greater control over partitioning the effects of shared variance was even more important, since greater statistical control over extraneous variables could change decisions to support or fail to support the propositions of this study.

As a result, a regression approach was conducted to analyse the data. The sequential method, using SPSS default levels of inclusion was chosen as this method enabled a less biased study of the effects of each independent variable of concern by partialing out the effects of the other (excluded) independent variables. In this way, the forward model served as a test of the validity of the ANOVAs as it tested for the significance of each individual independent variable while excluding the combined effects of the extraneous independent variables.

These regression analyses consisted of a total of twelve tests. Three tests were conducted for each of the four dependent variables (actual and expected performance, duration and time in narration). In these tests, an independent variable (e.g. gender) was held constant while the remaining independent variables were entered together (as in the full model) and consisted of the excluded variables (e.g. all remaining independent variables in the equation).

Again, the results were essentially the same as the results of the analyses of variance, a general trend towards failing to reject the null (see tables 25-28, same Appendix). The one exception among these twelve analyses was personality and duration in narration, which was significant (see table 27, same Appendix), consistent with the corresponding ANOVA. One interesting finding of the sequential method analysis was that with one exception, the proportion of explained variance for each of the independent variables was not significant, even when the effects of the other independent variables were partialled out. There may be a number of reasons for this, one of which is that the independent variables may have been highly correlated with one another; a possibility that would not have been detected by analyses of variance.

In conclusion, the consequence of subjecting the data from two different perspectives was that each approach supported the same results: essentially nonsignificant findings. With the exception of one test (personality and duration in text-voice, excluding the effects of gender and perception style) the regression analyses failed to reject all propositions pertaining to individual differences in this study. Considering that the reasonable probability of the sole significant finding may have occurred through random chance, these analyses do not suggest that individual differences have a significant effect on performance in bi-modal learning conditions.

Table 25

Sequential Regression Analysis of Personality, Perception Style and Gender on Performance in Text-Voice.

<u>Variable</u>	<u>Unique R²</u>	<u>df</u>	<u>F</u>
Personality	.027	1	1.30
Perception Style	.000	1	0.01
Gender	.016	1	0.77
Residual	.957	44	
<u>Note:</u> * $p < 0.05$			

Table 26

Sequential Regression Analysis of Personality, Perception Style and Gender on Expected
Performance in Text-Voice.

<u>Variable</u>	<u>Unique R²</u>	<u>df</u>	<u>F</u>
Personality	.015	1	0.70
Perception Style	.031	1	1.48
Gender	.073	1	3.62
Residual	.088	44	
<u>Note:</u> * $p < 0.05$			

Table 27

Sequential Regression Analysis of Personality, Perception Style and Gender on Duration
of Time Spent in TeXt-Voice.

<u>Variable</u>	<u>Unique R²</u>	<u>df</u>	<u>F</u>
Personality	.098	1	4.98*
Perception Style	.013	1	0.60
Gender	.059	1	2.86
Residual	.830	44	

Note: * $p < 0.05$

Table 28

Sequential Regression Analysis of Personality, Perception Style and Gender on Frequency of Time Spent in TeXt-Voice.

<u>Variable</u>	<u>Unique R²</u>	<u>df</u>	<u>F</u>
Personality	.061	1	3.00
Perception Style	.000	1	0.02
Gender	.051	1	2.45
Residual	.888	44	

Note: * $p < 0.05$