National Library of Canada

Acquisitions and Bibliographic Services Branch

395 Wellington Street
Ottawa, Ontario
K1A 0N4

Bibliothèque nationale du Canada

Direction des acquisitions et des services bibliographiques

395, rue Wellington
Ottawa (Ontario)
K1A 0N4

Your file Votre référence

Our file Notre référence

NOTICE

The quality of this microform is heavily dependent upon the quality of the original thesis submitted for microfilming. Every effort has been made to ensure the highest quality of reproduction possible.

If pages are missing, contact the university which granted the degree.

Some pages may have indistinct print especially if the original pages were typed with a poor typewriter ribbon or if the university sent us an inferior photocopy.

AVIS

La qualité de cette microforme dépend grandement de la qualité de la thèse soumise au microfilmage. Nous avons tout fait pour assurer une qualité supérieure de reproduction.

S'il manque des pages, veuillez communiquer avec l'université qui a conféré le grade.

La qualité d'impression de certaines pages peut laisser à désirer, surtout si les pages originales ont été dactylographiées à l'aide d'un ruban usé ou si l'université nous a fait parvenir une photocopie de qualité inférieure.

Canada

UNIVERSITY OF ALBERTA

INFORMATION SEARCH BEHAVIOUR OF EXPERIENCED AND NOVICE AUDITORS WHEN A DIRECTED SEARCH STRATEGY IS REQUIRED

BY

JANET BEVERLEY ASHFORD MORRILL 

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

in

ACCOUNTING

FACULTY OF BUSINESS

EDMONTON, ALBERTA

FALL, 1994

ISBN 0-315-95222-9

Canada

UNIVERSITY OF ALBERTA

RELEASE FORM

NAME OF AUTHOR: Janet B. A. Morrill

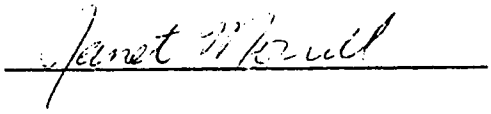
TITLE OF THESIS: Information Search Behaviour of Experienced and Novice Auditors When a Directed Search Strategy Is Required

DEGREE: Doctor of Philosophy

YEAR THIS DEGREE GRANTED: 1994

Permission is hereby granted to THE UNIVERSITY OF ALBERTA LIBRARY to reproduce single copies of this thesis and to lend or sell such copies for private, scholarly or scientific research purposes only.

The author reserves all other publication and other rights in association with the copyright in this thesis, and except as hereinbefore provided neither the thesis nor any substantial portion thereof may be printed or otherwise reproduced in any material form whatever without the author's prior written permission.



Janet B. A. Morrill
1012, rue Robert-L.-Séguin
Sainte-Foy, Quebec
G1X 4K5

Date: May 9, 1994

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studi and Research for acceptance, a thesis entitled INFORMATION SEARCH BEHAVIOUR O EXPERIENCED AND NOVICE AUDITORS WHEN A DIRECTED SEARCH STRATEGY I REQUIRED submitted by JANET B. A. MORRILL in partial fulfillment of the requirements f the degree of DOCTOR OF PHILOSOPHY in Accounting.

Michael Gibbins

Don Heth

Jim Newton

Steve Salterio

February 4, 1994

Urton Anderson

ABSTRACT

The information search behaviour of experienced and novice auditors has traditionally been studied by providing participants with an information menu from which they selected their information requirements. By doing so, the cognitive demands of the information search task were different from tasks where auditors must generate hypotheses and determine their own information search requirements without the aid of an external list containing all the information germane to the case.

This research examined this contention by manipulating the information search regime. The task information was identical under the two regimes, but under the traditional regime auditors chose items from a menu of all the information available; under the active search regime auditors had to determine what information was required and pose questions to a computer. The results indicated that indeed the performance of the two groups did differ: auditors under the active search regime conducted less information search, accessed fewer categories of information and were more likely to generate hypotheses without conducting any corresponding information search. Participants under the traditional search regime were more likely to conduct search without an underlying hypothesis, supporting the notion that information search tasks under such a regime indeed require less cognitive involvement. These results were generally more pronounced for unstructured tasks.

It was also expected that experienced auditors would demonstrate superior performance compared to the novices by virtue of their more elaborate memory network and detailed problem schema. Furthermore, it was hypothesized that there would be an interaction between the information search regime and experience: if the active search regime was more cognitively demanding, experienced subjects would outperform novices to a greater extent as they would be more capable of meeting these demands. Differences between the two groups would be less apparent under the traditional search regime as participants could passively scan through the information. There was some evidence to indicate that the differences in the amount of information search were more pronounced. There were also more pronounced differences in efficiency of search between experienced and novice auditors under the active search regime versus the traditional one.

The results of this study were also run using various measures of expertise. Many of the findings were similar, and it appeared that general problem solving ability as measured by participants' scores on four General Management Admissions Test questions was related to efficient information search.

Overall the results indicate that the ability to conduct information search is a component of the professional judgment possessed by experienced auditors, and that the way in which information is presented and retrieved affects the cognitive processes required to perform information search tasks.

ACKNOWLEDGEMENTS

This thesis has attained its present form thanks to the contribution of many people, and I am pleased to acknowledge them here. I would like first of all to thank my supervisor, Mike Gibbins, for his insight, effort, time and patience. I would also like to thank the members of my thesis and examining committees: Don Heth, Jim Newton, Urton Anderson, Steve Salterio, Rick Johnson and Karim Jamal. In addition to giving helpful and insightful comments, they helped to make this whole process both enriching and enjoyable.

I am endebted to Ernst Young Chartered Accountants for their generosity throughout this process. In addition to providing participants and facilities for the experiment, their personnel provided insights regarding the experimental tasks as well as the contributions of thesis. The Apple Research Partnership Program provided substantial technical support towards the development of the programs used in the experiment. I am also grateful for financial support provided by Université Laval, University of Alberta, the Social Sciences and Humanities Research Council of Canada, The Outreach Fellowship for Women, and the Institute of Chartered Accountants of Alberta.

I would also like to take this opportunity to let my family and friends know how very much I have appreciated their love and support, especially over the last few years. In this, I would like to accord special recognition to my parents, Ian and Ruth Ashford; my parents-in-law, Alfred and Carole Morrill; and my friends Danielle and Bill Howe.

However, the most important acknowledgement must go to my husband, Cam, without whom I could never have finished this thesis. He has unfailingly supported me in many ways, both helping with the thesis and at home with our two children. He has

been a source of encouragement, reassurance and motivation and I am continually thankful that he is a part of my life.

Finally, I acknowledge the contribution of my daughters Susanne and Gabrielle who have proved to be the most delightful distractions any researcher could ever wish for.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1. Introduction

I. INTRODUCTION

The purpose of this research is to examine the information search behaviour of expert and novice auditors in an experimental setting under two different information search regimes. The principal difference between the two regimes is the way in which participants request information. Under the traditional regime, as with most information search studies (eg. Abdel-Khalik and El-Sheshai, 1980; Bédard and Mock, 1992; Kaplan and Reckers, 1989; Knechel and Messier Jr. 1990; Simnett and Trotman, 1989), participants are presented with a menu of all the information available, from which they make their information selections. In contrast, the active regime does not provide participants with the information menu. Instead, they must determine their own information requirements and enter information requests into the computer. The computer program contains a natural language processor which interprets the requests and provides the subjects with the appropriate information. This second regime is designed to provide a more realistic task environment since in many real life situations problem solvers are rarely explicitly told what information might be relevant to a problem solution (Bowden, 1985).

It is proposed that the cognitive processes utilized by the participants are different under the two regimes. The second regime forces the participants to engage in a more active information search process, which in turn encourages them to draw on their pre-existing knowledge to guide that search. This study may therefore be more effective than previous studies in uncovering differences between experienced and inexperienced

auditors as their knowledge structure is a more influential determinant of their behaviour.

Also, participants in this study performed multiple tasks which varied in their degree of structure and complexity. The level of task complexity may have a significant impact on the results found (Abdelmohammadi and Wright, 1987; Adelson, 1984; Bonner, 1990). Furthermore, there is increased interest in auditing research in employing scenarios that are both more complex and closer to actual auditing contexts (Tubbs, Messier Jr., and Knechel, 1990; Bedard and Biggs, 1990, Gibbins and Jamal, 1993).

This chapter proceeds as follows. The next section discusses the motivation for this research and its contribution. The third section contains the literature review. The literature review will examine the findings regarding how the memory structure of experts and novices differ, and then will consider the implications of that expertise under the two different information search regimes. The last section discusses the experimental design, and includes details regarding the tasks used and the administration of the experiment.

II. MOTIVATION FOR STUDY

One of the principal objectives of auditor research is to eventually improve the efficiency and effectiveness of the auditing profession. An understanding of auditors' decision processes can improve audit efficiency by permitting a comparison of different processes, and ultimately allowing the firms to develop training methods and decision aids to encourage processes that are considered desirable. Insight into decision processes can also improve audit effectiveness by highlighting common weaknesses or judgment fallacies, and by providing an expert "benchmark" against which actual judgments can be compared. In order to attain these goals, it is important to understand the differences,

if any, that exist between the decision processes of expert auditors and novices: such knowledge would be required, for example, to establish what sorts of tasks can be appropriately assigned to junior auditors, where errors in judgment are likely to arise, and how decision aids can be used to reduce the occurrence of such errors.

This research is designed to contribute to our understanding of auditor judgment in three ways. The first goal of the study is to investigate the role of experience in the information acquisition phase of the judgment process. The information acquisition phase of the judgment process has received relatively little attention in the past (Bédard and Mock, 1992) although there are ample reasons to devote research efforts to this area. Generally Accepted Auditing Standards require that auditors must document the audit evidence obtained to support the content of his report (CICA Handbook, Section 5145). This would imply that significant audit decisions must be supported by information gathered and that the decisions must be congruent with that information. Indeed, Anderson (1984, page 100) noted that information search and collection are among the most time consuming areas of the audit process. This contention has been supported by studies such as Biggs and Mock (1983) which found that information acquisition accounted for between 31% and 49% of the total operators generated in subjects' protocols. Moreover, research has indicated that the selections made at the information acquisition stage can be critical to the final judgment. Abdel-Khalik and El-Sheshai (1980) and Simnett and Trotman (1989) compared the performance of auditors to computerized models in predicting firm failure. Both studies divided the auditors into various groups which differed by whether the information was selected by human

participants or computerized models, and by whether the information was evaluated by human participants or computerized models. By comparing the success rates of the various groups in predicting the likelihood of bankruptcy, they were able to determine whether humans performed better than the models or vice versa, and whether the source the performance differences occurred in the information selection or evaluation stages. They found that the participant's choice of information, rather than their processing of the chosen cues, was the limiting factor in their eventual conclusion. Similarly, Biggs and Mock (1983) concluded that incomplete search and premature closure on alternatives limited the quality of auditor decision processes. Thus, information search is critical to the effective and efficient course of an audit (Heiman, 1990) and any improvements in this phase could potentially yield large benefits to the profession. Finally, it has been suggested that incorporating information search into experiments is more realistic (Einhorn, 1976) and could increase task involvement (Abdel-Khalik and El-Sheshai, 1980).

The second goal of this research is to study the impact of the two different information search regimes. Although information search has received some attention in auditor judgment research, it has been studied more extensively in fields such as consumer research, medical diagnosis, and judicial decision making. The traditional information search regime has been the dominant paradigm among these information search studies, usually using information display boards (IDB's). With an IDB, subjects are given a "menu" of information cues. When they select a particular cue, they are then presented with the detailed information pertaining to that cue. Their information search

behaviour is examined by monitoring the cues selected. Computers have been used to refine this methodology by having the menu of cues presented on the screen and subjects enter their selections on the keyboard. The methodology is essentially the same, except the computer rather than the researcher monitors the information selections and the computer can track the time elapsed at different phases of the experiment. Frequently, the focus of these studies is to determine under what conditions the subjects neglect some of the information available since he or she can choose to view the entire information set if he or she chooses by requesting to see each information item on the menu.

The IDB methodology and its computer variations place some constraints on the type of problems used and the insights gained. IDB's in particular are often used in problems where the information can be easily organized into a matrix format. For instance, in consumer research the problem often involves a brand by attribute matrix where the subject must choose among the different alternatives (Brucks, 1985). More generally, however, this methodology is most easily applied to problems where the relevant information can be clearly and concisely divided under easily labelled and well-understood cues that can then be displayed in a menu format.

Protocol studies have also been used to study information search behaviour (eg. Anderson, 1988; Biggs and Mock, 1983; Bouwman et al 1987). In these studies, the researcher assumes that information is acquired if it is mentioned in a subject's protocols[1].

---

[1]The use of protocol methods and IDB's are not mutually exclusive as it is possible for the researcher to collect subject's protocols while they are completing an IDB task. An example of such an approach is Biggs, Rosman and Sergenian

Using a protocol study in general permits the use of more complex tasks than those imposed by the use of IDB's and allows a very rich, detailed analysis (Klersey and Mock, 1989); however, protocol studies generally have very small sample sizes and are thus arguably more useful for generating theory than testing hypotheses (Payne, Braunstein and Carroll, 1978). In addition, Biggs, Rosman and Sergenian (forthcoming) found using a computer-based methodology provided a more accurate trace of information search behaviour than protocols alone. However, the greatest limitation is that these traditional regime studies, whether they use IDB's or protocols, readily provide all the information to the subject, or at least a description of all the information available. The subjects do not have to determine beforehand what information they need: their information acquisition decisions are based on the list presented to them.

The information search regime is important as it significantly affects the task demands faced by the subject. For example, when a person looks for an apartment as in Payne (1976) he or she may decide that the rent and the number of bedrooms are the criteria to use in his or her selection. However, if presented with an exhaustive list of the criteria that could be applied to apartment hunting (noise level, access to bus routes, elevator vs. walkup, cleanliness, free cable, balcony, air conditioning etc.) the subject may decide that several additional cues are also important to the decision and will gather information on those cues. The act of presenting the cues therefore may affect the outcome of the task because the information search may be more extensive, particularly if the subject is inexperienced to the task.

(forthcoming).

Another difficulty with the traditional search regime is that it is not well suited to some problems, because allowing a subject to see all the relevant information may unduly point subjects towards a particular conclusion. For example, consider a medical diagnosis problem where the patient has a rare condition that requires some sort of unusual diagnostic test. According to the standard IDB technology, for instance, subjects would see from the menu of diagnostic information available that they could ask for the results from that particular test. Because the subject sees that that test is potentially relevant and assuming he or she knows what illness it detects, the subject will consider the rare condition as a possible solution when it otherwise may not have occurred to him or her.

The second contribution of this study is thus to examine the effect of a different information search regime, where participants generate their own information requests rather than being presented with all the information up front, or choosing items from an exhaustive menu. The details of the computer program used for the experiment are included in Appendix A.

There are several advantages to this methodology. As mentioned previously, there is increased interest in examining behaviour in realistic audit environments (Biggs, Mock and Watkins, 1989). Studying information search in this manner may preserve an important facet of the real world task environment. In many, if not most, real life information search tasks auditors must determine on their own what information they require as there is no external source of guidance, such as a menu of cues. Indeed, Robinson and Fertuck (1985) noted that a major criticism of most clinical studies is that the information is neatly summarized whereas information is rarely received in such

simplified form in real life. Also, when subjects are given a limited number of factors to consider artificial model-fitting may result because subjects will tend to use all the information provided to them. Similarly, Bédard and Chi (forthcoming) have suggested that future research studies should try to present the information in such a way that they auditor is forced to make "order out of chaos".

At this point, it should be noted that a few information search studies have used an information search methodology similar to the active information search regime proposed here. Brucks (1985) did a study of consumers' information search behaviour in the decision to select a sewing machine. In her study, subjects entered their information requests into a computer which was relayed to the researcher's computer in another room. The researcher then interpreted the request and relayed the appropriate information back to the subject. This avoided the menu of cues problem, although the interface proposed here is different as the computer program interprets the question rather than the researcher doing so. This allows many subjects to perform the experiment simultaneously, thus decreasing practical constraints on the number of subjects. More importantly, it also reduces the possibility of experimenter bias that could occur if the requests of different experimental groups are systematically interpreted differently. Using a computer program also reduces the delays imposed on the subjects between entering the question and receiving the answer. Hershey et al (1990) also conducted an information search study with financial planners where subjects told the experimenter what information they would require and were then given cards containing the appropriate information. This approach was also vulnerable to the problem of researcher bias in the

interpretation of subjects' questions[2] as well as a limited number of subjects.

Although these two studies did use a active information search regime, the goals of this study are different. First, this study examines auditors rather than consumers or financial planners. Thus the participants as well as the nature of the tasks are very different. Secondly, the other studies did not consider the impact of the information search regime or the underlying reasons for its effects.

The final contribution of this research is to use an unstructured task, which is characterized as a unique and undefined problem with little or no external guidance available. According to Gorry and Scott-Morton (1971) and Keen and Scott-Morton (1978) the degree of judgment required in a task increases as the task becomes less structured. Expertise thus becomes more important and novices may be less equipped to rise to the demands of the task (Abdolmohammadi and Wright, 1987; Bédard, 1989). The nature of this expertise and how it affects information search will be discussed in detail in the next section.

The active interface discussed here is particularly well suited for examining unstructured tasks because the degree of structure inherent in the experimental task is compromised less by the methodology used to study information search. The use of an IDB imposes some structure on the information search task because it provides external guidelines to the subject regarding what information is potentially relevant. Also, having

---

[2]The problem of research bias could be reduced or eliminated by having the experiments administered by assistants who were blind to the research hypotheses or by having assistants monitor each other. It appears that these measures were not taken in either study.

an orderly list of cues may help the subjects develop an orderly approach to the problem which would lessen the necessity of having an internal problem solving schema to draw upon. Compared to a traditional information search regime, participants under the active regime are not given a list of cues so the task does not become more structured simply as a by-product of the experimental interface.

If the experimental task is both more realistic and more difficult than experimental tasks used in the past, due both to the nature of the task itself as well as the challenges imposed by the experimental interface, it could be more successful in uncovering differences between the performance of experts and novices. As discussed, one goal of auditor expertise research is to discover how to impart the experts' problem solving ability to the novices. It is particularly important that auditors possess such expertise when they encounter unstructured tasks. It may be impossible or inefficient to construct decision aids such as audit firm questionnaires for these tasks (McDaniel, 1990) since they are unique or undefined problems by definition, and there may be little external guidance available. Thus, problem solving expertise becomes more critical. Furthermore, these types of tasks may be encountered more frequently by the auditing profession as the business environment becomes more complex. For example, as industries become more specialized, assets become more technologically complicated, and financing instruments become more exotic, it becomes increasingly likely that standardized decision aids would not be applicable to many situations encountered by auditors.

Despite the importance of understanding the differences between expert and novice auditors, there have been few consistent findings regarding the superiority of experts over

novices (for reviews, see R. Ashton, 1983, Bédard, 1989, Bédard and Chi forthcoming, Bonner, 1990 and Joyce and Libby, 1982). One possible reason for this may have been that the tasks were easy enough that novices could perform as well as the experts. Shanteau (1984) suggests that, once given the relevant cues, inexperienced subjects may be able to act like experienced subjects. Indeed, Adelson (1984) noted that if a task is phrased in a certain way novices can actually outperform experts. Frederick and Libby (1986), Abdolmohammadi and Wright (1987) and Bonner (1990) have noted that the differential between novice and expert auditor performance can be affected by the nature of the task used.

The realism of the active interface could also increase the likelihood of uncovering differences between experienced auditors and novices since experienced auditors have had greater exposure to real-life auditing tasks. If providing all the information either up front or via a menu reduces the task to a "textbook" case, there may be few differences between the groups as their formal classroom training is similar. In fact, novices may have a significant advantage in this type of setting as their training is more recent. Thus, the further removed the experimental situation is from "real life" the more the experienced subjects and novices are on a level playing field. Hogarth (1991) noted that in (traditional) laboratory experiments:

> subjects are presented with relatively isolated experimental stimuli and are asked to make judgments concerning hypothetical clients. However, in the context-rich domain of real world audit experience it is feasible that auditors may be alerted to examining particular variables by picking up cues that would be hard to replicate in an experimental setting. For example, one domain of auditor expertise that would be difficult to study in laboratory settings is the ability to detect rare "broken leg" cues that alert auditors to potential problems.

Hogarth then suggests the development of a computerized audit game not unlike the experiment being done here.

Finally, the active interface could reveal experience effects as the increased cognitive demands imposed on the participants by a directed search process may essentially force experts to "reveal their hand". Figure 1-1 contains a model of the information search process. The subject begins by reading the problem statement and deciding whether he or she is ready to arrive at a conclusion. If not, the subject then acquires more information. Under the traditional methodology the subject can either select and read the next information item (a passive search strategy) or the subject can engage in a more active search process. The decision diamond at this stage is blank, to indicate that many factors could influence the subject's decision to either deviate from or maintain a passive search strategy. These factors could include the subject's ability, interest, or motivation. For instance, Bédard and Mock (1992) found that only 17 percent of their experts and 4 percent of their novices deviated significantly from a sequential search at the detailed level, consistent with subjects minimizing their cognitive effort for any of the aforementioned reasons. If a subject chooses to engage in a more active search process this involves using the knowledge contained in long term memory to determine what information is required and where to obtain that information. This active, directed search strategy will be apparent to an observer as long as the information chosen by the subject is in a different order than its sequential presentation in the experiment. The two possible information search paths correspond to a distinction between bottom up and top down processing. The left path, corresponding to a passive search, is characterized by bottom

up or stimulus driven processing in that the information is received by the subject in the same sequence that it is presented. The right path, corresponding to an active, directed search, is characterized by top-down processing in that the subject's long term memory is used to determine what information is required (Eisenstadt and Kareev, 1975). These top down processing mechanisms will be discussed further on in this chapter. The point to be made here is that under the active regime the subject cannot follow a passive search strategy since no information is presented unless the subject requests it. The research is less vulnerable the problem of subjects choosing against an active strategy due to a lack of interest or motivation, as they have no option. They have to utilize top down processing to guide their information search, thus better revealing their cognitive capabilities in this area and highlighting differences, if they exist, between experts and novices.

III. LITERATURE REVIEW

A. Introduction

The key focus of this and other information search studies is to understand what factors affect both the extent and the nature of information search. Memory structure is considered to play a pivotal role in this process. The literature suggests that experts conduct information search differently from novices because their memory structures are different. The first section of the literature review discusses the nature of memory structure, how that structure may differ between experts and novices and implications for information search in general. The results of the testing of the hypotheses developed in this section will be presented in Chapter 2. The second section of the literature review

will discuss the effects of expertise under the two different information search regimes. The results of the testing of the hypotheses developed in this section will be presented in Chapter 3. Table 1-1 summarizes the variable(s) investigated under the hypotheses.

Before embarking on the literature review, two general caveats must be mentioned. First, up to this point the terms "expertise" [3]and "experience" have been used interchangeably, and this chapter will quote studies that used experience measures as well as studies on expertise. This has been a source of confusion in the expertise literature, particularly in auditing: very often experience is used as a proxy for expertise, so studies have made conclusions regarding expertise based on research which actually classified subjects according to experience[4]. This is probably due to the practical difficulty involved in identifying beforehand what would constitute an expert for a given experimental task and finding an adequate sample of such experts[5]. Nevertheless, there is a growing body of evidence that indicates that the concepts of expertise and experience are indeed different so experience alone as a proxy may be problematic. (Bedard and Biggs, 1991; Bédard, 1989; Bédard and Chi, forthcoming; Bonner and Lewis, 1990; Bonner and

---

[3]Although there are many definitions of expertise, this paper will use the definition advanced by Frensch and Sternberg (1989). They define expertise as "ability, acquired by practice, to perform qualitatively well in a particular task domain".

[4]Most studies actually classify subjects according to their position in the firm on the grounds that this "approximates the expertise the firm ascribed to each individual" (Moeckel, 1990).

[5]In a limited number of tasks, experts can be readily identified. For instance, studies of computer controls can use computer audit specialists (eg. Bédard and Mock, 1992; Biggs, Messier and Hansen, 1987; Weber, 1980) or studies with tasks requiring specific industry knowledge can use auditors who specialize in those industries (eg. Johnson, Jamal and Berryman, 1991).

Pennington, 1991).

Still, in the auditing domain both research on the effects of experience and expertise have interesting implications. It is valuable to understand the effects of experience because experience is generally the basis for task assignment in auditing firms (Libby and Frederick, 1990). It is likewise important to understand the effects of expertise as it is the cornerstone of the auditing profession (Bédard, 1989). As mentioned, an important goal of audit judgment research is to determine how expertise affects performance and how it can be imparted to novices.

This study follows the approach used by Bedard and Biggs (1991) and Choo (1991). These studies initially classified subjects based on years of experience and firm position, but also collected data regarding subjects' expertise in the specific task areas. These studies analyzed that information to determine if the additional measures provided increased explanatory power. As with those studies, the initial supposition here is that experience is indeed a proxy for expertise, and expertise literature is used to support the hypothesized differences between experienced and novice auditors. However, all hypotheses are also analyzed using various measures of expertise suggested by previous literature. The specific measures employed are discussed in Chapter 2.

A second caveat to note is that the literature review in some areas borrows from expertise research conducted in fields outside of auditing. It is efficient to take advantage of significant research endeavors undertaken in other domains, but care must be taken when applying them to auditing (Biggs, Mock and Watkins, 1989). There are several reasons why findings from other areas may not apply to auditors. First, the stimuli may

be different, which could result in different sorts of cognitive processes being invoked (Ericcson and Simon, 1980). For instance, chess players usually deal with visual images of chess patterns (Larkin et al, 1980) whereas auditors often deal with descriptions of events that can be encoded by propositions[6]. Second, some conjectures (which may not be correct) must be made in order to apply findings to auditing knowledge . For instance, researchers in other areas make distinctions between abstract and superficial problem characteristics, and it is unclear what the analogy in auditing would be. Thirdly, expert auditors may be fundamentally different from experts in other areas. There is a possibility of a self-selection bias: people who choose to become auditors may do so because they differ in their abilities or manner of processing information from people who choose other professions. Auditors also function in a different environment than other professionals and thus may subject to different influences (Gibbins and Jamal, 1993). Similarly, the need to justify his or her decisions is an integral part of an auditor's judgment process (Gibbins, 1984) while it may play a less important role for other professionals. Finally, it has been suggested that expertise in auditing may develop in a different fashion (or not at all) because the learning environment may be impoverished in terms of its feedback (Waller and Felix, 1984a) and compared to other disciplines, auditors have a great depth of exposure but to very few clients (A. Ashton, 1991). However, despite these differences, many of the expertise findings from other domains have indeed been found to hold in auditing (Bédard and Chi, forthcoming).

---

[6]Propositions can be defined as the smallest unit of knowledge that can possess a truth value (Anderson, 1980) and are often depicted as short sentences (Best, 1986).

B. Memory Structures, Expertise and Information Search

The building blocks for our current understanding of memory structures originate from theories of semantic memory networks. The idea of such a network was first advanced by Quillian (1968). According to his theory, concepts are nodes in the network that are linked together to reflect associations between those concepts. As a particular concept node is searched it becomes activated, that is, the knowledge contained in that node is brought into a state of heightened accessibility. That activation spreads outward along the associative links to other related nodes, also heightening their accessibility. This is referred to as the spreading activation effect. The strength of the activation of a related node is influenced by the strength of the association between it and the source node (Collins and Loftus, 1975).

The existence of semantic priming has been well-documented (Best, 1986) and can be explained by the network model of memory and the spreading activation effect. An experiment conducted by Meyer and Schvaneveldt (1971) illustrates this phenomena. Subjects were given pairs of elements and had to state whether the elements were words or not. If both elements were words, subjects' reaction times were faster if the second word was semantically related to the first word. This supports the spreading activation effect because when the subject reads and thus activates the memory node representing the first word that activation spreads to semantically related nodes. Thus, when one of those related words is the second element of the pair the subject can decide more quickly if the element is a word as there is less effort and time involved to boost the activation of the second word sufficiently to perform the experimental judgment.

The original studies of the spreading activation model generally looked at very basic knowledge. For example, the word pairs used to document the semantic priming effect in the Meyer and Schvaneveldt (1971) expressed very commonly known relationships such as nurse-doctor, bread-butter, and apple-banana. Researchers have applied the notion of a semantic memory network to more specialized fields of knowledge, such as physics, computing science and medical diagnosis. The challenge for researchers studying expertise has been to discover the nature of the associations between concepts in these areas.

Schemas have been used to conceptualize the structure of this knowledge. Although there are many definitions of schema (Choo, 1989), one possible definition by Taylor and Crocker (1981) says that a schema contains general knowledge about a defined domain, including a specification of the relationships among its attributes, as well as specific examples or instances of the stimulus domain. In this manner, the schema conceptualization of knowledge is akin to the associative networks of memory; they both envision memory or knowledge as a series of concepts that are linked together according to shared relationships, and the activation of one concept will lead to increased activation of others related to it. Gibbins (1984) and Waller and Felix (1984c) have suggested that such schemas or "templates" are developed and used by auditors.

Expertise research has found at least three differences in the expert's and novice's structure of domain specific knowledge. First, the expert's memory structure contains more concepts because the expert has a greater amount of domain specific knowledge (Bettman and Park, 1980; Johnson and Russo, 1984; Punj and Staelin, 1983). Within the

domain of auditing, Waller and Felix (1984c) propose that the expert's schema contains information about the kinds of values that can be assigned to particular phenomena, the relations that must hold between these values, and default values, allowing them to make inferences beyond the information presented in a given situation. Empirical results have confirmed, for example, that experienced auditors have more extensive knowledge of potential financial statement errors and error occurrence rates (Libby and Frederick, 1990). Tubbs (1992) similarly found that experienced auditors could generate more potential errors in the sales/receivable/receipts transaction cycle in a free recall task than inexperienced auditors.

A second difference between experts and novices is that the concept nodes in their memory are linked together in a more complete and complex fashion as the expert has a greater understanding of the relationship between and patterns among concepts (Chase and Simon, 1973; Voss, Vesonder and Spilich, 1981; Johnson and Russo, 1984). One implication of this second difference was demonstrated in an experiment by Fiske, Kinder and Larter (1983). Humans have limited capacity in their working memory. Although the capacity in long term memory is virtually unlimited, humans only seem to be able to hold about seven "chunks" of information in working memory at a time. This poses constraints on the amount of information that can be processed and manipulated by subjects. Fiske, Kinder and Larter hypothesized that if experts' knowledge is linked together more tightly, their knowledge chunks are larger and thus hold more information. Essentially then, experts can handle more information because the "chunks" that they can handle and manipulate in working memory contain more concepts. To test this, they provided

subjects with political information about a hypothetical country that held various inconsistencies with the introductory information provided. If experts had more effective processing capacity, they would be more likely to process the inconsistencies and thus revise their conclusions away from the expectations created by the introductory information. This effect was found.

The content and composition of the experts' memory network carry several implications for information search. There are two predominant relationships between expertise and information search, referred to as the enrichment hypothesis and the inverted "u" hypothesis (Johnson and Russo, 1984). According to the enrichment pattern there is progressively more information search as expertise increases. Because the expert's knowledge is more tightly woven into chunks, he or she may have more processing capacity to handle more information. As Fiske, Kinder and Larter (1983) found, the memory network of the experts has more links due to their extensive knowledge of plausible relationships and categorical organization, allowing them to encode more information more efficiently (Johnson and Russo, 1984). Experts may be more likely to search for new information as they have a greater payoff in that they can understand and evaluate the implications of new information with comparatively less effort (Alba and Hutchinson, 1987). Similarly, following the results of Miyake and Norman (1979) the experts may be aware of some attributes about which they lack information and are more capable of forming questions about those attributes. These factors would all result in more extensive information search by experts.

In addition to generating larger processing capacity, the proposition that experts'

knowledge structure contains more relational linkages has implications regarding their ability to generate hypotheses. If an expert's knowledge network contains more information regarding cause-and-effect relationships, he or she should be able to generate a greater number of hypotheses regarding causes of a particular event. For instance, Libby and Frederick (1990) found that more experienced auditors have a larger number of plausible errors available from which to form hypotheses. Similar results were found by Bedard and Biggs, 1991.

However, because the expert has more knowledge content, he or she may need to retrieve less information from the situation at hand, which could result in the inverted "u" pattern. According to this pattern, the amount of information search increases as expertise increases for the reasons mentioned, up to an intermediate level. At high levels of expertise, though, the amount of information search begins to decline. This is because experts can retrieve information either from the situation at hand or it may be directly retrieved or inferred from the information stored in their memory (Brucks, 1985; Lawrence, 1988). That is, pre-existing knowledge may act as a substitute for information from the situation at hand. For example, some lens studies for internal control judgment have found that experts rely on fewer cues than novices, and that they place a large degree of reliance on segregation of duties (Hamilton and Wright, 1982). Experts may have found in the past that segregation of duties is so effective that it compensates for otherwise weak controls, or that segregation of duties is strongly correlated with other effectively designed controls. Therefore the expert may not retrieve any information other than segregation of duties from the information at hand because of pre-existing knowledge

in his or her memory structure regarding the relationship between segregation of duties and other control mechanisms.

In essence then, experts may exhibit either more or less information search than novices depending on which effect dominates in a given situation (Johnson and Russo, 1984). The inverted "u" effect occurs as experts take advantage of their previous knowledge, whereas the enrichment effect occurs as experts take advantage of their superior encoding and hypothesis generation skills. It is reasonable to expect that the more novel are the details of the problem situation at hand the less direct relevance previous knowledge will have. Thus, the inverted "u" effect will become less pronounced relative to the enrichment effect. Supporting this assertion, Punj and Staelin (1983) found that specific prior knowledge was related to less information search while general prior knowledge led to increased information search. Similarly, Brucks (1985) looked at information search in a purchase situation using hypothetical brands so specific prior knowledge was not usable. She found that experts' superior encoding ability resulted in an enrichment effect as hypothesized.

It is expected in this study that the enrichment effect will dominate the inverted "u" effect because of the nature of auditing. In auditing, as opposed to judgments made in many other domains, auditors must gather information not only to make decisions but also to justify them (Gibbins, 1984). It is therefore unlikely that an auditor, at least consciously, would substitute pre-existing knowledge for external knowledge as this would be less justifiable according to generally accepted auditing standards. Moreover, the substitution of pre-existing knowledge for information from the task at hand is

somewhat unlikely given the design of the experimental tasks, which are discussed in detail in the fourth section of this chapter. Although the tasks were based on real audit situations, the clients that served as the bases for the cases were from a different office and their names were changed. Hence, the subjects are unlikely to have specific prior knowledge germane to the task. Therefore it is expected that experienced auditors will search for more information as a result of their superior encoding and hypothesis generation abilities. Furthermore, it is expected that more categories of information will be searched when information items are categorized by the underlying hypothesis that the information addresses. That is, if more hypotheses are generated by experienced auditors, it is expected that will conduct a commensurately broader search to investigate those hypotheses. This leads to the following hypotheses, stated in alternative form[7]:

H 2.1: Experienced auditors will request more information items than the novices will.

H 2.2: Experienced auditors will generate more hypotheses than novices will.

H 2.3: Experienced auditors will search through more categories of information than novices will.

---

[7]The following conventions will be used for the statement of hypotheses throughout this thesis: First, all hypotheses are stated in alternative form. Second, all hypotheses are numbered in a manner consistent with the chapters of the thesis. For example, tests of hypotheses 2.1 through 2.9 are presented in Chapter 2. There is no hypothesis 1. Third, all hypotheses relating to the effects of "expertise" refer to the relevant experimental groups as "experienced auditors" and "novices". This was done as the subjects were initially classified according to their experience on the grounds that many studies in auditor research use experience as a proxy for expertise, as already discussed. The hypotheses were also tested using different measures of expertise.

It is also expected that experienced auditors will be more efficient in allocating their information search efforts (Bédard and Chi, forthcoming). Heiman (1990) suggested that the ability to generate hypotheses regarding the causes of errors and to rank their likelihood is an important ability that auditors develop. However, Heiman did not study the differences in the ability of expert vs. novice auditors to generate hypotheses and assess their likelihood. Also, she stated that such an ability is important to the efficiency and effectiveness of the audit process as this information guides the information search. However, she did not study the link between the generation of those causes and the subsequent information search. That is, one may be able to generate hypotheses and rank their likelihood, but if the subsequent information search is not guided by those hypotheses, or the amount of information search allocated to investigate a particular hypothesis is not proportional to its likelihood, audit efficiency and effectiveness may still be compromised.

In order to assess search efficiency, participants were asked to report all possible hypotheses they investigated, plus any other hypotheses that they can think of after each experimental task is completed. They were then asked to rank these hypotheses in order of likelihood. This information is used to test the following hypothesis:

H 2.4: Experienced auditors will be more efficient in that the amount of information search in an area will be proportional to the likelihood they assign to it.

It is expected that since the experienced auditors will have a larger information set when solving the problem they are likely to generate different solutions than the novices. This follows from the results of Abdel-Khalik and El-Sheshai (1980) and Simnett

and Trotman (1989) who found that the information searched was an influential determinant of the conclusion reached. The hypothesis is:

H 2.5: Experienced auditors will reach a different conclusion than the novices will.

A third difference between novice and expert memory structure lies in the types of associations represented by the links between concept nodes. An expert forms links based on more abstract or deep relationships while the novice forms links based on surface relationships. Chi, Feltovich and Glaser (1981) had experts and novices sort physics problems according to the similarity between the problems. The experts sorted the problems into fewer piles, and sorted them according to a "deeper" relationship (the physics laws employed to generate a solution) as opposed to the novices who sorted the problems according to the superficial similarities of the problems (such as whether they involved an inclined plane). The authors suggested that since experts can see more abstract relationships between concepts, their memory networks would include such abstract linkages. Furthermore, Adelson (1984) demonstrated that novices think more like experts when the task is designed to highlight abstract relationships between concepts.

It is difficult to apply this finding to auditing as one can only speculate what would constitute a concrete or abstract relationship between concepts. However, Weber (1980) used a cued recall method of an extensive list of EDP controls and found that EDP auditors (the experts) exhibited more clustering by category than the novices did, where the categories included input controls, output controls, documentation controls and so on. Frederick and Libby (1986) designed an experiment to assess the knowledge content of the memory network. The subject had to assess the likelihood of combinations of errors

occurring, where the combinations were designed in such a way as to reveal the nature of domain specific knowledge held by the subject. They found that experienced subjects had more knowledge of the relations between controls and errors which affected their likelihood judgments, whereas novices' knowledge base was dominated by knowledge of common account relations. Finally, Frederick (1991) found that both experienced subjects and novices organized internal controls according to both a taxonomic representation of control objectives within transaction cycles, and according to a schematic representation of transaction flow. However, the experienced subjects exhibited greater clustering under both representations than the novices, and were able to recall more controls when they were presented schematically versus taxonomically.

It is contended here that experienced auditors will tend to categorize auditing concepts and procedures according to their goals. Simply put, experienced auditors would ask themselves "what could go wrong?", and the goals of their information search would be to determine if these problems actually occurred. Depending on the particular task, examples of such goals could be the detection of errors that may have occurred, or the detection of financial statement assertions that may have been violated. This categorization is consistent with the categorization differences found in the aforementioned studies. Weber found that experts grouped controls that ensured proper functioning of a particular phase of the process (a goal). Frederick and Libby's findings demonstrated that experienced auditors are more familiar with the errors that each control is designed to prevent or detect (ie. their goals). Experienced auditors could presumably use that knowledge as a basis for categorization.

Novices, on the other hand, may categorize concepts and procedures according to the methods performed such as vouching, confirmation, and analytical review[8], as they are less likely than experienced auditors to have the knowledge to categorize by goals. According to schema theory, experience and repeated exposure promotes the development of linkages. For example, a script is one type of schema that contains knowledge of expected sequences of behaviours, actions and events; it enables understanding of a particular accounting/auditing situation and provides a guide to appropriate behaviour in that situation (Choo, 1989). According to the theory, scripts are episodic at first in that they are retained as a context specific remembrance of a single experience (eg. an audit). As similar episodic scripts are collected, commonalities are noted and generalizations are made, thus eventually elevating the script to the categorical and finally the generalized level (Choo, 1989; Kaplan and Reckers, 1989). The goals of a particular audit and the particular audit procedures conducted to achieve them are generally specified in the planning and evaluation stages of the audit (Ernst and Young, 1991) which are generally performed by auditors at the senior level (Bonner and Pennington, 1991). Thus, novice auditors may have had limited exposure to these stages of the audit process and the connection between procedures and their goals may not be well formed. However, novices are directly involved in the performance of these procedures; hence the methods employed may be a salient feature which forms the basis of their mental scripts developed to date.

A similar distinction between expert and novice categorization was made by

---

[8]Although this contention could lead to an implication that goal associations is an "abstract" concept whereas a methodological orientation is a "concrete" concept, this represents a leap in inference which is beyond the scope of this research.

Adelson (1984) who suggested that computer programming experts as well as experts in other domains tend to distinguish between *what* something accomplishes, ie. the goal, while novices concentrate on *how* it is done, ie. the method. She suggested that goal oriented categories are developed by experts because their flexibility provides greater utility: the problem can be decomposed into elements that describe the subproblem to be solved (the goal) and how it is to be done (the method). The goals are relatively fixed, but they can be achieved several different ways. Having procedures grouped according to the goals they solve allow them to be worked with easily and easily changed, enabling the expert to find an optimal solution to a problem. That is, the expert can select among various procedures that all perform the same objective to find the procedure that is the most appropriate. Similarly, Alba and Hutchinson (1987) noted that goal-derived categories are much less well established in consumers' memory and the size of the memory effects associated with goal derived categories increases with product familiarity.

It could therefore be considered desirable that experts be able to categorize concepts according to their goals. Indeed, the audit manual of the national accounting firm providing the participants for this study requires that in the planning stage, auditors identify what could go wrong and evaluate the internal controls to prevent or detect these errors and/or design substantive tests to provide assurance that these problems have not occurred (Ernst and Young, 1991). This leads to the following hypothesis:

H 2.6: Experienced auditors will tend to retrieve information according to goal derived categories whereas novices will tend to retrieve information according to methodologically derived categories.

A final difference between experts and novices lies in the amount of procedural knowledge and problem solving templates or schemata they possess (Linde, 1986). An expert may have a schema or framework containing general problem-solving strategies (Voss, Greene, Post and Penner, 1983) and may also have templates developed through exposure to problems in the past that are similar to the present situation and provide guidance as to the correct procedures to follow (Novick, 1988; Bouwman, Frishkoff and Frishkoff, 1987; Biggs, Messier and Hansen, 1987; Gibbins 1984). Several research studies have supported the existence of a problem solving schema. Voss, Greene, Post and Penner (1983) analyzed the protocols of subjects who were asked to discuss the Soviet agricultural problem. Experts from a field outside political science who had no domain specific knowledge still enjoyed an advantage over the novices, presumably because they at least were able to apply general problem solving principles from their own area to the new area. Similarly, studies in analogical transfer, which is the ability to apply pre-existing knowledge gained from source problem to a target problem which differs in some way from the source, have found that experts can use their knowledge from past problems to approach new situations (Marchant, 1989; Marchant et al, 1991; Novick, 1988). As a result it is expected that experienced auditors will be more efficient and faster in performing the experimental task as their schema will contain certain pre-learned condition-action rules (Larkin et al, 1980; Salterio, 1993). This leads to the following hypothesis :

H 2.7: Experienced auditors will be more efficient in that they will spend less time per item of information acquired than novices will.

A related hypothesis is that experts will tend to return less to information they have already seen. With a well developed-schema, experts will be better equipped to understand the implications of each information item and will have appropriate condition-action rules in place to enable them to progress to the next step. Such results have been found by Anderson (1988) and Hershey et al (1990). The hypothesis is:

H 2.8: Experienced auditors will perform fewer recursions than novices will.

Another manifestation of this general problem solving approach is that experts may perform a more extensive search of the environmental context and background information. Experts may be more conscious of the consequences of their judgment and take more general business factors into account when gathering input for their decisions (Gibbins and Wolf, 1982) and, according to the enrichment effect, they are capable of handling such larger amounts of information (Fiske, Kinder and Larter, 1983; Johnson and Russo, 1984). Biggs, Mock and Watkins (1989) found that experienced subjects spent a good deal of time constructing a problem representation that included many domain specific and general constraints. It is possible that the real-life problem solving schemas of expert auditors direct them to gain a thorough understanding of the client, the nature of the business and the problems they face. Such knowledge is required by generally accepted accounting standards and enables the auditor to tailor the audit and to better provide certain services to the client, such as the management letter. Therefore, when they invoke their problem solving schema in an experimental situation it may direct them to conduct an information search that is more extensive than is required to solve the express demands of the experimental task. Novices, on the other hand, tend to acquire

only the information that is necessary for the given problem. This is consistent with the observation that one drawback of expertise is that experts develop a highly proceduralized problem solving approach, which may bring with it a degree of inflexibility (Marchant et al. 1991): experts may search for more information than is required in the given instance because they are unable to tailor their problem solving schema to the specific demands of an experimental task. That is, experts in their day to day situations are used to gathering background data regarding the nature of the client's business, business risks, and so on. Such information for some experimental tasks may provide the expert with a richer understanding allowing him or her to arrive at a better judgment. However, even if such information is not expressly helpful or required to conduct an experimental task, the experts may gather the information anyways because it is dictated by their problem solving schema. This leads to the following hypothesis:

H 2.9: Experienced auditors will retrieve proportionately more contextual data of a general background nature than will the novices.

The hypotheses generated to this point deal with expected differences between experienced and novice auditors, regardless of the information search regime. As such, they will be evaluated in Chapter 2 by comparing experienced auditors and novices across both regimes as well as within the active regime alone. Chapter 3 will deal with the testing of the hypotheses below regarding the impact of the information search regime. The literature review and hypotheses for that chapter are contained in the next section.

C. Expertise and the Information Search Regime

It is expected that the participants' information search behaviour will be different under the traditional and active information search regimes. The reason for these expected differences is that the underlying cognitive processes are different under each regime. Specifically, under the active regime participants must generate hypotheses to guide the information search so the process is relatively more cognitive-driven rather than data driven. That is, the active regime discourages subjects from working backward from the information provided to determine what the underlying hypotheses were. Secondly, the active regime is more conducive to forward than backward reasoning. These two factors and their implications are discussed below.

Einhorn (1976) noted that search cannot be directed without some sort of hypothesis and therefore hypothesis formation occurs at a very early stage in the information search process. The process of hypothesis formation is quite complex. Bettman (1986) asserted that consumer information choices probably originate from a mixture of memory- and stimulus-based processes. Similarly, the hypothesis generation process in an audit situation can similarly be either top-down (memory driven) or bottom-up (stimulus driven). A hypothesis may be generated through the activation of nodes that are causally linked in memory. Alternatively, a hypothesis may be suggested by the data presented in the case or otherwise "inherited" from some external source. It is likely that hypotheses tend to be produced by a bottom up process early in the problem solving situation by both experts and novices as evidenced by the fact that both novices and experts tend to scan the information until they have compiled a list of significant findings.

Once that list has reached a sufficient size, then a hypothesis will be formulated (Bouwman, Frishkoff and Frishkoff, 1987). For instance, research in the field of medical diagnosis has found that subjects do not generate a hypothesis until some evidence supports its existence (Rubin, 1975, as referenced in Biggs and Mock, 1983). Until the hypothesis formation stage is reached, then, information search is passive and can generally be characterized by a sequential strategy (Bouwman, Frishkoff, and Frishkoff, 1987). Once the subject has formulated hypotheses it is more likely that a direct, active information search strategy will ensue as the subject gathers specific information to investigate the hypotheses. If novices have more difficulty in generating hypotheses from memory this would explain why research has found that they tend to favour a sequential strategy throughout a task rather than a directed strategy (Bouwman, Frishkoff and Frishkoff, 1987; Bédard and Mock, 1992; Johnson, 1988).

The active information search regime requires using a directed search strategy since it is not possible to passively scan the information available in the order of presentation. It is therefore expected that experienced auditors will outperform novices to a greater extent than under a traditional search regime since the hypothesis formation must be memory driven rather than stimulus driven and an expert's memory structure contains a more complex network of causal links and a larger store of plausible errors to assist in the process. Essentially, the auditor must recall from memory an explanation that is appropriate to the observed situation, a process which is more difficult than recognizing whether an established (stimulus-driven) hypotheses fits the observations (Bedard and Biggs, 1991b).

A second difference in the processing under the active and traditional search regimes corresponds with the distinction between forward and backward reasoning. Larkin et al (1980) described forward reasoning in a kinematics problem as starting from the information given, accumulating knowledge about the initially unknown quantities, and working forward to the problem solution. When subjects following this approach knew all the values of the independent variables in a particular equation, they solved for the dependent variable and continued this process until they reached the solution. Backward reasoning, on the other hand, involves working backwards from the unknown solution to the givens of the problem. Subjects employing this strategy looked through all the equations available until they identified one where the variable they were solving for was the dependent variable. They then tried to solve the equation, and if any of the independent variables were unknown they then tried to identify an equation that solved for that variable. Larkin et al (1980) found that forward processing was characteristic of experts' problem solving, whereas backwards processing was employed more often by novices. Backwards problem solving is much slower as deciding what to do next occupies considerable time and places a substantial burden on short term memory (Larkin et al, 1980); Also, such a process entails continually monitoring to see if each successive step has reduced the difference between the starting point and the goal state (Hershey et al, 1990).

Backwards reasoning is facilitated by the information presentation format under the traditional information search regime: in the kinematics example above, for instance, backwards problem solving would be facilitated if all the possible equations were listed

for the subjects. In a similar fashion, the traditional information search regime for this study facilitates backwards reasoning. The goal is to provide an audit opinion, and the various information items represent the means to arrive at that goal. Subjects can scan the list and determine which of those information items will move them towards that goal. This backwards reasoning process is more difficult under the active information regime, however, as the subject must determine what information they need to arrive at their goal and how to satisfy those requirements, without the aid of a list.

In summary, the active information search regime encourages participants to engage in a directed search strategy. This is cognitively more demanding than a passive strategy permitted under the traditional regime, so it is expected that the information search behaviour of all participants will be less extensive and efficient under the active regime, regardless of experience level. Specifically, since subjects under the traditional search regime can infer the underlying hypotheses from the information presented whereas active regime participants must generate their own hypotheses, it is expected that the participants under the active regime will provide fewer hypotheses and conduct commensurately less information search. This leads to the following hypotheses:

H 3.1:Participants under the active search regime will search for less information than participants under the traditional one.

H 3.2: Participants under the active search regime will generate fewer hypotheses than participants under the traditional one.

H 3.3: Participants under the active search regime will search through fewer categories of information than participants under the traditional one.

It is further expected that since information search under the active regime is cognitively driven, it will be more closely tied to the participants' generation of hypotheses. On the other hand, traditional regime participants have the option of conducting search without an underlying hypotheses so the link between their hypotheses and search may be somewhat weaker. This leads to the next hypothesis:

H 3.4: Participants under the active search regime will demonstrate a closer correlation between their information search and their hypothesis generation than participants under the traditional one.

Following the same line of reasoning as hypothesis 2.5, it is expected that the active and traditional search participants will arrive at different conclusions because the extent of their information search is expected to differ. The hypothesis is therefore:

H 3.5: Participants under the active search regime will arrive at different conclusions than participants under the traditional one.

Under the active information search regime, without a menu of the information available, participants perhaps need to draw more extensively on their own problem solving schema to direct the problem solving process. Engaging such a schema is likely to be time consuming in that participants must decide what to do next compared to participants under the traditional regime who can simply choose the next item on the information menu. A second implication is that auditors may have difficulty proceeding in an orderly fashion if their problem solving schema is not sufficiently developed. For example, they may be unsure of the implications of a given piece of information and may need to return to it later. Traditional regime participants, in contrast, may spend

proportionately less time deciding what to do next as they may choose to passively scan through the information. Furthermore, they may perform fewer recursions as the menu of cues facilitates proceeding in an organized and methodical manner. This leads to the next two hypotheses:

H 3.6: Participants under the active search regime will spend more time per item of information acquired than participants under the traditional one.

H 3.7: Participants under the active search regime will be less efficient in that they will perform more recursions than participants under the traditional regime.

The next major group of hypotheses predicts interactions between experience and the interface. This is due to the fact that experienced auditors, by virtue of their more elaborate memory network and problem solving schema as discussed in first section of the literature review, will be more capable of handling the additional cognitive demands imposed by the active information search regime which have been discussed above. Thus, it is expected that the decrements in performance of experienced auditors in the active search regime compared to the traditional regime will be less than the performance decrements in the novice group. This expected relationship is shown in figure 1-3. For instance, since experienced subjects may be able to generate more hypotheses and invoke their problem solving schema to ensure that these hypotheses are adequately investigated, it is expected that they will conduct more information search than novices. However, since under the traditional regime search can be conducted without an underlying hypothesis, any such differences between experienced subjects and novices may be less apparent. The hypotheses are therefore:

H 3.8: The extent by which the amount of information requested by experienced auditors exceeds the amount requested by novices will be greater under the active regime than under the traditional one.

H 3.9: The extent by which the number of hypotheses generated by experienced auditors exceeds the number generated by novices will be greater under the active regime than under the traditional one.

H 3.10: The extent by which the number of categories searched by experienced auditors exceeds the number searched by novices will be greater under the active regime than under the traditional one.

Similarly, it has been discussed that experienced auditors may possess more detailed problem solving schema. Such schema could facilitate information search by ensuring that hypotheses are appropriately generated and investigated, thus leading experienced auditors to demonstrate closer links between hypotheses and search than novices do. However, again these differences may be less evident under the traditional regime as both experienced auditors and novices can conduct search without an underlying hypothesis. Following the same reasoning, any differences in the goal and method categorizations underlying the generation of hypotheses and subsequent information search for experienced subjects and novices may be attenuated by the passive scanning of information possible under the traditional search regime. The hypotheses are:

H 3.11: The disparity in the correlation between hypothesis generation and information search of experienced auditors and novices respectively will be greater under the active regime than under the traditional one.

H 3.12 The differences in the goal and method categorizations used by the experienced and novice subjects respectively will be greater under the active regime than under the traditional one.

The variables reflecting the efficiency of information search in terms of time per item of information search and the number of recursions are also expected to follow this same pattern: experienced auditors may be more efficient than novices by virtue of their more complete problem solving schema, but the differences may be more apparent under the active search regime where the problem solving schema is more critical to the performance of the task. The hypotheses are therefore:

H 3.13: The extent to which experienced auditors require less time per item of information than novices will be greater under the active regime than under the traditional one.

H 3.14: The extent to which experienced auditors perform fewer recursions than novices will be greater under the active regime than under the traditional one.

One interesting result of information search studies is that subjects tend to overestimate the completeness of the information they have seen and are insensitive to information that is missing (Fischoff, Slovic and Lichtenstein, 1978; Mehle et al, 1981). Therefore, even if hypothesis 3.1 is confirmed as participants in the active regime search for less information, it is expected that they will be insensitive to the incompleteness of their information set. This leads to the final two hypotheses, stated in alternative form:

H 3.15: Participants under both regimes will not differ in their ratings of the completeness of the information.

H 3.16: Participants under both regimes will not differ in their confidence in their decisions.

In summary, then, it is likely that experienced auditors enjoy a significant advantage over novices in the information search phase of the judgment process.

IV. EXPERIMENTAL DESIGN

The experiment was administered to auditors from one national accounting firm gathered expressly to perform the experiment. Having all the auditors from one firm limits the generality of the findings, so performing the experiment on auditors from other firms may be a useful extension of the research.

As discussed in Appendix A, the experiment uses a program that runs on Macintosh computers. Owing to funding limitations, the audit firm rather than the researcher had to provide the computers. Thus, the population for the experiment was restricted to those firms that use Macintosh computers.

The experiment was pilot tested twice on a total of 20 auditors. The purpose of these pilot tests was to ensure that the instructions were clear, the information provided was complete and adequately realistic, and the computer programs were working properly.

The actual experiment was administered on two consecutive days in the summer of 1992. The active information search group consisted of 30 auditors who performed the experiment in a Thursday afternoon session and the traditional information search group consisted of 22 auditors performed the experiment the following day. Participants were cautioned not to talk about the experiment after it was over. Both sessions were from 12 noon to 2 pm, with lunch provided for the participants beforehand.

Participants in both sessions were given a brief training demonstration. Both sessions were given an example involving the audit of accounts payable. Participants were shown how to select three pieces of information; the materiality for the audit, confirming the account balances with major suppliers and vouching subsequent payments to supporting invoices. Thus the participants in the traditional interface were shown an overhead of a computer screen which contained a menu of those three information items and were told that the items could be seen by using the computer mouse to point to the button beside each item and clicking. The participants in the new interface were also shown an overhead of the computer screen that they would see and were shown how retrieve the information pertaining to those same three items by typing their questions into the computer. Participants in the new interface were also told that the computer answered their questions by searching their questions for key words it recognized; hence, if one of their questions wasn't answered they should try to substantively rephrase it to increase the likelihood that they would have different key words which would then trigger successful retrieval. No participants in either session demonstrated any problems with the operation of the programs.

The experienced group consisted of 26 managers and partners with an average of 7 years of experience. The novice group consisted of 26 juniors who had an average of 1.1 years of experience in public accounting. The training room where the experiment was administered contained 30 portable Macintosh powerbooks, one for each participant.

The experiment was a repeated measure split plot design as the information search regime was manipulated between subjects, and each subject performed multiple

experimental tasks. The design of the experiment is shown in Figure 1-2.

There were three experimental tasks in total, which varied in their degree of structure. Firms generally develop decision aids such as questionnaires to aid problem solving when problems are familiar, routine and structured. By using such a task there is a danger that any expert-novice differences will occur simply because the experts have used the decision aids more often and thus have memorized the procedures more thoroughly. Therefore unstructured tasks should draw more extensively on the problem-solving capabilities of the auditors as there are fewer guidelines available to assist the information search and problem solving . As such, it is expected that the hypothesized results for experienced auditors vs. novices will be stronger in the unstructured tasks[9].

The structured task was the typical audit of a cash section of a small enterprise. The task was completely straightforward, except that participants were told that it was the first time their firm had audited the client and they had forgotten the firm's detailed audit verification questionnaire. The participants were therefore forced to conduct the information search for this structured task without external guidance.

The next two tasks, which were less structured, were developed based on a series of interviews with six practising auditors from a medium sized office of a national accounting firm. These auditors were asked to describe difficult situations they had encountered that had required professional judgment, and why such judgment was required. The experimental tasks were selected from these situations as they required

---

[9] The results of the hypotheses in Chapters 2 and 3 were analyzed separately for each experimental task. Then ANOVA analyses were used to determine if the results between experienced subjects and novices were different among the tasks.

extensive information search, and met the definition of unstructured as the problems were unique and undefined with few or no guidelines available. (Gorry and Scott-Morton, 1971; Keen and Scott-Morton, 1978). In both cases, the actual auditors found that the detailed audit questionnaires developed by the firm were not applicable. The information provided to the participants was based on the contents of the actual client files, although it was simplified to reduce the time required to complete the task. Also, the names of the client were changed and certain details were altered to protect their anonymity.

The first unstructured task required the auditor to make decisions regarding the audit and valuation of animal inventory in a wildlife park. The auditor had to consider both the most desirable accounting valuation treatment, and also consider the audit implications and the degree of assurance that could be provided. The auditors had to consider difficulties in verifying the quantities and historic costs of the animals. Also, the client wanted to value the inventory according to market value. The auditors had to consider the propriety of this as well how to verify the market values.

The second unstructured task was based on a special engagement. The client was party to an exclusive supply arrangement whereby it purchased explosives exclusively from another company. The other company was allowed to increase the price of the explosives over the term of the contract in proportion to the increase in their own costs. The client felt that the price increases had been excessive and commissioned an audit to verify that the increases had been justified within the terms of the contract. Participants had to determine error and non-error causes of the increases, and design and conduct procedures to determine which causes were responsible. The information for all three

tasks is provided in Appendix B.

According to Simon (1973), an ill-defined problem may be defined as a problem whose structure lacks definition in its initial state, its set of permissible operators, or its goal state. The first task, the audit of a cash section, was structured in all respects. It was a typical situation that is well known to the participants. The goal was a standard audit opinion and the possible errors that would preclude a clean opinion and the procedures to detect those errors are well known and understood. The second task, the audit of the animal park inventory, was less defined. In this case the initial state and the goal state were still neatly defined. That is, the goal was still a standard audit opinion and the errors are still well understood: difficulties in verifying quantities, determining costs, and determining the appropriate valuation procedures. However, the operators required were not clear. Because of the nature of the inventory (animals roaming freely in an open area) many of the standard audit precautions may not have been applicable, such as laying inventory out in an orderly fashion or tagging inventory after counting. Also, verifying market values required different procedures and sources of evidence than the verification of historic cost. These problem characteristics forced the auditors to depart from standard audit procedures and use their abilities to develop more creative audit solutions (or to assess the implications of their inability to do so). The third task, the purchase audit, was the most ill-defined. In this case, the initial state was unusual in that it may have presented a novel business situation to some participants. The goal state was likewise ill-defined because it was not a standard audit report, and the participants had to reason what errors and non-error causes could have been driving the situation. Finally, the

operators needed to verify those causes had to be determined by the participants based on their knowledge of the relationship between errors and evidence needed to evaluate those errors, since no guidelines would be available.

Choosing a task that is relatively unfamiliar to the experimental participants incurs some trade-offs. As mentioned, it is important that participants can still apply some of their expertise to the experimental task so that experienced auditors can outperform the novices. A second problem is the sacrifice of generality - although an unfamiliar task may yield more differences the findings may be less generalizable. This criticism can be raised against virtually any judgment experiment because the findings may only apply to the particular task being examined. However, the likelihood of this occurring is perhaps greater for an unusual task as opposed to, say, an internal control judgment task which is performed many times with relatively little change in the components of the task. For this reason, useful extensions of this study would include replications with different experimental tasks to determine the robustness of the conclusions drawn.

Although all three tasks could provide interesting insights into auditor judgment, it was felt that the third task, although the most unstructured, was also the least generalizable since it was not a normal audit situation. Furthermore, since each task could easily take up to an hour, there was concern that participants might drop out before finishing all three tasks. To avoid having too few subjects to assess the results on the first and second tasks, participants were told that the third task was optional and should be done last. It was stressed to them that the results from the third task were important, but that the researcher was aware of the demands on their valuable time. Thirty-four of the

fifty-two subjects (65%) did attempt the optional task. The order of the first two tasks was counterbalanced to minimize any systematic training effects.

The results of the experiment are contained in the following two chapters. Chapter 2 presents the results regarding the differences between experienced and novice auditors across both information regimes and within the active search regime alone. Chapter 3 contains the results of the effects of the information search regime and its interaction with experience. Chapter 4 contains the discussion and conclusion.

Figure 1-1. The Information Search Process

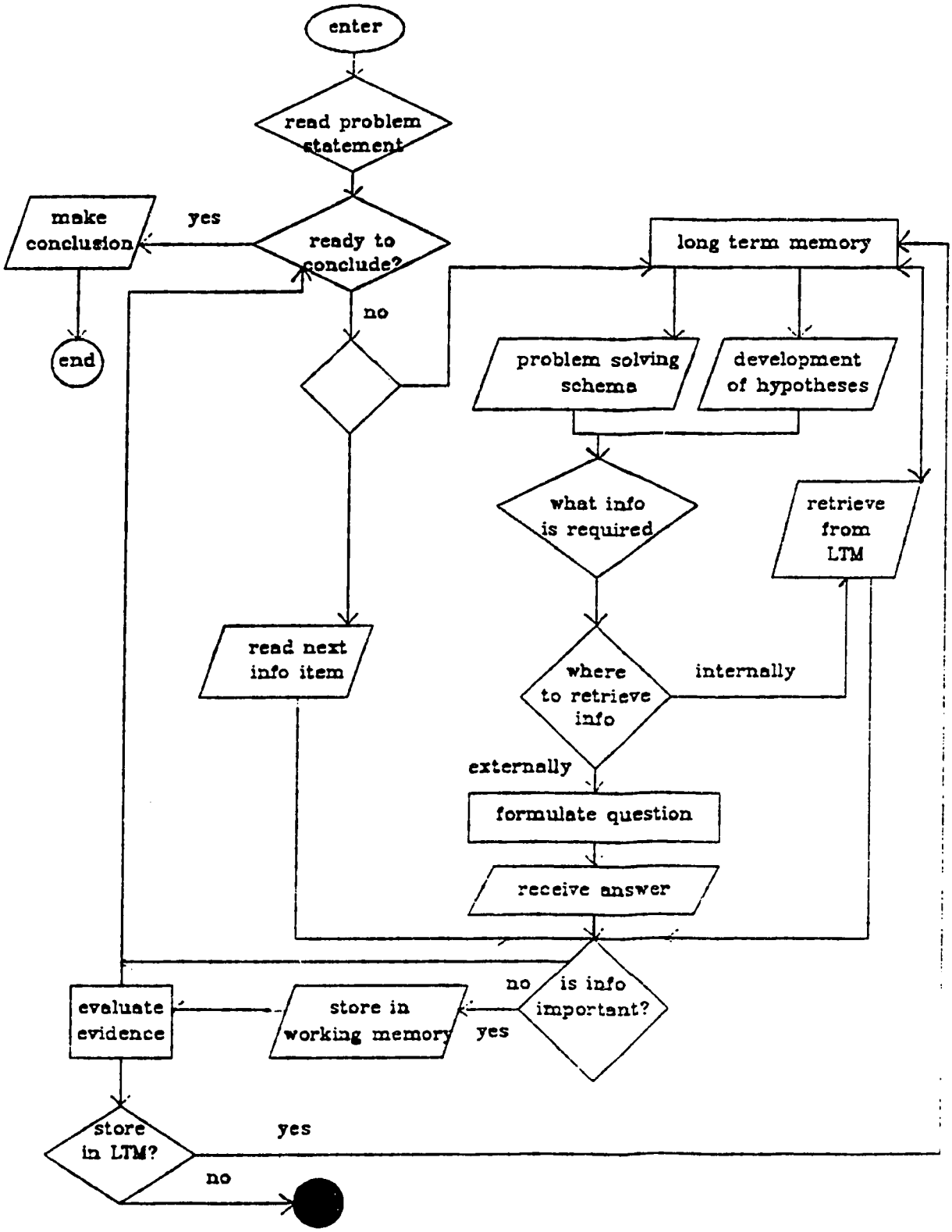


Figure 1-2. Experimental Design

			Cash Task (structured)	Park Task (semi-structured)	Digger Task (unstructured)
Active Search Regime	Novices	Subject 1 to Subject 14			
	Experienced Subjects	Subject 15 to Subject 30			
Traditional Search Regime	Novices	Subject 31 to Subject 42			
	Experienced Subjects	Subject 43 to Subject 52			

Figure 1-3. Expected Pattern of Results For Hypotheses Predicting Experience by Interface Interaction

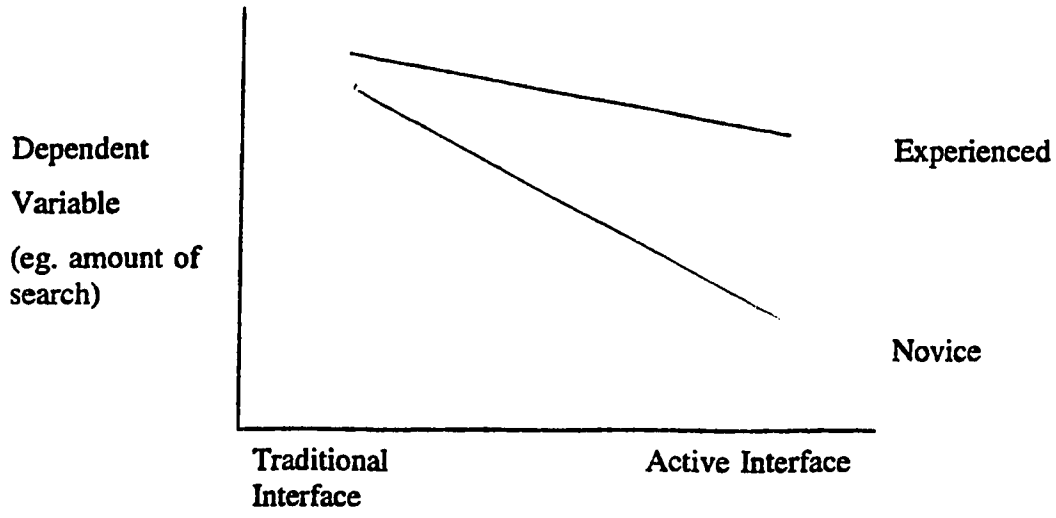


Table 1-1. Variables Investigated Under Each Hypothesis

Hypotheses Investigating Experienced Auditor vs. Novice Main Effect	Hypotheses Investigating Active vs Traditional Interface Main Effect	Hypotheses Investigating Experience by Interface Interaction
2.1 Number of items retrieved	3.1 Number of items retrieved	3.8 Number of items retrieved
2.2 Number of hypotheses generated	3.2 Number of hypotheses generated	3.9 Number of hypotheses generated
2.3 Number of categories searched	3.3 Number of categories searched	3.10 Number of categories searched
2.4 Link between assessed likelihood and actual search	3.4 Link between assessed likelihood and actual search	3.11 Link between assessed likelihood and actual search
2.5 Conclusion	3.5 Conclusion	
2.6 Categorical clustering of information retrieved		3.12 Categorical clustering of information retrieved
2.7 Time per information item	3.6 Time per information item	3.13 Time per information item
2.8 Number of recursions	3.7 Number of recursions	3.14 Number of recursions
2.9 Proportion of background information		
	3.15 Rating of completeness of information	
	3.16 Confidence in Decision	

Bibliography

Abdel-Khalik, A.R. and K.M. El-Sheshai, "Information Choice and Utilization in an Experiment on Default Prediction," Journal of Accounting Research (Autumn 1980), 325-341.

Abdolmohammadi, M., and A. Wright, "An Examination of the Effects of Experience and Task Complexity on Audit Judgments," The Accounting Review, (January 1987), 1-13.

Adelson, B., "When Novices Surpass Experts: The Difficulty of a Task May Increase with Expertise," Journal of Experimental Psychology: Learning, Memory and Cognition (1984, Vol 10, No 3), 483-495.

Alba, J.W. and L. Hasher, "Is Memory Schematic?" Psychological Bulletin, Vol 93 No 2, (1983), 203-231.

Alba, J.W. and Hutchinson, J. W., "Dimensions of Consumer Expertise," Journal of Consumer Research (March 1987), 411-454.

Anderson, J.R., Cognitive Psychology and its Implications, San Francisco: W.H. Freeman and Company, (1980).

Anderson, M.J. "Some Evidence on the Effect of Verbalization of Process: A Methodological Note," Journal of Accounting Research, (Autumn,1985), 843-852.

Anderson, M.J., "A Comparative Analysis of Information Search and Evaluation Behaviour of Professional and Non-Professional Financial Analysts," Accounting, Organizations and Society, Vol 13 No 5, (1988), 431-446.

Anderson, R.J., The External Audit, Second edition, Toronto: Copp, Clark and Pitman, (1984).

Anderson, U. and W.F. Wright, "Expertise and the Explanation Effect," Organizational Behavior and Human Decision Processes, (1988), 250-269.

Arens, A.A., "Educating the Partner of the Year 2000," presented at Arthur Young Roundtable, (November 14, 1987).

Asare, S. K., "The Auditor's Going-Concern Decision: Interaction of Task Variables and the Sequential Processing of Evidence," Accounting Review, Vol 67 no 2, (April, 1992), 379-393.

Asare, S.K., and W.R. Knechel, "Termination of Information Search in Auditing,"

Working Paper, University of Florida, Fisher School of Accounting, (June, 1992).

Ashton, A.H., "Experience and Error Frequency Knowledge as Potential Determinants of Auditor Expertise," Accounting Review, (April, 1991), 218-239.

Ashton, R.H., "An Experimental Study of Internal Control Judgments," Journal of Accounting Research (1974), 143-157.

Ashton, R. H., Research in Audit Decision Making: Rationale, Evidence and Implications, The Canadian Certified General Accountants' Research Foundation, Research Monograph Number 6, 1983.

Bedard, J.C. and S.F. Biggs, "The Effect of Domain-Specific Experience on Evaluation of Management Representations in Analytical Procedures," Auditing: A Journal of Practice and Theory, Vol 10, (Supplement, 1991), 77-90.

Bedard, J.C. and S.F. Biggs, "Pattern Recognition, Hypothesis Generation and Auditor Performance in an Analytical Task," Accounting Review, Vol 66 No 3, (July, 1991), 622-642.

Bédard, J.L. Expertise in Auditing: Myth or Reality?", Accounting, Organizations and Society (1989), Vol. 14, 113-131.

Bédard, J. and M. T. H. Chi, "Expertise in Auditing," Auditing: A Journal of Practice and Theory, (forthcoming).

Bédard, J. and T.J. Mock, "Expert and Novice Problem Solving Behaviour in Audit Planning" , Auditing: A Journal of Practice and Theory , Vol 11, Supplement (1992), 1-20.

Bereiter, C. and M. Scardamalia, "Educational Relevance of the Study of Expertise," Interchange (1986), 10-18.

Best, J.B., Cognitive Psychology, St. Paul, Minnesota: West Publishing Company, (1986).

Bettman, J.R., "Consumer Psychology,", Annual Review of Psychology (1986), 257-289.

Bettman, J.R. and C.W. Park, "Effects of Prior Knowledge and Experience and Phase of the Choice Process on Consumer Decision Processes: A Protocol Analysis," Journal of Consumer Research (December, 1980), 234-248.

Biggs, S.F., W.F. Messier, Jr., and J.V. Hansen, "A Descriptive Analysis of Computer

Audit Specialists' Decision-Making Behaviour in Advanced Computer Environments," Auditing: A Journal of Theory and Practice, Vol 6, No.2 (1987).

Biggs, S.F., and T.J. Mock, "An Investigation of Auditor Decision West, J.B., Processes in the Evaluation of Internal Controls and Audit Scope Decisions," Journal of Accounting Research, (Spring, 1983), 234-255.

Biggs, S. F., T. J. Mock and P. R. Watkins, Analytical Review Procedures and Processes in Auditing, The Canadian Certified General Accountants' Research Foundation, Monograph Number 14, (1989).

Biggs, S.F., A. J. Rosman and G.K. Sergenian, "Methodological Issues in Judgment and Decision-Making Research: Concurrent Verbal Protocol Validity and Simultaneous Trace of Process," Journal of Behavioral Decision Making, (forthcoming).

Bonner, S. E., "Experience Effects in Auditing: The Role of Task-Specific Knowledge," The Accounting Review (January 1990), 72-92.

Bonner, S.E. and B.L. Lewis, "Determinants of Auditor Expertise," Journal of Accounting Research, Vol 28, (supplement 1990), 1-20.

Bonner, S.E. and N. Pennington, "Cognitive Processes and Knowledge as Determinants of Auditor Expertise," Journal of Accounting Literature,(1991), 1-50.

Bouwman, M.J., P.A. Frishkoff, and P. Frishkoff, "How Do Financial Analysts Make Decisions? A Process Model of the Investment Screening Decision," Accounting, Organizations and Society (1987), 1-29.

Bowden, Edward M., "Accessing Relevant Information during Problem Solving: Time Constraints on Search in the Problem Space," Memory and Cognition, vol 13 No 3, (1985), 280-286.

Brehmaner, Berndt, "Hypotheses about Relations Between Scaled Variables in the Learning of Probabilistic Inference Tasks," Organizational Behaviour and Human Performance, Vol 11, (1974), 1-27.

Brown, C., "Causal Reasoning in Performance Assessment: Effects of cause and Effect Temporal Order and Covariation," Accounting, Organizations and Society, Vol 10, No 3, (1985), 255-266.

Brucks, M., "The Effects of Product Class Knowledge on Information Search Behaviour," Journal of Consumer Research (June 1985), 1-16.

Brucks, M., "Search Monitor: An Approach for Computer-Controlled Experiments Involving Consumer Information Search," Journal of Consumer Research (June, 1988), 117-121.

Butt, J.L. and T.J. Campbell, "The Effect of Information Order and Hypothesis-testing Strategies on Auditors' Judgments," Accounting, Organizations and Society, (1989).

Chase, W.G. and H.A. Simon, "Perception in Chess," Cognitive Psychology, (January, 1973), 55-81.

Chi, M. and S.J. Ceci, "Content Knowledge: Its Role, Representation and Restructuring in Memory Development," in Advances in Child Development and Behaviour, Vol 20, H.W. Reese (Ed.), Orlando, Florida: Harcourt Brace Jovanovich, (1987).

Chi, M., P. Feltovich and R. Glaser, "Categorization and Representation of Physics Problems by Experts and Novices," Cognitive Science 5 (1981), 121-152.

Chi, M., R. Glaser and Rees, "Expertise in Problem Solving," in Advances in the Psychology of Human Intelligence, R.J. Sternberg (ed), Vol 1, 1982.

Choo, F., "Cognitive Scripts in Auditing and Accounting Behaviour," Accounting, Organizations and Society, (1989).

Choo, F., "The Relationship between Knowledge Structure and Judgments for Experienced and Inexperienced Auditors," Accounting Review, Vol 66 No 3 (July 1991), 464-485.

Christ, M.Y., "Evidence on the Nature of Audit Planning Problem Representations: An Examination of Auditor Free Recalls," Accounting Review, Vol 68 No 2, (April, 1993), pp-304-322.

Church, Bryan K. and A. Schneider, "The Effect that a Superior's Suggestion Has on Auditors' Abilities to Generate Diagnostic Hypotheses", Working paper, School of Management, Georgia Institute of Technology, (May, 1990).

CICA Handbook, Canadian Institute of Chartered Accountants.

Collins, A.M., and E.F. Loftus, "A Spreading-Activation Theory of Semantic Processing," Psychological Review, (1975), 407-428.

Einhorn, H.J., "A Synthesis: Accounting and Behavioral Science," Journal of Accounting Research, (1976 Supplement), 196-206.

Eisenstadt, M. and Y. Kareev, "Aspects of Human Problem Solving: The Use of Internal Representations," in Explorations in Cognition, D.A Norman and D.E. Rumelhart (eds.), San Francisco: Wilt Freeman and Company (1975).

Ericcson, K.A., and H.A. Simon, "Verbal Reports as Data," Psychological Review, Vol 87 No 3,(May, 1980), 215-251.

Ernst and Young, "Our Audit Approach", (April, 1991).

Fischoff, B., P. Slovic and S. Lichenstein, "Fault Trees: Sensitivity of Estimated Failure Probabilities to Problem Representation," Journal of Experimental Psychology: Human Perception and Performance, Vol 4 No 2 (1978), 330-344.

Fiske, S., D. Kinder and W. Larter,"The Novice and the Expert: Knowledge-Based Strategies in Political Cognition," Journal of Experimental Social Psychology 19 (1983), 381-400.

Frederick, D.M., "Auditors' Representation and Retrieval of Internal Control Knowledge," Accounting Review, (April, 1991), 240-258.

Frederick, D.M. and R. Libby, "Expertise and Auditors' Judgments of Conjunctive Events," Journal of Accounting Research 24, No. 2 (1986).

Frensch, P.A. and R. J. Sternberg, "Expertise and Intelligent Thinking: When Is It Worse to Know Better," in Advances in the Psychology of Human Intelligence, Vol 5, R. Sternberg (ed.), Hillsdale, N.J.: Erlbaum (1989), 157-188.

Gemunden, H.G., "Perceived Risk and Information Search. A Systematic Meta-Analysis of the Empirical Evidence," International Journal of Research in Marketing (1985), 79-100.

Gibbins, M., "Easing the Tension Between Professional Judgment and Standards," CA Magazine, (May, 1983), 37-43.

Gibbins, M., "Propositions about the Psychology of Professional Judgment in Public Accounting," Journal of Accounting Research, Vol 22, No. 1, (Spring, 1984), 103-125.

Gibbins, M., "Knowledge Structures and Experienced Auditor Judgment," in Auditor Productivity in The Year 2000, Andrew Bailey (ed.), Reston, Virginia: Arthur Young, (1988).

Gibbins, M. and Jamal, K. (1993). "Problem-Centred Research and Knowledge-Based

Theory in the Professional Accounting Setting," Accounting, Organizations and Society, (June, 1993).

Gibbins, M. and F. M. Wolf, "Auditors' Subjective Decision Environment-The Case of a Normal External Audit," The Accounting Review, (1982), 105-124.

Goodman, D. The Complete Hypercard Handbook, Second Edition, New York: Bantam Computer Books, (1988).

Gorry, G. and M. Scott-Morton, "A Framework for Management Information Systems," Sloan Management Review (Fall 1971), 55-71.

Grunert, K.G., "Cognitive Determinants of Attribute Information Usage," Journal of Economic Psychology, (1986), 95-124.

Hamilton, R.E. and W.F. Wright, "Internal Control Judgments and Effects of Experience: Replications and Extensions," Journal of Accounting Research (Autumn, 1982), Part II, 756-765.

Hayes-Roth, F., D.A. Waterman and D.B. Lenat, "An Overview of Expert Systems," in Building Expert Systems, Hayes-Roth, Waterman and Lenat (eds.), Reading, Mass: Addison-Wesley, (1983).

Heiman, V.B., "Auditors' Assessments of the Likelihood of Error Explanations in Analytical Review," Accounting Review, (October, 1990), 875-890.

Hershey, D. A., D. A. Walsh, S. J. Read and A. S. Chulef, "The Effects of Expertise on Financial Problem Solving: Evidence for Goal Directed, Problem-Solving Scripts," Organization Behaviour and Human Decision Processes, 46, (1990), 77-101.

Hogarth, R.M., "A Perspective on Cognitive Research in Accounting," Accounting Review, (April, 1991), 277-290.

Jeffrey, C., "The Relation of Judgment, Personal Involvement and Experience in the Audit of Bank Loans," Accounting Review, Vol 67 No 4 (October, 1992), 802-819.

Johnson, E.J.,"Expertise and Decision Under Uncertainty:Performance and Process," in The Nature of Expertise (eds. M.T. H. Chi, R. Glaser and M.J. Farr), Hillsdale, N.J.: Lawrence Erlbaum Associates, (1988).

Johnson, J.E. and E. J. Russo, "Product Familiarity and Learning New Information," Journal of Consumer Research, Vol. 11 (June, 1984) 542-550.

Johnson, P.E., K. Jamal and R.G. Berryman, "Effects of Framing on Auditor Decisions," Organizational Behaviour and Human Decision Processes, Vol 50, (1991), 75-105.

Johnson, P.E., A.S. Duran, F. Hassebrock, J. Moller, M. Prietula, P.J. Feltovich and D.B. Swanson, "Expertise and Error in Diagnostic Reasoning," Cognitive Science, vol 5, (1981), 235-283.

Joyce, E.J. and R. Libby, "Behavioral Studies of Audit Decision Making," Journal of Accounting Literature (1982), 103-123.

Kaplan, S.E., C. Moeckel and J.D. Williams, "Auditors' Hypothesis Plausibility Assessments in an Analytical Review Setting," Auditing: A Journal of Practice and Theory, Vol 11 No 2, (Fall, 1992), 50-65.

Kaplan, S.E. and P. M. J. Reckers, "An Examination of Information Search During Initial Audit Planning," Accounting, Organizations, and Society, (1989), 539-550.

Keen, P.G.W., and M.S. Scott Keen, Decision Support Systems: An Organization Perspective, Peter Keen (ed.), Reading, Massachusetts:Addison-Wesley, (1978).

Kida, T., "The Impact of Hypothesis-Testing Strategies on Auditors' Use of Judgment Data," Journal of Accounting Research, (Spring, 1984), 332-340.

Klersey, G.F. and T.J. Mock, "Verbal Protocol Research in Auditing," Accounting, Organizations and Society, (1989), 133-151.

Knechel, W. R. and W. F. Messier Jr., "Sequential Auditor Decision Making: Information Search and Evidence Evaluation," Contemporary Accounting Research, Vol 6 No 2 (1990), 385-406.

Koonce, L., "Explanation and Counterexplanation During Audit Analytical Review," Accounting Review, Vol 67 No 1, (January, 1992), 59-76.

Larkin, J., J.M. McDermott, D.P. Simon, and H.A. Simon, "Expert and Novice Performance in Solving Physics Problems," Science, Vol 208, (June 20, 1980), 1335-1342.

Lawrence, J.,"Expertise on the Bench: Modelling Magistrates' Judicial Decision Making," in The Nature of Expertise (eds. M.T. H. Chi, R. Glaser and M.J. Farr), Hillsdale, N.J.: Lawrence Erlbaum Associates, (1988).

Libby, R., Accounting and Human Information Processing: Theory and Applications, Englewood Cliffs, N.J. : Prentice-Hall, (1981).

Libby, R., "Availability and the Generation of Hypotheses in Analytical Review," Journal of Accounting Research, Vol. 23, No. 2, (Autumn, 1985), 648-667.

Libby, R. and D. Frederick, "Expertise and the Ability to Explain Audit Findings," Journal of Accounting Research (Autumn 1990), 348-367.

Linde, L., "What is domain skill? Frames in Information Seeking," Behavioral Science (April, 1986), 89-102.

Marchant, G., "Analogical Reasoning and Hypothesis Generation in Auditing," Accounting Review, (1989), 501-513.

Marchant, G., J.Robinson, U. Anderson and M. Schadewald, "Analogical Transfer and Expertise in Legal Reasoning," Organizational Behaviour and Human Decision Processes, Vol 48, (1991), 272-290.

McDaniel, Linda S., "The Effects of Time Pressure and Audit Program Structure on Audit Performance," Journal of Accounting Research, Vol 28 No 2, (Autumn 1990), 267-285.

Mehle, T., C.F. Gettys, C. Manning, S. Baca and S. Fisher, "The Availability Explanation of Excessive Plausibility Assessments," Acta-Psychgologica, vol 49, (1981), 127-140.

Meyer, D.E., and R.W. Schvaneveldt, "Facilitation in Recognizing Pairs of Words: Evidence of a Dependence Between Retrieval Operations," Journal of Experimental Psychology, (1971) 227-234.

Miyake, N. and D.A. Norman, "To Ask A Question, One Must Know Enough To Know What Is Not Known," Journal of Verbal Learning and Behaviour, Vol. 18, (June, 1979), 357-364.

Moeckel, C., "The Effect of Experience on Auditors' Memory Errors," Journal of Accounting Research, Vol 28 No 2 (Autumn, 1990), 368-387.

Novick, L., "Analogical Transfer, Problem Similarity and Expertise," Journal of Experimental Psychology: Learning, Memory and Cognition, Vol. 14, No. 3 (1988), 510-520.

O'Reilly, Charles, "The Use of Information in Organization Decision Making: A Model and Some Propositions," Research in Organizational Behaviour, Vol 5, (1983), 103-139.

Payne, J.W., "Task Complexity and Contingent Processing in Decision Making: An

Information Search and Protocol Analysis," Organization Behaviour and Human Performance, (1976), 366-387.

Payne, J.W., M.L. Braunstein and J.S. Carroll, "Exploring Predecisional Behaviour: An Alternative Approach to Decision Research," Organizational Behaviour and Human Performance, Vol 22, (1978), 17-44.

Peters, James M., "A Cognitive Computational Model of Risk Hypothesis Generation," Journal of Accounting Research, Vol 28, (Supplement, 1990), 83-109.

Punj, G.N. and R. Staelin, "A Model of Consumer Information Search Behaviour for New Automobiles," Journal of Consumer Research, Vol. 9 (March, 1983), 366-380.

Quillian, M.R., "Semantic Memory," in Semantic Information Processing, Cambridge: MIT Press, (1968).

Ricchiute, David N., "Working Paper Order Effects and Auditors' Going concern Decisions," Accounting Review, Vol 67 No 2, (January, 1992), 46-58.

Robinson, C. and L. Fertuck, Materiality: An Empirical Study of Actual Auditor Decisions, Certified General Accountants' Research Foundation, Research Monograph Number 12, (1985).

Roenker, D.L., C.P. Thompson, and S.C. Brown, "Comparison of Measures for the Estimation of Clustering in Free Recall," Psychological Bulletin (November, 1969), 45-48.

Rubin, A.D, "Hypothesis Formation and Evaluation in Medical Diagnosis," MIT-A1 Technical Report no 316, Massachusetts Institute of Technology, 1975.

Salterio, Steven, "A study of Expertise Development in Public Accounting," Working paper presented at The Contemporary Accounting Research Conference, Edmonton, Alberta, May 1-3 (1993).

Shaklee, H. and B. Fischhoff, "Strategies of Information Search in Causal Analysis," Memory and Cognition, Vol 10 No 6, (1982), 520-530.

Simnett, R. and K. Trotman, "Auditor vs. Model: Information Choice and Information Processing," Accounting Review, (1989), 514-529.

Simon, H., The New Science of Management , New York: Harper & Row, (1960).

Simon, H., "The Structure of Ill-Structured Problems," Artificial Intelligence.,Vol 4 (1973), 181-202.

Shanteau, J., "Some Unasked Questions About the Psychology of Expert Decision Makers," in Proceedings of the 1984 IEEE Conference on Systems, Man and Cybernetics, (ed. M.E. El Hawary, IEEE), 1984.

Taylor, S.E. and J. Crocker, "Schematic Bases of Social Information Processing, in Social Cognition, The Ontario Symposium, Higgins, E.T., C.P. Herman and M.P. Zanna (eds.), Hillsdale, N.J.: Lawrence Erlbaum Associates, (1981), 89-134.

Trotman, K.T., and J. Sng, "The Effect of Hypothesis Framing, Prior Expectation and Cue Diagnosticity on Auditors' Information Choice," Accounting, Organizations and Society, (1989), 565-576.

Tubbs, R. M., "The Effect of Experience on the Auditor's Organization and Amount of Knowledge," Accounting Review, Vol 67 No 4, (October, 1992), 783-801.

Tubbs, R. M., W.F. Messier, Jr., and W.R. Knechel, "Recency Effects in the Auditor's Belief-Revision Process," The Accounting Review, (April, 1990), 452-460.

Tversky, A. and D. Kahneman, "Judgment Under Uncertainty: Heuristics and Biases," Science, (27 September 1974), 1124-1131.

Voss, J.F., T.R. Greene, T.A. Post and B.C. Penner, "Problem Solving Skill in the Social Sciences," in The Psychology of Learning: Advances in Research and Theory, Vol. 17, G. Bower (ed.), N.Y., N.Y: Academic Press, (1983), 165-213.

Voss, J.F. and T.A. Post, " On the Solving of Ill-Structured Problems. in The Nature of Expertise (eds. M.T. H. Chi, R. Glaser and M.J. Farr), Hillsdale, N.J.: Lawrence Erlbaum Associates, 1988.

Voss, J.F., G.T. Vesonder and G.J. Spilich, "Text Generation and Recall by High-Knowledge and Low-Knowledge Individuals," Journal of Verbal Learning and Verbal Behaviour, (1980), 651-667.

Waller, W.S., and W.L. Felix Jr., "The Effects of Incomplete Outcome Feedback on auditors' Self-Perceptions of Judgment Ability," The Accounting Review, (October 1984a), 637-646.

Waller, W.S. and W.L. Felix Jr., "The Auditor and Learning From Experience: Some Conjectures," Accounting, Organizations and Society, Vol. 9, (1984b),383-408.

Waller, W.S. and W.L. Felix Jr., "Cognition and the Auditor's Opinion Formulation Process: A Schematic Model of Interactions Between Memory and Current Audit Evidence," in Decision Making and Accounting: Current Research, S. Moriarity and E. Joyce (eds.), University of Oklahoma, Center for Economic and

Management Research, (1984c).

Weber, R. "Some Characteristics of the Free Recall of Computer Controls by EDP Auditors," Journal of Accounting Research, Vol 18 No 1 (1980), 214-241.

Chapter 2. Experience and Information Search Behaviour

I. INTRODUCTION

This chapter examines the differences in the information search behaviour of experienced and novice auditors. As was discussed in chapter 1, it was expected that the behaviour of the two groups would differ. This expectation was based on evidence that has shown that the knowledge structure of experienced auditors, like other experts, tends to contain more concepts which are more tightly linked together according to more abstract relationships. Additionally, experts tend to have more richly developed procedural schema which guide them in the problem solving process. These findings led to the following hypotheses, stated in alternative form:

H 2.1: Experienced auditors will request more information items than the novices will.

H 2.2: Experienced auditors will generate more hypotheses than novices will.

H 2.3: Experienced auditors will search through more categories of information than novices will.

H 2.4: Experienced auditors will be more efficient in that the amount of information search in an area will be proportional to the likelihood they assign to it.

H 2.5: Experienced auditors will reach a different conclusion than the novices will.

H 2.6: Experienced auditors will tend to retrieve information according to goal derived categories whereas novices will tend to retrieve information according to methodologically derived categories.

H 2.7: Experienced auditors will be more efficient in that they will spend less time

per item of information acquired than novices will.

H 2.8: Experienced auditors will perform fewer recursions than novices.

H 2.9: Experienced auditors will retrieve proportionately more contextual data of a general background nature than will the novices.

These hypotheses were all tested using data gathered from the experiment described in Chapter 1. The results were analyzed across information search regime; that is, experienced auditors under the active search regime were combined with experienced auditors under the traditional search regime and likewise for novices. This was done as the hypotheses above were solely concerned with experience main effects, while the effect of the interface and its interaction with experience are discussed in Chapter 3. As will be seen in the discussion at the end of Section II, neglecting the effect of the interface influenced the findings regarding the effects of experience on information search.

The variables used in the analysis are listed and defined in Table 2-1 and the descriptive statistics are contained in tables 2-4 to 2-10. There were two main groups of analyses performed. First, t-tests were performed on experienced auditors vs. novices for all the variables for all three tasks. These t tests are grouped by task in tables 2-11 to 2-17 inclusive. Next, since the tasks varied in their degree of structure, ANOVA analyses with repeated measures were performed on each variable to determine if there was a task by experience interaction. Such an interaction should be present if expertise does become more important when tasks are less structured, as was suggested in Chapter 1. As the third task was optional, it was not done by 18 of the 52 participants. As a result, the ANOVA analysis using all three tasks was less powerful than an analysis comparing just

the Cash and Park Tasks because the analysis for each variable only included cases where there were values for all three tasks. The analysis was run both ways, and since most of the results were identical only those from the three task analysis are presented in tables 2-18 to 2-26 inclusive. Any different results are mentioned in the text.

The chapter proceeds as follows. The second section discusses the results of the hypotheses, including the effects of task structure. This section also contains the results of the manipulation checks. The third section discusses the robustness of the results using different measures of expertise. Finally, a brief conclusion is offered.

II. RESULTS

The first three hypotheses dealt with the extent and breadth of the auditors' information search. The number of cards searched by an auditor for each task (Ncard), and the net number of cards searched (Net) were used to evaluate hypothesis 2.1. These two variables were different as participants often requested to see a particular item of information more than once. The Ncard variable included these repetitions, whereas Net did not. At the end of each task, participants were asked to list the hypotheses they considered throughout the task and rank them according to their likelihood[10]. The total number of these hypotheses generated by each participant (Nalt) was used to test hypothesis 2.2. In order to test hypothesis 2.3, all the information cards were first categorized by the researcher according to the goal that the information would satisfy, as

---

[10]Appendix B contains copies of the screens presented to the participants after they had completed their information search. These screens requested them to enter their conclusions, the hypotheses they considered, the likelihood of those hypotheses, and the demographic information that formed the basis of the expertise classifications used for the next section of this chapter.

discussed in Chapter 1. Examples of such goals would be the detection of errors that may have occurred, or the detection of financial statement assertions that have been violated. The goal categories for each task are shown in Table 2-2. A fellow Ph.D. student with several years experience as a chartered accountant agreed with the goal categories and independently categorized each of the information cards. Kappa Coefficients for the Cash, Park, and Digger tasks, were 1.0, .92, and .87 respectively and all disagreements were reconciled. For hypothesis 2.3, then, the number of goal categories from which information was requested was counted for each auditor (Ncat).

The results from the first four hypotheses were generally in the expected direction, although none of the t statistics were significant. The experienced auditors did search for more information cards (both Ncard and Net) in all three tasks. Experienced auditors also generated more hypotheses and searched through more categories than the novices in the Park and Digger tasks, but not in the Cash Task. The ANOVA analysis in tables 2-18 through 2-20 did show highly significant task effects for all 4 variables as expected, although again the experience effect and the experience by task interaction were not significant. An ANOVA analysis comparing just the Cash and Park tasks (not shown in the tables) indicated a significant experience effect for the Net variable only, with all other results being the same as under the three task level analysis.

Hypothesis 2.4 stated that experienced auditors would devote greater information search to investigate those hypotheses that they felt were more likely. As mentioned above, participants were asked to list and rank the alternatives they considered after the

task was completed, similar to a retrospective protocol[11]. These alternatives were then coded according to their goal category. Next, these goal categories were ranked according to the likelihood ranks provided by each participant. Then, the goal categories were ranked according to the extent that information was actually requested from that category. For each category, a measure was constructed of the number of information requests from that category, divided by the total number of information items available from the category. Such a scaling was necessary as the number of items in each category differed. Finally, the Spearman Rank Correlation Coefficient (Corr) was calculated based on the similarity between the ranking of the categories based on the participant's assessment of the likelihood of alternatives, and the ranking of the categories based on the subject's actual information search.

The results for hypothesis 2.4 were in the expected direction: experienced auditors had a higher correlation between their likelihood rankings and their actual information search than did the novices. The difference was highly significant in the Park task, although not for the Cash or Digger tasks. The ANOVA results[12] in table 2-21 demonstrated a highly significant task effect, indicating that it was more difficult to

---

[11]It was decided that this method was preferable to having the subjects list the alternatives throughout the task, as that could act as a decision aid by perhaps helping the subject to organize their information search. Nevertheless, the evidence of the completeness of retrospective protocols is somewhat mixed (Ericcson and Simon, 1980), so caution should be exercised when interpreting these results.

[12]The degrees of freedom in the ANOVA analyses for Corr, Srcnhyp and Hypnsrc are lower than for other variables because of the 34 participants who performed all three tasks, 19 did not state any hypotheses for at least one of those three tasks. Hence, it was not possible to calculate values for Corr, Srcnhyp or Hypnsrc in these cases.

follow a clear and organized search strategy as tasks became less structured. The experience effect and the task by experience interaction were not significant. There was a significant experience effect in addition to the significant task effect, however, for the ANOVA analysis comparing only the Cash and Park tasks (not shown in the tables).

In addition to the correlation between the participants' likelihood rankings and their actual information search, data was also gathered on how well the hypotheses or alternatives suggested by the participants corresponded with their information search. The variable Hypnsrc measured the number of goal categories from which a hypothesis was generated but no information was searched, and Srcnhyp counted the number of goal categories from which information was requested but no hypothesis was generated. In effect, a positive Hypnsrc could indicate that participants were following a self-terminating search strategy. That is, once they were satisfied that one hypothesis was confirmed they would not continue to investigate the others. Alternatively, it could indicate inadequate search, or that participants did not use hypotheses to guide information search. A positive Srcnhyp could likewise indicate that participants did not use hypotheses to guide information search or that they had forgotten to report a hypothesis.

The results for Hypnsrc and Srcnhyp were not significant. Hypnsrc was lower for experienced auditors in the Cash and Park tasks but higher in the Digger task. Srcnhyp was higher for experienced auditors in all three tasks. The ANOVA analysis in table 2-21 also revealed that Srcnhyp had a significant task effect.

Hypothesis 2.5 stated that the experienced auditors would reach different

conclusions than the novices would. The actual conclusion variables were different for each task. In the cash task, participants had to decide whether cash was fairly stated. The conclusion variables were therefore whether the account was fairly stated (FairC) and its amount (ValueC). Similarly, for the Park task, participants had to decide on what basis they would value the animal inventory (MethodP), the assurance they would provide in the audit report (AssurP) and the amount of the inventory (ValueP). Finally, for the Digger task participants had to determine whether the client was overcharged or not (ChargeD). There was absolutely no difference in the conclusion variables for the cash task, consistent with it being an uncomplicated, well-structured task. For the Park Task, the MethodP variable was moderately significant, although AssurP and ValueP were not. Finally, in the Digger task, the ChargeD variable was highly significant, consistent with this task being the least structured. However, since the variables differed for each task, it was not possible to use ANOVA to establish a task by experience interaction.

It was possible in the Cash and Digger tasks to evaluate whether the auditors arrived at the correct decision. In the Cash task, the account was actually fairly stated. All participants reported this conclusion (FairC=1), although one expert and one novice reported an incorrect value for the account (ValueC), that being the value on the bank statement rather than the account balance. For the Digger task, the correct answer was that the client had been overcharged (Charged=1), but interestingly more novices than experts arrived at this conclusion.

According to Einhorn (1974), experts should exhibit more consensus than novices. It is apparent from the standard deviation of the response variables that the experienced

auditors did exhibit greater consensus than the novices in the Cash and Digger tasks, but less consensus than the novices in the Park Task.

Hypothesis 2.6 stated that experienced auditors would cluster their information search according to goal derived categories whereas novices would cluster their information search according to the method employed to gather the information. The procedure used to develop the goal categories and classify the information items was discussed above. The same procedure was followed to develop the method categories. The method categories for all three tasks were developed based on the classification of methods listed in the CICA handbook Section 5100 and are shown in Table 2-3. The information items were then classified independently by the researcher and the same colleague mentioned above. The Kappa coefficients of agreement for the Cash, Park and Digger tasks were 1.0, .86, and .91, and all disagreements were reconciled.

The dependent variable for each participant was index of clustering developed by Roenker, Thompson, and Brown (1971) called the adjusted ratio of clustering (ARC). They argue the their ARC measure provides an uncontaminated measure of relative amount of clustering in free recall, thereby allowing for comparisons between and within subjects. The measure scores clustering where zero represents clustering according to chance and 1 represents perfect clustering. The measure is invariant to the number of categories the subject recalls, the distribution of total items recalled across categories and the total number of items recalled. It should be noted that although the measure is intended to look at clustering under a free recall situation, it is equally applicable in this case for determining the clustering of information items requested. If experts had a

memory structure that reflects goal-derived categorization it was expected that they would exhibit a higher ARC when the information items were categorized by goal, and would exhibit lower categorization when the information items were categorized by method. Therefore, each participant had two measures: Goal represented the ARC score when information items were classified into goal categories and Meth represented the ARC score when the classification was based on the method categories.

The hypothesis was not confirmed. As expected, the Goal measure was higher for experienced auditors in the Cash and Digger tasks, but not the Park task. However, the differences between the groups were not significant. The ANOVA analysis[13], as shown in table 2-22 did reveal a significant task effect. Contrary to expectation, the Meth score was higher for experienced auditors than novices in the Cash and Digger tasks, although again the differences were not significant.

Hypothesis 2.7 stated that experienced auditors would be more efficient in that they would spend less time to evaluate each information item . The computer program tracked the amount of time spent in minutes by each participant to complete each task (Time). The variable Eff was computed as the total time for the participant to complete the task divided by the total number of information items requested. Therefore, it was expected that Eff would be lower for the experienced auditors. This was indeed the case

---

[13] the ANOVA analyses for Meth and Goal contained fewer degrees of freedom because participants were excluded from the analysis if all the information items they requested were within only one category for at least one of the tasks. This exclusion was done to avoid artificially inflating the Meth and Goal scores because the values for these participants would have been 1 (perfect categorization). This resulted in the exclusion of 13 participants for Goal and 10 participants for Meth out of the 34 participants who performed all three tasks.

for the Cash and Park tasks, although only the Park task results were significant. Oddly enough, the reverse relationship held in the Digger task: experienced auditors took longer over each information item, although again the difference was not significant. The ANOVA results shown in table 2-23 likewise were not significant.

Hypothesis 2.8 was tested by looking at the number of times a particular information item was re-requested (Rpeat). Contrary to expectations, experienced auditors performed more recursions than the novices in all three tasks, although only the differences in the Digger task were significant. The ANOVA analysis comparing only the Cash and Park tasks (not shown in the tables) also shows a significant task effect, which would indicate that auditors performed more recursions for the more difficult and less structured task. This effect was no longer significant, however, when the Digger task was added to the ANOVA as can be seen in table 2-24.

Hypothesis 2.9 predicted that experienced auditors would retrieve more background information item than the novices. The variable Propk1 was computed as the number of items retrieved from goal category 1 (Background information) divided by the total number of information items retrieved. For all three tasks experienced auditors retrieved slightly more background items but the differences were not significant. The ANOVA analysis shown in table 2-25 did reveal a significant task main effect.

The experiment also included a number of manipulation checks to ensure that the experienced auditors and novices did not systematically differ in other than their experience, and that the participants were motivated. The experienced group and the novices did differ significantly in their age, their score on four GMAT questions

(Gmatscor), and the number of hours (Hourread) spent reading each week. The implications of these three variables is discussed in the next section. The two groups did not differ in how easy they found the computer program to use (Easy), how interesting they found the experiment (Interest), how long they felt the experiment was (Long), how much they felt the computer program interfered with their natural thought processes (Interfere), or their performance on a typing test (Typetest). Similarly, the two groups did not differ in how complete they thought the information was for each of the three tasks (Comp), or how realistic they found the tasks (Real). Not surprisingly, the novices did rate the park task as being significantly more difficult than the experts did (Diff) , and were less confident in their answers (Conf). There were no significant differences in the other two tasks. Finally, the ANOVA analyses shown in table 2-26[14] did indicate significant experience and task effects for the Diff variable and for the number of years experience the participants thought would be needed to perform the task (Assgn). This indicates that participants did indeed feel that the tasks were progressively more difficult[15]. When evaluated together, the participants rated the program as easy to use (mean score of 3.55 out of 5), the experiment as being interesting (mean score of 3.36

---

[14] The degrees of freedom in the ANOVA analyses of Conf, Assgn and Diff are lower than other variables because, out of the 34 participants performing all three tasks, 10 did not answer the manipulation questions regarding Assgn and Diff in at least one task and 11 did not answer the manipulation question for Conf in at least one task.

[15] The subjects were not asked specifically whether they found the tasks varied in their degree of structure as it is a concept that they are unfamiliar with. However, since unstructured tasks are generally more difficult and require greater expertise the results of Diff and Assgn would seem to indicate that the Park and Digger tasks were less structured than the Cash task, as intended.

out of 5), and realistic (mean scores for the three tasks respectively were 3.9,3.2, and 4.2 out of 5), although they found that the program interfered somewhat with their natural thought processes (mean 2.58 out of 5).

In general, the pattern of results was consistent with the hypothesized relationships, but most of the differences were not significant. Similarly weak results have been found in other studies examining the effects of experience on information search using traditional information search methodologies (Bédard and Mock, 1992; Kaplan and Reckers, 1989). Three eventualities may have contributed to the lack of findings in this study. First, constraints on the number of subjects available may have limited the statistical power of the tests. This possibility is addressed in Table 2-27 which shows the t-test results that would have occurred in the park task had a greater number of auditors participated in the experiment. This analysis was performed on park task variables because it was the least structured task that was performed by all subjects; hence, it would have been the most likely to demonstrate experience effects. The table contains five variables which were selected because they did not provide significant results, and varied in the extent of the difference between experienced subjects and novices. It was assumed that the sample means and standard deviations would be unchanged if more subjects participated in the experiment. Thus, the change in the significance of the results would arise only from the sample standard deviation being divided by a larger sample size and the additional degrees of freedom. As the table demonstrates, having 100 or 200 subjects versus the 52 that were actually used for the experiment would not have greatly improved the findings. Furthermore, finding 100 or more participants would not

have been feasible.

Another possible cause for the lack of results may have been the way in which the results in this chapter were analyzed. Recall that this chapter ignored the way in which participants requested information: participants from the different information search regimes were collapsed into one experienced and one novice group. However, the hypotheses tested in Chapter three propose that the results are different under the information search regimes. Indeed, the results from those hypotheses demonstrate that participants under the traditional information search regime perform differently from participants under the new information search regime, regardless of experience. However, the implications for the results presented in this chapter are as follows: the different information search regimes introduced additional variability within the experienced and novice groups when the information search regimes were combined. Thus, although the means of various variables were different between the experienced and novice groups some of the hypotheses were not confirmed because the variance overall and within each group was too large. That is, the effect of the information search regime "swamped" the experience effect. The ANOVA analyses in chapter three demonstrate that this was the case. The analyses in that chapter partition out the effects of the interface, experience and task and the interactions between these effects. Thus the variability attributable to the information search regime was removed from the experience main effects in the chapter three analyses. Table 2-28 compares the results on experience from this chapter with the results regarding the experience main effects in Chapter three: that is, the table compares the effect of experience with and without the effect of the interface removed. As is

shown in the table, the effects of experience are more evident when the information search regime effect is removed; experienced auditors retrieved more information than novices (hypothesis 2.1), searched through more categories of information (hypothesis 2.3), exhibited stronger links between their assessed likelihood of hypotheses and the extent of information search devoted to those hypotheses (hypothesis 2.4), and spent less time per information item (hypothesis 2.7).

A third eventuality that may have contributed to the lack of findings is the possibility that experience is not a good measure of expertise. This is investigated in the next section.

III. IMPACT OF DIFFERENT EXPERTISE MEASURES

The results in the previous section compared "expert" and novice auditors where expertise was defined by the participant's years of experience. However, as discussed in Chapter 1, several researchers have suggested that expertise is task specific, and that experience may not be a good indicator of expertise. As a result, a number of other measures of expertise were gathered. This section investigates the sensitivity of the research findings to alternative measures of expertise.

This paper followed approximately the types of expertise suggested by Bonner and Lewis (1990), hereafter referred to as BL. They defined four major types of knowledge and ability as relevant to auditing tasks. General domain knowledge includes "a basic level of accounting and auditing knowledge, including knowledge of generally accepted accounting principles, generally accepted auditing standards, and the flow of transactions through an accounting system". Since this knowledge would be acquired by

general experience, years of experience was used as its proxy. Second, BL identified general business knowledge, such as "an understanding of management incentives in a variety of contractual situations". They thought that one major avenue for acquiring this knowledge was through reading business related literature. Therefore, participants were asked how many hours per week they spend reading business journals, magazines and financial statements (hourread). Next, BL suggested that problem solving ability could be an important determinant of expertise. This ability was measured using four questions drawn from the Problem Solving section of the Graduate of Management Admissions Test (GMAT). These questions were numerical in nature, but required only simple arithmetic computations. "Gmatscor" was the participant's number of correct responses to these questions. Finally, BL thought subspecialty knowledge, such as knowledge of specialized industries, would be important. Following a similar approach as theirs, a determination was made of what types of specific experience could be helpful in performing the experimental tasks. This determination was made through discussions between the researcher and the auditors who had initially encountered the tasks in actual practice. Additionally, participants in the pilot studies were asked to explain what types of prior experience would be helpful in performing the tasks. From this information, it was determined that prior experience with the audit of cash sections (CashC) would be relevant (not surprisingly) for the Cash task. Experience with audits of livestock inventory (LivestkP) and assets valued on a non-historic cost basis (NonhcP) would be relevant for the Park task. Experience with special audits (SpecialD) and familiarity with cost-plus contracts (CostD) would be beneficial for performing the Digger task. The

participants in the experiment were asked to self-assess their familiarity with the tasks, and then were asked to what prior experiences, if any, had helped them to perform the experimental tasks. None of the participants reported any source situations other than the ones already determined. Finally, participants rated their familiarity in each of the specific areas above.

Table 2-29 shows the correlation between these expertise measures. The correlations were nearly all positive, indicating that an auditor possessing expertise according to one dimension would be more likely to possess expertise on other dimensions as well. However, since the correlations were less than perfect, it was possible that different expertise measures would yield different results.

The determination of the impact of the alternative expertise measures was a three step process. First, two sets of regressions were run. The first set contained the experience measure (exp) as its only independent variable. The second set contained exp as well as the other expertise measures. By comparing the amount of unexplained variation of the two sets of regressions, one could ascertain whether the additional expertise measures together made an incremental explanatory contribution. The following F test was appropriate to test this :

$$F(j, n\text{-}m\text{-}1) = [(SSE_s - SSE)/j] / [SSE/(n\text{-}m\text{-}1)]$$

where SSE_s was the unexplained variation of the regression with only Exp as the independent variable, SSE was the unexplained variation of the full regression, and j was the number of additional variables entered into the full regression (Harnett, 1982 page 576).

Once it was ascertained that the additional variables were jointly significant, the t statistics on the individual coefficients in each particular regression were examined to compare the relative significance of each measure. The regression results and F tests are shown on tables 2-30 through 2-32. After determining which measures overall tended to yield the most significant results, these measures were used to divide the participants into re-defined novice and expert groups based on whether participants were above or below the median value of the expertise measure. Then, the t statistics for the dependent variables were re-run using the re-defined experts and novices. The t statistics under the alternative measures are compared on tables 2-33 through 2-35.

Regressions were first run on the participants' self-assessed familiarity with the tasks (Sim) against the measures of expertise above. This could be considered as a validity check on these measures as they showed how well the expertise measures chosen could explain the participants' own perceptions of their expertise. The R^2 for the regressions on the Cash task, Park task and Digger task were .30, .43, and .13 respectively. The significance of the individual coefficients in these regressions are the first entries on tables 2-30 through 2-32. For the cash task, Hourread and [illegible] were significant explanatory variables. For the Park task, LivestkP was highly significant. Hourread was significant in the wrong direction. None of the expertise variables were significant for the Digger task. However, as this was the most unusual and unstructured task, 22 out of 25 participants rated the task as being completely unfamiliar, with the other 3 rating it as being somewhat unfamiliar. This lack of variance in the dependent measure may have contributed to the lack of findings in the regression.

Tables 2-30 through 2-32 then show the explanatory strength of the expertise measures on the dependent variables used to test the research hypotheses. It was evident that the joint effect of the additional expertise measures frequently provided explanatory power over and above the experience measure alone. Among the additional measures, the measures for specific experience had relatively little explanatory power, with the exception of CashC. However, Gmatscor and Hourread were frequently significant. Therefore, the T tests were re-run using Gmatscor and Hourread as the categorical variables. T tests were also run classifying participants on their self-assessed familiarity with the tasks (Sim).

The results on table 2-33 for the cash task show that categorizing participants according to Sim produced the strongest results between groups. Classifying participants on the other measures showed few differences. This is not surprising: the Cash task was very structured, relatively uncomplicated and would likely be assigned to an auditor with very little experience. Indeed, participants felt on average that the task was appropriate for someone with only one year of experience (mean of AssgnC=.959). Therefore, if the task required little experience, problem solving ability or general business knowledge as measured by Exp, Gmatscor and Hourread, the lack of results would be expected.

The Park task demonstrated stronger results under all four measures as would be expected following this line of reasoning. Again, table 2-34 shows that the participants' perceptions of their own expertise provided the classification with the strongest results. Gmatscor and Experience provided similar results, and indeed these variables were correlated: table 2-29 shows a correlation of .25, and table 2-11 shows that experienced

auditors and novices differed significantly on their GmatScor. If Gmatscor does indeed demonstrate general problem solving ability, it is interesting that this may develop along with general auditing experience. Participants classified according to Hourread also showed some interesting results: the "experts" here saw fewer information cards, requested fewer repeats, had a closer mapping between their hypotheses and their information search (Srcnhyp) and reached different conclusions. This is consistent with Hourread indeed being a proxy for general business knowledge which could in turn provide a problem solving schema that would allow subjects to search more effectively.

The Digger task showed no differences between participants classified according to SimD. However, since nearly all the participants reported that they were completely unfamiliar with the task (as expected), there were only 3 participants in the "expert" category. This could have contributed to the lack of findings. Gmatscor showed the strongest results, which is consistent with this being an unfamiliar task where auditors would probably have no schema or source analog to draw upon. Moreover, this task was not a typical audit situation but instead required more reasoning ability regarding how the formula for cost increases worked and where the exposure to errors and misstatements lay. Therefore, it is interesting that Gmatscor, which was designed to proxy for general problem solving ability, was the most significant.

IV. CONCLUSION

In general, most of the hypothesized relationships between experienced and novice auditors held. The experienced auditors did conduct a more complete information search, did so more efficiently than the novices and reached different conclusions. There was

also evidence to indicate that their search was more effective in that they tended to concentrate their effort in areas of higher priority However, few of these differences were statistically significant. Results were stronger when auditors were classified according to their self-perceptions of expertise. The classification of auditors by their score on four GMAT questions and the number of hours spent per week reading business literature, which were designed to proxy for problem solving ability and general business knowledge, also produced somewhat stronger results. Using the specific experience measures generally did not provide significant results.

The results also confirmed prior research findings that it is important to consider task structure when studying expertise. Participants found that the less structured tasks were more difficult, and these tasks revealed more differences between novices and experts.

Table 2-1. List of Variables

Descriptive Variables and General Manipulation Checks:	
VARIABLE	DESCRIPTION
Exp	classification based on experience: 1=3 Yrs or more, 0=less than 3 yrs
Gmatscor	Number of correct responses to GMAT questions (max=4)
Age	Age of participant
Hourread	Number of hrs spent per week reading business journals etc.
Interfac	Information Search Regime (1=active, 2=traditional)
Easy	Ease of interface to use (1=hard, 5=easy)
Interest	How interesting experiment was (1=not, 5=very)
Long	How long experiment was (1=too long, 5=too short)
Interfere	How much interface interfered with natural thought processes (1=a lot, 5=not at all)
Typetest	Number of seconds to complete typing test

...continued

Table 2-1 (continued). List of Variables

Task Variables:	
VARIABLE	DESCRIPTION
Ncard	Number of information cards requested (repeats included)
Net	Number of net information cards requested (repeats eliminated)
Nalt	Number of alternative hypotheses advanced by par[illegible]
Ncat	Number of categories searched
Corr	Correlation between priority of hypothesis and a[illegible] of search devoted to it
Hypnsrc	Number of categories from which a hypotheses was generated but from which no information was retrieved
Srcnhyp	Number of categories from which information was retrieved but from which no hypothesis was generated
FairC	Whether cash in cash task is fairly presented (1=yes, 2=no)
ValueC	Value of cash in cash task
AssurP	Assurance level in park task (1=clean, 2=qualified as to quantity, 3=quali[illegible]s to value, 4=qualified as to both, 5=adverse)
MethodP	Inven[illegible]on method recommended in park task (1=his[illegible]=market, 3=nomi[illegible]l amount)
ValueP	Value of in[illegible]ory in park task
ChargeD	Whether client was overcharged in digger task (1=yes, 2=no)
Meth	Index of Methodological Category Clustering
Goal	Index of Goal Category Clustering
Time	Time in minutes to complete task
Eff	Efficiency (time/number of cards requested)
Rpeat	Number of recursions (cards seen more than once)
Propk1	Proportion of information retrieved of background nature

...continued

Table 2-1 (continued). List of Variables

Task Descriptive Variables and Manipulation Checks:	
VARIABLE	DESCRIPTION
Comp	How complete information provided was (1=not, 5=very)
Conf	How confident participant was regarding conclusion (1=not, 5=very)
Diff	How difficult task was (1=easy, 5=hard)
Real	How realistic task was (1=not, 5=very)
Assgn	Number of years experience person assigned to task should have
Sim	Familiarity of task (5=very similar and recent, 4=very similar but not recent, 3=somewhat similar and recent, 2=somewhat similar but not recent, 1=never seen anything like it)
CashC	Familiarity with cash sections (same coding as Sim)
LivestkP	Familiarity with accounting for and auditing livestock (same coding as Sim)
NonhcP	Familiarity with accounting for and auditing assets valued on a basis other than historic cost (same coding as Sim)
CostD	Familiarity with auditing cost-plus contracts (same coding as Sim)
SpecialD	Familiarity with special audits (same coding as Sim)

Table 2-2. Goal Categories
Cash Task:

	It is hypothesized that the appropriate goals would be the relevant financial statement assertions for the cash account. The categories are as follows:
Number	Description
1	Background data/knowledge of business/information schedules
2	procedures to verify system and internal controls
3	procedures to verify existence/completeness of cash

Park Task:

	As with the cash task, it is hypothesized that the appropriate goals would be the relevant financial statement assertions for the animal inventory of the park. Furthermore, since the participants must also decide on the appropriate valuation method, the goal for the valuation assertion is subdivided into goals for each valuation alternative. The categories are as follows:
Number	Description
1	Background data/knowledge of business/information schedules
2	procedures to verify valuation based on market value
3	procedures to verify valuation based on historic cost
4	procedures to verify valuation / writedowns due to health or age of animals
5	procedures to verify quantities of animals

...continued

Table 2-2 (continued). Goal Categories
Digger Task:

	It is hypothesized that the goals would be to detect various errors that could contribute to the pattern of large price increases being passed on to the client. The categories are as follows:
Number	Description
1	Background data/knowledge of business/information schedules
2	procedures to detect warranted and unwarranted increases in current cost
3	procedures to detect inefficient purchasing or collusion
4	procedures to detect mathematical errors or incorrect selling prices
5	procedures to detect record keeping errors
6	procedures to detect incorrect base price

Table 2-3. Method Categories

Number	Description
1	Background data/knowledge of business/information schedules
2	analytical review
3	computation
4	inspection and vouching
5	enquiry
6	confirmation
7	observation and count attendance
8	compliance tests

Table 2-4. Descriptive Statistics: Descriptive Variables and General Manipulation Checks

Variable	N	Min	Max	Mean	S.D.
Exp	52	0.000	1.000	.500	.505
Gmatscor	51	0.000	4.000	2.314	1.010
Age	48	22.000	35.000	27.000	3.952
Hourread	50	.500	15.000	5.890	3.537
Interfac	52	1.000	2.000	1.423	0.499
Easy	50	1.000	5.000	3.550	1.153
Interest	50	1.000	5.000	3.360	0.851
Long	50	2.000	5.000	3.300	0.678
Interfere	50	1.000	5.000	2.580	1.144
Typetest	50	81.000	338.000	148.880	46.418

Table 2-5. Descriptive Statistics: Cash Task Variables

Variable	N	Min	Max	Mean	S.D.
Ncard	49	3.000	20.000	9.000	3.808
Ner	49	2.000	15.000	7.061	3.579
Nalt	49	0.000	7.000	2.878	1.844
Ncat	52	0.000	3.000	2.135	0.950
Corr	44	0.257	1.000	0.735	0.201
Hypnsrc	44	0.000	2.000	0.250	0.534
Srcnhyp	44	0.000	2.000	1.205	0.795
FairC	49	1.000	1.000	1.000	0.000
ValueC	48	41750.000	43075.000	42697.917	309.290
Meth	45	-2.000	1.000	0.073	0.502
Goal	38	-2.000	1.000	0.205	0.569
Time	49	11.000	55.000	24.776	9.410
Eff	49	0.733	14.667	3.346	2.274
Rpeat	49	0.000	10.000	1.939	2.125
Propk1	49	0.000	0.667	0.229	0.173

Table 2-6. Descriptive Statistics: Cash Task Descriptive Variables and Manipulation Checks

Variable	N	Min	Max	Mean	S.D.
Comp	49	1.000	5.000	3.408	1.206
Conf	49	1.000	5.000	3.633	1.202
Diff	48	1.000	5.000	2.094	0.885
Real	49	1.000	5.000	3.949	1.209
Assgn	49	0.000	2.000	0.959	0.509
Sim	47	1.000	5.000	3.383	1.714
CashC	49	2.000	5.000	3.969	1.166

Table 2-7. Descriptive Statistics: Park Task Variables

Variable	N	Min	Max	Mean	S.D.
Ncard	51	1.000	48.000	15.020	10.672
Net	51	1.000	34.000	11.961	9.193
Nalt	51	0.000	6.000	3.353	1.610
Ncat	52	0.000	5.000	3.442	0.378
Corr	49	-0.086	0.943	0.533	0.251
Hypnsrc	49	0.000	2.000	0.469	0.680
Srcnhyp	44	0.000	2.000	1.205	0.795
AssurP	45	1.000	4.000	2.333	0.953
MethodP	48	1.000	3.000	1.292	0.544
ValueP	42	0	2,300,000	1,185,357	608,716
Meth	45	-1.000	1.000	0.121	0.419
Goal	45	-0.615	1.000	0.090	0.372
Time	50	12.000	80.000	40.240	15.819
Eff	51	0.000	16.500	4.114	3.512
Rpeat	51	0.000	14.000	3.059	3.608
Propk1	51	0.000	1.000	0.519	0.212

Table 2-8. Descriptive Statistics: Park Task Descriptive Variables and Manipulation Checks

Variable	N	Min	Max	Mean	S.D.
Comp	49	1.000	5.000	3.041	1.241
Conf	48	1.000	5.000	3.042	1.091
Diff	49	1.000	5.000	3.592	0.888
Real	49	1.000	5.000	3.194	1.065
Assgn	49	2.000	8.000	3.316	1.257
Sim	47	1.000	3.000	1.213	0.623
LivestkP	49	1.000	3.000	1.122	0.389
NonhcP	48	1.000	5.000	1.958	1.220

Table 2-9. Descriptive Statistics: Digger Task Variables

Variable	N	Min	Max	Mean	S.D.
Ncard	30	0.000	40.000	11.233	9.985
Net	30	0.000	32.000	9.800	8.782
Nalt	30	0.000	5.000	2.033	1.847
Ncat	28	1.000	6.000	3.964	1.575
Corr	19	-0.343	1.000	0.506	0.351
Hypnsrc	19	0.000	1.000	0.316	0.478
Srcnhyp	19	0.000	4.000	2.211	1.182
ChargeD	31	1.000	2.000	1.710	0.461
Meth	25	-1.000	1.000	0.172	0.529
Goal	24	-1.000	1.000	0.181	0.544
Time	29	7.000	44.000	25.000	8.944
Eff	29	0.000	13.000	3.422	2.747
Rpeat	30	0.000	8.000	1.433	1.906
Propk1	29	0.000	0.750	0.235	0.221

Table 2-10. Descriptive Statistics: Digger Task Descriptive Variables and Manipulation Checks

Variable	N	Min	Max	Mean	S.D.
Comp	25	1.000	5.000	3.480	1.046
Conf	25	1.000	5.000	3.320	1.215
Diff	25	1.000	5.000	3.480	1.122
Real	25	3.000	5.000	4.160	0.850
Assgn	25	1.000	5.000	3.100	0.979
Sim	25	1.000	2.000	1.120	0.332
CostD	25	1.000	5.000	1.640	1.075
SpecialD	24	1.000	5.000	2.083	1.283

Table 2-11. T tests: Descriptive Variables and Generai Manipulation Checks

Variable	Novices			Experienced			T
	N	Mean	S.D.	N	Mean	S.D.	
Gmatscor	26	2.038	1.038	25	2.600	0.913	-2.05**
Age	24	24.167	1.685	24	29.833	3.510	-7.13**
Hourread	26	4.962	3.240	24	6.896	3.636	-1.98*
Easy	25	3.780	0.936	25	3.320	1.314	1.43
Interest	25	3.360	0.700	25	3.360	0.995	0.00
Long	25	3.400	0.577	25	3.200	0.764	1.04
Interfere	25	2.800	1.190	25	2.360	1.075	1.37
Typetest	24	145.833	40.699	26	151.692	51.788	-0.45

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$

Table 2-12. T tests: Cash Task Variables

Variable	Novices			Experienced			T
	N	Mean	S.D.	N	Mean	S.D.	
Ncard	25	8.560	3.190	24	9.458	4.384	-0.82
Net	25	7.000	3.674	24	7.125	3.555	-0.12
Nalt	25	3.000	1.893	24	2.750	1.824	0.47
Ncat	26	2.115	0.909	26	2.154	1.008	-0.15
Corr	23	0.725	0.227	21	0.746	0.173	-0.35
Hypnsrc	23	0.348	0.573	21	0.143	0.478	1.29
Srcnhyp	23	1.130	0.815	21	1.286	0.784	-0.64
FairC	25	1.000	0.000	24	1.000	0.000	NA
ValueC	24	42697	332.310	24	42697	291.633	0.00
Meth	23	0.008	0.614	22	0.141	0.352	-0.89
Goal	19	0.184	0.655	19	0.226	0.485	-0.23
Time	25	26.600	8.466	24	22.875	10.131	1.39
Eff	25	3.754	2.691	24	2.921	1.694	1.30
Rpeat	25	1.560	1.530	24	2.333	2.582	-1.27
Propk1	25	0.226	0.162	24	0.233	0.187	-0.15

* denotes statistical significance at p<.10
** denotes statistical significance at p<.05
NA denotes insufficient data for test

Table 2-13. T tests: Cash Task Descriptive Variables and Manipulation Checks

Variable	Novices			Experienced			T
	N	Mean	S.D.	N	Mean	S.D.	
Comp	25	3.280	1.242	24	3.542	1.179	-0.76
Conf	25	3.760	1.091	24	3.500	1.319	0.75
Diff	25	2.180	0.720	23	2.000	1.044	0.69
Real	25	4.100	0.979	24	3.792	1.414	0.88
Assgn	25	0.820	0.405	24	1.104	0.571	-2.00*
Sim	24	3.750	1.648	23	3.000	1.732	1.52
CashC	25	4.000	1.190	24	3.938	1.164	0.19

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$

Table 2-14. T tests: Park Task Variables

Variable	Novices			Experienced			T
	N	Mean	S.D.	N	Mean	S.D.	
Ncard	26	14.192	10.925	25	15.880	10.557	-0.56
Net	26	11.192	9.143	25	12.760	9.364	-0.61
Nalt	26	3.269	1.511	25	3.440	1.734	-0.37
Ncat	26	3.346	1.413	26	3.538	1.363	-0.50
Corr	26	0.457	0.263	23	0.620	0.209	-2.42**
Hypnsrc	26	0.577	0.643	23	0.348	0.714	1.17
Srcnhyp	26	1.462	0.859	23	1.478	1.082	-0.06
AssurP	22	2.182	0.907	23	2.478	0.994	-1.05
MethodP	26	1.154	0.368	22	1.455	0.671	-1.89*
ValueP	22	1175454	564298	20	1196250	668869	-0.11
Meth	21	0.125	0.456	24	0.118	0.394	0.06
Goal	21	0.127	0.363	24	0.058	0.385	0.62
Time	26	41.115	19.086	24	39.292	11.634	0.41
Eff	26	4.909	4.341	25	3.287	2.160	1.70*
Rpeat	26	3.000	3.752	25	3.120	3.528	-0.12
Propk1	26	0.497	0.257	25	0.543	0.153	-0.79

* denotes statistical significance at p<.10
** denotes statistical significance at p<.05

Table 2-15. T tests: Park Task Descriptive Variables and Manipulation Checks

Variable	Novices			Experienced			T
	N	Mean	S.D.	N	Mean	S.D.	
Comp	25	3.120	1.092	24	2.958	1.398	0.45
Conf	25	2.640	0.995	23	3.478	1.039	-2.85**
Diff	25	3.800	0.764	24	3.375	0.970	1.70*
Real	25	3.440	0.821	24	2.938	1.236	1.67
Assgn	25	2.640	0.550	24	4.021	1.402	-4.50**
Sim	24	1.000	0.000	23	1.435	0.843	NA
LivestkP	25	1.000	0.000	24	1.250	0.532	NA
NonhcP	25	1.480	1.005	23	2.478	1.238	-3.05**

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$
NA denotes insufficient data for test

Table 2-16. T tests: Digger Task Variables

Variable	Novices			Experienced			T
	N	Mean	S.D.	N	Mean	S.D.	
Ncard	14	9.071	6.788	16	13.125	12.027	-1.15
Net	14	8.286	6.900	16	11.125	10.191	-0.90
Nalt	14	1.714	1.858	16	2.313	1.852	-0.88
Ncat	26	3.346	1.413	26	3.538	1.363	-0.50
Corr	8	0.452	0.422	11	0.545	0.305	-0.54
Hypnsrc	8	0.250	0.463	11	0.364	0.505	-0.51
Srcnhyp	8	2.125	1.246	11	2.273	1.191	-0.26
ChargeD	15	1.533	0.516	16	1.875	0.342	-2.16**
Meth	11	0.125	0.526	14	0.209	0.548	-0.39
Goal	10	0.012	0.439	14	0.301	0.593	-1.37
Time	13	25.231	10.576	16	24.813	7.731	0.12
Eff	13	3.086	2.189	16	3.695	3.174	-0.61
Rpeat	14	0.786	0.975	16	2.000	2.338	-1.90*
Propkl	13	0.219	0.245	16	0.249	0.206	-0.35

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$

Table 2-17. T tests: Digger Task Descriptive Variables and Manipulation Checks

Variable	Novices			Experienced			T
	N	Mean	S.D.	N	Mean	S.D.	
Comp	10	3.600	1.174	15	3.400	0.986	0.44
Conf	10	2.900	1.197	15	3.600	1.183	-1.44
Diff	10	3.600	1.578	15	3.400	0.737	0.38
Real	10	4.000	0.816	15	4.267	0.884	-0.77
Assgn	10	2.800	0.632	15	3.300	1.131	-1.41
Sim	10	1.000	0.000	15	1.200	0.414	NA
CostD	10	1.100	0.316	15	2.000	1.254	-2.66**
SpecialD	10	1.500	1.269	14	2.500	1.160	-1.97*

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$
NA denotes insufficient data for test

Table 2-18. ANOVA Results for Ncard and Net

Variable: Ncard

Source	SS	DF	MS	F
Between subjects:				
Exp	124.80	1	124.80	0.88
Error	3832.35	27	141.94	
Within Subjects:				
Task	753.51	2	376.75	6.88**
Task x Exp	69.88	2	34.94	0.64
Error	2956.98	54	54.76	

Variable: Net

Source	SS	DF	MS	F
Between Subjects:				
Exp	58.40	1	58.41	0.46
Error	3462.03	27	128.23	
Within Subjects:				
Task	528.25	2	264.13	8.97**
Task x Exp	57.86	2	28.93	0.98
Error	1589.57	54	29.44	

* denotes statistical significance at $p<.10$

** denotes statistical significance at $p<.05$

Table 2-19. ANOVA Results for Nalt

Source	SS	DF	MS	F
Between Subjects:				
Exp	0.10	1	0.10	0.03
Error	104.13	27	3.86	
Within Subjects:				
Task	27.00	2	13.50	5.31**
Task x Exp	4.25	2	2.12	0.84
Error	137.25	54	2.54	

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$

Table 2-20. ANOVA Results for Ncat

Source	SS	DF	MS	F
Between Subjects:				
Exp	0.83	1	0.83	0.24
Error	90.45	26	3.48	
Within Subjects:				
Task	41.35	2	20.67	25.71**
Task x Exp	0.40	2	0.20	0.25
Error	41.82	52	0.80	

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$

Table 2-21. ANOVA Results for Corr, Hypnsrc and Srcnhyp

Variable: Corr

Source	SS	DF	MS	F
Between Subjects:				
Exp	0.01	1	0.01	0.22
Error	0.43	13	0.03	
Within Subjects:				
Task	0.92	2	0.46	3.85**
Task x Exp	0.05	2	0.03	0.22
Error	3.09	26	0.12	

Variable: Hypnsrc

Source	SS	DF	MS	F
Between Subjects:				
Exp	0.13	1	0.13	0.54
Error	3.07	13	0.24	
Within Subjects:				
Task	0.35	2	0.18	0.87
Task x Exp	0.35	2	0.18	0.87
Error	5.25	26	0.20	

Variable: Srcnhyp

Source	SS	DF	MS	F
Between Subjects:				
Exp	1.62	1	1.62	1.16
Error	18.29	13	1.41	
Within Subjects:				
Task	8.75	2	4.38	4.82**
Task x Exp	0.48	2	0.24	0.27
Error	23.61	26	0.91	

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$

Table 2-22. ANOVA Results for Meth and Goal

Variable: Meth

Source	SS	DF	MS	F
Between Subjects:				
Exp	0.04	1	0.04	0.22
Error	3.76	22	0.17	
Within Subjects:				
Task	0.10	2	0.05	0.29
Task x Exp	0.01	2	0.01	0.04
Error	7.36	44	0.17	

Variable: Goal

Source	SS	DF	MS	F
Between Subjects:				
Exp	0.04	1	0.04	0.19
Error	4.11	19	0.22	
Within Subjects:				
Task	.760	2	0.38	2.77*
Task x Exp	.159	2	0.08	0.58
Error	5.209	38	0.14	

* denotes statistical significance at p<.10
** denotes statistical significance at p<.05

Table 2-23. ANOVA Results for Eff

Source	SS	DF	MS	F
Between Subjects:				
Exp	2.50	1	2.50	0.22
Error	294.17	26	11.31	
Within Subjects:				
Task	9.87	2	4.94	1.53
Task x Exp	8.04	2	4.02	1.24
Error	168.27	52	3.24	

* denotes statistical significance at p<.10
** denotes statistical significance at p<.05

Table 2-24. ANOVA Results for Rpeat

Source	SS	DF	MS	F
Between Subjects:				
Exp	12.45	1	12.45	2.23
Error	151.11	27	5.60	
Within Subjects:				
Task	27.66	2	13.83	2.09 *
Task x Exp	6.69	2	3.34	0.51
Error	357.89	54	6.63	

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$

Table 2-25. ANOVA Results for Propk1

Source	SS	DF	MS	F
Between Subjects:				
Exp	0.01	1	0.01	0.04
Error	1.37	26	0.05	
Within Subjects:				
Task	1.54	2	0.77	26.04**
Task x Exp	0.09	2	0.05	1.54
Error	1.54	52	0.03	

* denotes statistical significance at p<.10
** denotes statistical significance at p<.05

Table 2-26. ANOVA Results for Conf, Assgn and Diff

Variable: Conf

Source	SS	DF	MS	F
Between Subjects:				
Exp	2.03	1	2.03	1.52
Error	27.91	21	1.33	
Within Subjects:				
Task	5.36	2	2.68	1.73
Task x Exp	11.16	2	5.58	3.60**
Error	65.16	42	1.55	

Variable: Assgn

Source	SS	DF	MS	F
Between Subjects:				
Exp	12.15	1	12.15	8.14**
Error	32.83	22	1.49	
Within Subjects:				
Task	96.13	2	48.07	77.59**
Task x Exp	6.03	2	3.01	4.86**
Error	27.26	44	0.62	

Variable: Diff

Source	SS	DF	MS	F
Between Subjects:				
Exp	3.90	1	3.90	2.99*
Error	27.38	21	1.30	
Within Subjects:				
Task	49.95	2	24.97	36.68**
Task x Exp	0.39	2	0.19	0.28
Error	28.60	42	0.68	

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$

Table 2-27. Statistical Significance of t test results of park task for actual and hypothetical N

Variable	Novices			Experienced			T
	N	Mean	S.D.	N	Mean	S.D.	
NcardP	26 (actual) 50 100	14.2	10.9	25(actual) 50 100	15.9	10.6	-0.56 -0.79 -1.12
NaltP	26(actual) 50 100	3.27	1.51	25(actual) 50 100	3.44	1.73	-0.37 -0.52 -0.74
HypnsrcP	26(actual) 50 100	0.58	0.64	23(actual) 50 100	0.35	0.71	1.19 1.70* 2.41*
GoalP	21(actual) 50 100	0.13	0.36	24(actual) 50 100	0.06	0.39	0.63 0.93 1.32
RpeatP	26(actual) 50 100	3.00	3.75	25(actual) 50 100	3.12	3.53	-0.12 -0.16 -0.23

* denotes statistical significance at $p < .05$

Assumption: Sample mean and standard deviation are unaffected by increased sample size

Table 2-28. Comparison of Results of Chapter Two Hypotheses Analyzed With and Without Information Search Regime Effects Removed

Results of Hypotheses according to Chapter Two Analyses (Information Regime Effects not accounted For)	Results of Hypotheses according to Chapter Three ANOVA Analyses (Information Regime Effects Removed)
2.1 Number of items retrieved (net -2)	2.1 Number of items retrieved
2.2 Number of hypotheses generated	2.2 Number of hypotheses generated
2.3 Number of categories searched	2.3 Number of categories searched
2.4 Link between assessed likelihood and actual search (corr -2)	2.4 Link between assessed likelihood and actual search
2.5 Conclusion	2.5 Conclusion
2.6 Categorical clustering of information retrieved	2.6 Categorical clustering of information retrieved
2.7 Time per information item	2.7 Time per information item
2.8 Number of recursions	2.8 Number of recursions
2.9 Proportion of background information	N/A: Proportion of Background Information not tested in Chapter three

[ ] denotes that hypothesis was confirmed at $p < .10$

Table 2-29. Correlation Between Alternative Measures of Expertise

Variable	Exp	Gmatscor	Hourread	Age	CashC	LivestkP	NonhcP	CostD	SpecialD
Exp									
Gmatscor	.28 **								
Hourread	.28 *	.05							
Age	.73 **	.35 **	.15						
CashC	-.03	-.11	.22	-.10					
LivestkP	.33 **	.08	.03	.32 **	-.12				
NonhcP	.41 **	-.06	.31 **	.27 *	.17	-.03			
CostD	.42 **	.27	.07	.25	-.11	.29	-.08		
SpecialD	.39 *	.05	.18	.40 *	.14	.37 *	.15	.24	

* denotes statistical significance at p<.10
** denotes statistical significance at p<.05

Table 2-30. Regression Results for Cash Task: Explanatory Power of Alternative Measures of Expertise

Dependent Variable	R^2	Joint Sig. of Alternative Measures	Independent Variable Regression Coefficients (t statistics)			
			Exp	GmatScor	Hourread	CashC
Sim	.30	x	-0.64 (-1.33)	-0.16 (-0.71)	0.13 (1.96)+	0.50 (2.54)++
Ncard	.06		1.62 (1.38)	0.14 (0.24)	-0.15 (-0.90)	0.06 (0.12)
Net	.13	x	0.58 (0.53)	0.79 (1.51)	-0.29 (-1.89)-	0.37 (0.82)
Nalt	.05		-0.44 (-0.76)	0.31 (1.09)	0.05 (0.60)	-0.22 (-0.92)
Ncat	.09	x	0.39 (1.58)	-0.09 (-0.75)	-0.05 (-1.44)	0.05 (0.52)
Corr	.12		-0.02 (-0.24)	0.07 (2.13)	-0.00 (-0.13)	-0.01 (-0.40)
Hypnsrc	.20		-0.26 (-1.57)	-0.02 (-0.29)	0.07 (2.70)-	0.01 (0.20)
Srcnhyp	.24	x	0.46 (1.98)-	-0.26 (-2.16)++	-0.08 (-2.31)++	0.10 (1.03)
FairC	insufficient data for regression					
ValueC	.08		18.27 (0.19)	-12.24 (-0.26)	-21.81 (-1.56)	-25.30 (-0.62)

...continued

x denotes joint effect of alternative expertise measures is significant at $p<.05$
+ (++) denotes statistical significance at $p<.10$ (.05), coefficient in expected direction
- (--) denotes statistical significance at $p<.10$ (.05), coefficient in unexpected direction
* (**) denotes statistical significance at $p<.10$ (.05), no expected direction for coefficient

Table 2-30 (continued). Regression Results for Cash Task: Explanatory Power of Alternative Measures of Expertise

Dependent Variable	R^2	Joint Sig. of Alternative Measures	Independent Variable Regression Coefficients (t statistics)			
			Exp	GmatScor	Hourread	CashC
Meth	.08		0.11 (0.70)	0.05 (0.57)	-0.03 (-1.39)	-0.02 (-0.27)
Goal	.07		0.05 (0.26)	0.05 (0.52)	-0.00 (-0.08)	0.12 (1.39)
Time	.12		-4.65 (-1.61)	0.24 (0.17)	0.83 (2.03)++	-0.52 (-0.44)
Eff	.11		-1.21 (-1.69)+	-0.11 (-0.31)	0.15 (1.51)	-0.31 (-1.04)
Rpeat	.21	x	1.05 (1.69)-	-0.66 (-2.19)++	0.14 (1.62)	-0.31 (-1.21)
Propk1	.20	x	0.06 (1.14)	0.02 (0.64)	-0.02 (-3.03)--	0.00 (0.21)
Assgn	.17	x	0.26 (1.72)*	0.06 (0.85)	-0.03 (-1.32)	-0.07 (-1.16)
Conf	.05		-0.45 (-1.16)	0.22 (1.16)	-0.00 (-0.08)	0.05 (0.33)
Diff	.15		-0.19 (-0.69)	-0.04 (-0.33)	0.02 (0.42)	-0.30 (-2.61)++

x denotes joint effect of alternative expertise measures is significant at $p<.05$
+ (++) denotes statistical significance at $p<.10$ (.05), coefficient in expected direction
- (--) denotes statistical significance at $p<.10$ (.05), coefficient in unexpected direction
*(**) denotes statistical significance at $p<.10$ (.05), no expected direction for coefficient

Table 2-31. Regression Results for Park Task: Explanatory Power of Alternative Measures of Expertise

Dependent Variable	R^2	Joint Sig. of Alternative Measures	Independent Variable Regression Coefficients (t statistics)				
			Exp	GmatScor	Hourread	LivestkP	NonhcP
Sim	.43	x	0.31 (0.57)	0.04 (0.40)	-0.04 (-1.81)-	0.78 (3.72)++	-0.00 (-0.03)
Ncard	.25	x	0.88 (0.23)	2.89 (1.80)+	-1.17 (-2.62)--	6.19 (1.51)	0.16 (0.12)
Net	.11		0.20 (0.17)	0.11 (0.21)	0.08 (0.56)	0.10 (0.07)	0.74 (1.58)
Nalt	.06		0.04 (0.06)	0.26 (0.99)	0.02 (0.26)	-0.40 (-0.60)	0.17 (0.74)
Ncat	.18	x	0.05 (0.10)	0.39 (1.91)+	-0.09 (-1.51)	0.75 (1.44)	0.12 (0.69)
Corr	.17		.22 (2.03)++	-0.08 (-1.73)-	0.00 (0.26)	-0.16 (-0.76)	-0.06 (-1.49)
Hypnsrc	.10		-0.28 (-1.06)	-0.01 (-0.09)	0.03 (1.11)	-0.28 (-0.96)	0.06 (0.57)
Srcnhyp	.20		-0.25 (-0.71)	0.31 (2.07)--	-0.06 (-1.44)	0.78 (1.98)-	0.07 (0.54)
AssurP	.14		-0.11 (-0.30)	0.05 (0.35)	0.04 (0.95)	0.53 (1.32)	0.20 (1.44)
MethodP	.13		0.21 (1.05)	0.12 (1.38)	-0.00 (-0.10)	0.13 (0.57)	-0.01 (-0.08)
ValueP	.10		6051 (0.03)	63511 (0.58)	-49187 (-1.58)	210119 (0.80)	78835 (0.87)

...continued

x denotes joint effect of alternative expertise measures is significant at p<.05
+ (++) denotes statistical significance at p<.10 (.05), coefficient in expected direction
- (--) denotes statistical significance at p<.10 (.05), coefficient in unexpected direction
*(**) denotes statistical significance at p<.10 (.05), no expected direction for coefficient

Table 2-31 (continued). Regression Results for Park Task: Explanatory Power of Alternative Measures of Expertise

Dependent Variable	$\bar{R}^2$	Joint Sig. of Alternative Measures	Independent Variable Regression Coefficients (t statistics)				
			Exp	GmatScor	Hourread	CostD	SpecialD
Meth	.03		-0.03 (-0.15)	0.01 (0.07)	-0.02 (-0.73)	-0.05 (-0.25)	0.05 (0.70)
Goal	.16	x	-0.08 (-0.17)	-0.48 (-2.32)	-0.00 (-0.05)	-0.17 (-0.34)	-0.14 (-0.80)
Time	.05		-3.66 (-0.60)	2.60 (1.01)	-0.59 (-0.81)	1.00 (0.15)	0.51 (0.22)
Eff	.19		-0.04 (-0.03)	-1.16 (-2.13)++	0.15 (1.00)	-1.67 (-1.20)	-0.69 (-1.43)
Rpeat	.24	x	0.67 (0.16)	2.78 (1.55)	-1.26 (-2.50)++	6.09 (1.33)	-0.57 (-0.36)
Propk1	.05		-0.02 (-0.21)	0.05 (1.34)	-0.00 (-0.14)	0.00 (0.01)	0.02 (0.51)
Assgn	.40		1.50 (3.85)**	0.10 (0.63)	-0.05 (-1.11)	0.45 (1.05)	-0.19 (-1.31)
Conf	.18		0.77 (2.01)++	-0.18 (-1.10)	-0.02 (-0.48)	0.41 (0.98)	-0.01 (-0.04)
Diff	.15	x	-0.64 (-2.15)++	0.20 (1.60)	0.00 (0.00)	0.54 (1.67)	0.04 (0.38)

x denotes joint effect of alternative expertise measures is significant at p<.05
+ (++) denotes statistical significance at p<.10 (.05), coefficient in expected direction
- (--) denotes statistical significance at p<.10 (.05), coefficient in unexpected direction
*(**) denotes statistical significance at p<.10 (.05), no expected direction for coefficient

Table 2-32. Regression Results for Digger Task: Explanatory Power of Alternative Measures of Expertise

Dependent Variable	R^2	Joint Sig. of Alternative Measures	Independent Variable Regression Coefficients (t statistics)				
			Exp	GmatScor	Hourread	CostD	SpecialD
Sim	.13		0.20 (1.27)	-0.05 (-0.80)	-0.02 (-0.71)	0.02 (0.25)	-0.03 (-0.51)
Ncard	.45	x	-2.57 (-0.62)	2.17 (1.26)	-1.70 (-2.56)--	3.12 (1.70)	1.64 (1.07)
Net	.44	x	1.63 (0.52)	2.51 (1.87)+	-0.96 (-2.57)--	5.60 (1.63)	-0.56 (-0.47)
Nalt	.07		0.14 (0.14)	0.21 (0.52)	-0.12 (-0.77)	-0.29 (-0.69)	0.13 (0.37)
Ncat	.47	x	-0.73 (1.22)	0.51 (2.06)+	-0.24 (-2.57)++	0.20 (0.75)	0.40 (1.81)+
Corr	.47		-0.04 (-0.19)	-0.09 (-1.12)	0.03 (1.02)	-0.12 (-1.36)	-0.00 (-0.03)
Hypnsrc	.16		0.20 (0.63)	-0.02 (-0.13)	0.05 (1.98)	0.05 (0.28)	-0.08 (-0.76)
Srcnhyp	.65	x	-0.79 (-1.57)	0.54 (2.51)--	-0.20 (-2.30)++	0.23 (0.82)	0.49 (2.89)--
ChargeD	.55	x	0.50 (2.71)--	-0.03 (-0.36)	0.01 (0.17)	-0.11 (-1.42)	0.18 (2.62)--

...continued

x denotes joint effect of alternative expertise measures is significant at p<.05
+ (++) denotes statistical significance at p<.10 (.05), coefficient in expected direction
- (--) denotes statistical significance at p<.10 (.05), coefficient in unexpected direction
*(**) denotes statistical significance at p<.10 (.05), no expected direction for coefficient

Table 2-32 (continued). Regression Results for Digger Task: Explanatory Power of Alternative Measures of Expertise

Dependent Variable	R^2	Joint Sig. of Alternative Measures	Independent Variable Regression Coefficients (t statistics)				
			Exp	GmatScor	Hourread	CostD	SpecialD
Meth	.32	x	0.35 (1.44)	-0.11 (-0.98)	-0.09 (-2.04)+	-0.08 (-0.72)	0.01 (0.12)
Goal	.34		0.64 (2.38)++	-0.07 (-0.58)	-0.04 (-0.84)	-0.17 (-1.40)	-0.11 (-1.09)
Time	.27	x	-6.62 (-1.84)-	2.13 (1.45)	-0.51 (-0.89)	1.57 (1.00)	1.03 (0.79)
Eff	.34	x	0.38 (0.39)	-0.54 (-1.35)	0.36 (2.37)--	0.02 (0.04)	-0.37 (-1.04)
Rpeat	.37		-0.75 (-0.54)	0.39 (0.66)	-0.21 (-1.27)	0.59 (0.39)	0.72 (1.38)
Propk1	.12		-0.04 (-0.31)	-0.05 (-1.02)	-0.00 (-0.12)	0.07 (1.33)	-0.02 (-0.38)
Assgn	.27		0.37 (0.81)	-0.14 (-0.71)	1.11 (-1.44)	0.34 (1.68)	-0.12 (-0.72)
Conf	.28		0.05 (0.09)	0.26 (1.10)	-0.06 (-0.70)	0.32 (1.26)	0.19 (0.89)
Diff	.18		0.14 (0.23)	0.22 (0.94)	0.03 (0.28)	-0.13 (-0.51)	-0.33 (-1.56)

x denotes joint effect of alternative expertise measures is significant at $p<.05$
+ (++) denotes statistical significance at $p<.10$ (.05), coefficient in expected direction
- (--) denotes statistical significance at $p<.10$ (.05), coefficient in unexpected direction
*(**) denotes statistical significance at $p<.10$ (.05), no expected direction for coefficient

Table 2-33. Cash Task Variable Statistics Using Alternative Measures of Expertise to Classify Participants

Dependent Variable	Mean (S.D.) of Novices and Experts when participants are classified by:							
	Exp		Gmatscor		Hourread		Sim	
	Novice	Expert	Novice	Expert	Novice	Expert	Novice	Expert
Ncard	8.56 (3.19)	9.45 (4.38)	8.58 (3.16)	9.77 (4.32)	9.21 (3.91)	9.26 (3.49)	8.45 (4.21)	9.60 (3.54)
Net	7.00 (3.67)	7.12 (3.56)	6.27 (2.92)	8.18 (4.03) +	7.64 (3.80)	6.58 (3.20)	6.91 (3.94)	7.24 (3.38)
Nalt	3.00 (1.89)	2.75 (1.82)	2.96 (1.97)	2.91 (1.66)	2.82 (1.68)	3.05 (2.07)	2.23 (1.54)	3.52 (1.94) ++
Ncat	2.12 (0.91)	2.15 (1.01)	2.19 (0.92)	2.13 (0.99)	2.28 (0.80)	2.05 (1.12)	2.14 (0.83)	2.40 (0.76)
Corr	0.73 (0.23)	0.75 (0.17)	0.72 (0.19)	0.76 (0.21)	0.72 (0.21)	0.74 (0.19)	0.71 (0.25)	0.73 (0.16)
Hypnsrc	0.35 (0.57)	0.14 (0.48)	0.32 (0.57)	0.18 (0.50)	0.20 (0.41)	0.33 (0.69)	0.11 (0.33)	0.32 (0.64)
Srcnhyp	1.13 (0.82)	1.29 (0.78)	1.32 (0.84)	1.09 (0.75)	1.32 (0.69)	1.11 (0.90)	1.28 (1.13)	0.83 (0.80)
FairC	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
ValueC	42697 (332)	42697 (291)	42701 (319)	42675 (300)	42719 (271)	42644 (363)	42823 (139)	42615 (352) **

...continued

+(++) denotes independent samples T test significant at p<.10(.05), one-tailed test
*(**) denotes independent samples T test significant at p<.10(.05), two-tailed test

Table 2-33 (continued). Cash Task Variables Statistics Using Alternative Measures of Expertise to Classify Participants

Dependent Variable	Mean (S.D.) of Novices and Experts when participants are classified by:							
	Exp		Gmatscor		Hourread		Sim	
	Novice	Expert	Novice	Expert	Novice	Expert	Novice	Expert
Meth	0.01 (0.61)	0.14 (0.35)	0.09 (0.63)	0.05 (0.28)	0.12 (0.41)	-0.04 (0.59)	.22 (.48)	-.05 (.52) +
Goal	0.18 (0.66)	0.23 (0.49)	0.16 (0.69)	0.25 (0.42)	0.21 (0.66)	0.20 (0.35)	.30 (.48)	.11 (.63)
Time	26.60 (8.47)	22.88 (10.13)	25.89 (8.61)	24.09 (10.15)	23.43 (7.31)	27.68 (11.53)	23.46 (7.56)	26.64 (10.7)
Eff	3.75 (2.69)	2.92 (1.69)	3.64 (2.66)	2.98 (1.77)	3.19 (2.54)	3.46 (1.97)	3.25 (1.30)	3.52 (2.95)
Rpeat	1.56 (1.53)	2.33 (2.58)	2.31 (2.35)	1.59 (1.82)	1.57 (1.62)	2.68 (2.63)	1.54 (1.77)	2.36 (2.41)
Propk1	0.23 (0.16)	0.23 (0.19)	0.21 (0.19)	0.26 (0.15)	0.28 (0.16)	0.17 (0.16)	0.26 (0.20)	0.21 (0.15)
Assgn	0.82 (0.41)	1.10 (0.57)	0.87 (0.46)	1.02 (0.52)	1.02 (0.50)	0.82 (0.48)	1.11 (0.46)	0.84 (0.54)
Conf	3.76 (1.09)	3.50 (1.32) *	3.50 (1.21)	3.77 (1.23)	3.46 (1.29)	6.79 (1.08)	3.86 (0.94)	3.36 (1.38) *
Diff	2.18 (0.72)	2.00 (1.04)	2.12 (0.78)	2.07 (1.03)	2.15 (0.82)	2.08 (1.00)	2.18 (0.85)	2.06 (0.94)

+(++) denotes independent samples T test significant at p<.10(.05), one-tailed test
*(**) denotes independent samples T test significant at p<.10(.05), two-tailed test

Table 2-34. Park Task Variable Statistics Using Alternative Measures of Expertise to Classify Participants

Dependent Variable	Mean (S.D.) of Novices and Experts when participants are classified by:							
	Exp		Gmatscor		Hourread		Sim	
	Novice	Expert	Novice	Expert	Novice	Expert	Novice	Expert
Ncard	14.19 (10.93)	15.88 (10.56)	12.93 (9.01)	17.38 (12.04)	17.48 (12.11)	11.62 (7.64)	13.98 (9.38)	29.20 (11.9) ++
Net	11.19 (9.14)	12.76 (9.36)	9.96 (8.03)	14.21 (10.05) +	14.00 (10.30)	9.38 (6.98)	10.93 (8.07)	24.80 (10.23) ++
Nalt	3.27 (1.51)	3.44 (1.73)	3.33 (1.47)	3.38 (1.79)	3.17 (1.49)	3.52 (1.78)	3.48 (1.52)	3.80 (1.92)
Ncat	3.35 (1.41)	3.54 (1.36)	3.30 (1.35)	3.75 (1.23)	3.69 (1.39)	3.24 (1.18)	3.48 (1.23)	4.60 (0.89) ++
Corr	0.46 (0.26)	0.62 (0.21)	0.52 (0.28)	0.55 (0.22)	0.51 (0.25)	0.55 (0.26)	0.55 (0.28)	0.54 (0.26)
Hypnsrc	0.58 (0.64)	0.35 (0.71)	0.52 (0.70)	0.41 (0.67)	0.43 (0.63)	0.55 (0.76)	0.54 (0.71)	0.00 (0.00)
Srcnhyp	1.46 (0.86)	1.47 (1.08)	1.41 (1.01)	1.54 (.91)	1.68 (0.98)	1.20 (0.89) +	1.37 (0.92)	2.40 (0.55)
AssurP	2.18 (.91)	2.48 (0.99)	2.38 (0.88)	2.29 (1.06)	2.23 (0.86)	2.50 (1.10)	2.38 (0.95)	2.60 (0.89)
MethodP	1.15 (.37)	1.46 (0.67) *	1.22 (0.42)	1.38 (0.67)	1.29 (0.46)	1.26 (0.65)	1.30 (0.56)	0.40 (0.55)
ValueP	1175K (564K)	1196K (669K)	1208K (592K)	1158K (643K)	1307K (630K)	990K (538K) *	1213K (616K)	1268K (739K)

...continued

+(++) denotes independent samples T test significant at p<.10(.05), one-tailed test
*(**) denotes independent samples T test significant at p<.10(.05), two-tailed test

Table 2-34 (continued). Park Task Variable Statistics Using Alternative Measures of Expertise to Classify Participants

Dependent Variable	Mean (S.D.) of Novices and Experts when participants are classified by:							
	Exp		Gmatscor		Hourread		Sim	
	Novice	Expert	Novice	Expert	Novice	Expert	Novice	Expert
Meth	0.13 (0.46)	0.12 (0.39)	0.09 (0.46)	0.15 (0.38)	0.10 (0.34)	0.14 (0.52)	0.12 (0.43)	-0.01 (0.36)
Goal	0.13 (0.36)	0.06 (0.39)	0.10 (0.39)	0.09 (0.36)	0.04 (0.33)	0.14 (0.43)	0.10 (0.39)	-0.06 (0.32)
Time	41.11 (19.09)	39.29 (11.63)	40.04 (18.46)	40.43 (12.44)	42.52 (18.76)	36.90 (10.35)	40.74 (16.16)	45.00 (10.9)
Eff	4.91 (4.34)	3.29 (2.16) +	4.90 (4.18)	3.23 (2.36) +	4.24 (4.25)	4.01 (2.33)	4.10 (3.05)	1.82 (0.91) ++
Rpeat	3.00 (3.75)	3.12 (3.53)	2.96 (3.51)	3.17 (3.78)	3.48 (3.82)	2.24 (3.15)	3.05 (3.67)	4.40 (3.98)
Propk1	0.50 (0.26)	0.54 (0.15)	0.49 (0.25)	0.55 (0.16)	0.50 (0.23)	0.55 (0.19)	0.52 (0.22)	0.54 (0.06)
Assgn	2.64 (0.55)	4.02 (1.40) **	2.98 (0.80)	3.73 (1.58) *	3.38 (1.54)	3.20 (0.77)	3.26 (1.19)	4.40 (1.52)
Conf	2.64 (1.00)	3.48 (1.04) ++	2.89 (1.07)	3.23 (1.11)	3.14 (1.04)	2.84 (1.17)	3.07 (1.09)	3.00 (1.41)
Diff	3.80 (0.76)	3.38 (0.97) +	3.67 (0.78)	3.50 (1.01)	3.46 (1.00)	3.75 (0.72)	3.49 (0.87)	4.40 (0.55)

+(++) denotes independent samples T test significant at p<.10(.05), one-tailed test
*(**) denotes independent samples T test significant at p<.10(.05), two-tailed test

Table 2-35. Digger Task Variable Statistics Using Alternative Measures of Expertise to Classify Participants

Dependent Variable	Mean (S.D.) of Novices and Experts when participants are classified by:							
	Exp		Gmatscor		Hourread		Sim	
	Novice	Expert	Novice	Expert	Novice	Expert	Novice	Expert
Ncard	9.07 (6.79)	13.13 (12.03)	7.94 (6.41)	15.00 (12.10) +	13.29 (11.62)	8.54 (6.85)	12.77 (10.46)	10.67 (9.07)
Net	8.29 (6.90)	11.13 (10.19)	7.31 (6.28)	12.64 (10.50)	11.59 (9.77)	7.46 (6.97)	11.32 (8.90)	9.33 (9.29)
Nalt	1.71 (1.86)	2.31 (1.85)	1.81 (1.80)	2.29 (1.94)	2.41 (2.12)	1.54 (1.33)	2.41 (1.84)	2.00 (2.00)
Ncat	3.35 (1.41)	3.54 (1.36)	3.47 (1.55)	4.54 (1.45) +	4.38 (1.54)	3.42 (1.51)	4.18 (1.44)	3.67 (2.08)
Corr	0.45 (0.42)	0.55 (0.31)	0.70 (0.21)	0.29 (0.22)	1.45 (0.39)	0.59 (0.30)	0.51 (0.24)	0.49 (0.41)
Hypnsrc	0.25 (0.46)	0.36 (0.51)	0.22 (0.44)	0.40 (0.52)	0.27 (0.47)	0.38 (0.52)	0.38 (0.50)	0.00 (0.00)
Srcnhyp	2.13 (1.25)	2.27 (1.19)	1.67 (0.87)	2.70 (1.25)	2.36 (1.21)	2.00 (1.20)	2.13 (0.26)	2.50 (0.71)
ChargeD	1.53 (0.52)	1.88 (0.34)	0.77 (0.44)	0.64 (0.50)	1.68 (0.48)	1.75 (0.45)	1.64 (0.49)	2.00 (0.00)

...continued

+(++) denotes independent samples T test significant at p<.10(.05), one-tailed test
*(**) denotes independent samples T test significant at p<.10(.05), two-tailed test

Table 2-35 (continued). Digger Task Variable Statistics Using Alternative Measures of Expertise to Classify Participants

Dependent Variable	Mean (S.D.) of Novices and Experts when participants are classified by:							
	Exp		Gmatscor		Hourread		Sim	
	Novice	Expert	Novice	Expert	Novice	Expert	Novice	Expert
Meth	0.13 (0.53)	0.21 (0.55)	0.24 (0.62)	0.10 (0.43)	0.39 (0.40)	-0.15 (0.56) ++	0.18 (0.52)	0.21 (0.81)
Goal	0.01 (0.44)	0.30 (0.59)	0.25 (0.61)	0.11 (0.48)	0.35 (0.41)	-0.05 (0.64)	0.14 (0.57)	0.45 (0.59)
Time	25.23 (10.58)	24.81 (7.73)	22.38 (8.59)	28.23 (8.60) +	25.00 (10.17)	25.00 (7.30)	25.77 (7.94)	24.00 (5.57)
Eff	3.09 (2.19)	3.70 (3.17)	4.19 (3.13)	2.60 (2.07)	2.82 (1.76)	4.17 (3.56)	3.15 (2.13)	3.30 (2.22)
Rpeat	0.79 (0.98)	2.00 (2.34)	0.63 (0.72)	2.36 (2.41)	1.71 (2.26)	1.08 (1.32)	1.46 (2.15)	1.33 (0.57)
Propk1	0.22 (0.25)	0.25 (0.21)	0.29 (0.26)	0.18 (0.17)	0.25 (0.22)	0.22 (0.24)	0.24 (0.21)	0.47 (0.25)
Assgn	2.80 (0.63)	3.30 (1.13)	3.04 (0.78)	3.17 (1.19)	3.23 (0.98)	2.90 (0.99)	3.12 (1.02)	3.33 (0.58)
Conf	2.90 (1.20)	3.60 (1.18)	3.00 (1.23)	3.67 (1.12)	3.33 (1.23)	3.30 (1.25)	3.24 (1.30)	3.67 (0.58)
Diff	3.60 (1.58)	3.40 (0.74)	3.23 (1.24)	3.75 (0.97)	3.60 (0.91)	3.30 (1.42)	3.48 (1.21)	3.33 (0.58)

+(++) denotes independent samples T test significant at p<.10(.05), one-tailed test
*(**) denotes independent samples T test significant at p<.10(.05), two-tailed test

Bibliography

Bédard, J. and T.J. Mock, "Expert and Novice Problem Solving Behaviour in Audit Planning" , Auditing: A Journal of Practice and Theory , Vol 11, Supplement (1992), 1-20.

Bonner, S.E. and B.L. Lewis, "Determinants of Auditor Expertise," Journal of Accounting Research, Vol 28, (supplement 1990), 1-20.

CICA Handbook, Canadian Institute of Chartered Accountants.

Einhorn, H.J., "Expert Judgment: Some Necessary Conditions and an Example," Journal of Applied Psychology, (1974), 562-571.

Ericcson, K.A., and H.A. Simon, "Verbal Reports as Data," Psychological Review, Vol 87 No 3,(May, 1980), 215-251.

Harnett, Donald L., Statistical Methods, third edition, Addison Wesley, Reading, Massachusetts, (1982).

Kaplan, S.E. and P. M. J. Reckers, "An Examination of Information Search During Initial Audit Planning," Accounting, Organizations, and Society, (1989), 539-550.

Roenker, D.L., C.P. Thompson, and S.C. Brown, "Comparison of Measures for the Estimation of Clustering in Free Recall," Psychological Bulletin (November, 1969), 45-48.

Chapter 3. Information Search and the Information Search Regime

I. INTRODUCTION

This chapter examines the differences in the information search behaviour of experienced and novice auditors under different information search regimes. As discussed in Chapter 1, the active information search regime required participants to determine their own information requirements and enter their information requests into the computer, phrased in their own words. The traditional information search regime presented participants with a menu of information from which they selected their desired information. It was hypothesized that the processes underlying information search are different under the two regimes. The active information search regime forced participants to cognitively generate hypotheses to guide their information search, whereas it was possible to engage in information search under the traditional regime without generating any hypotheses, or to wait until the underlying hypotheses became apparent by the data itself. Under the active search regime participants also had to invoke their problem solving schema to facilitate and organize their information search, and had to continually plan and monitor their progress. Under the traditional information search regime, in contrast, participants could simply browse through the information available. These differences led to the following hypotheses, stated in alternative form:

H 3.1: Participants under the active search regime will search for less information than participants under the traditional one.

H 3.2: Participants under the active search regime will generate fewer hypotheses than participants under the traditional one.

H 3.3: Participants under the active search regime will search through fewer categories than participants under the traditional one.

H 3.4: Participants under the active search regime will demonstrate a closer correlation between their information search and their hypothesis generation.

H 3.5: Participants under the active search regime will arrive at different conclusions than participants under the traditional one.

H 3.6: Participants under the active search regime will spend more time per item of information acquired than participants under the traditional one.

H 3.7: Participants under the active search regime will be less efficient in that they will perform more recursions than participants under the traditional regime.

It was also expected that the discrepancies between the behaviour of experienced auditors and novices would be greater under the active search regime than under the traditional one. This expectation arose from the fact that experienced auditors would be more adept at the processes required by the active search regime because of their more elaborate knowledge structure and their possession of procedural schema to assist information search. The differences between the two groups would be commensurately less under the traditional information search regime as the participants, both experienced and novice, could minimize their cognitive involvement as discussed above. Thus, under the traditional regime the differences between experienced auditors and novices would be less apparent. This led to the following hypotheses, stated in alternative form:

H 3.8: The extent by which the amount of information requested by experienced auditors exceeds the amount requested by novices will be greater

under the active regime than under the traditional one.

H 3.9: The extent by which the number of hypotheses generated by experienced auditors exceeds the number generated by novices will be greater under the active regime than under the traditional one.

H 3.10: The extent by which the number of categories searched by experienced auditors exceeds the number searched by novices will be greater under the active regime than under the traditional one.

H 3.11 The disparity in the correlation between hypothesis generation and information search of experienced auditors and novices will be greater under the active regime than under the traditional one.

H 3.12: The differences in the goal and method categorizations used by the experienced and novice auditors respectively will be greater under the active regime than under the traditional one.

H 3.13: The extent to which experienced auditors require less time per item of information than novices will be greater under the active regime than under the traditional one.

H3.14: The extent to which experienced auditors perform fewer recursions than novices will be greater under the active regime than under the traditional one

Finally, prior research has shown that subjects are insensitive to the amount of information that is lacking in their analysis. This led to the final two hypotheses:

H 3.15: Participants under both regimes will not differ in their ratings of the completeness of the information.

H 3.16: Participants under both regimes will not differ in their confidence in their decisions.

These hypotheses were all tested using data gathered from the experiment described in Chapter 1. The variables used in the analysis are listed and defined in Table 3-1, and are identical to those used in Chapter 2. The main analyses performed were as follows: t tests were run comparing the performance of participants under the active and traditional interface, regardless of experience. These results were used to test the first seven and last two hypotheses, which are concerned solely with the effect of the interface. These results are presented in tables 3-2 through 3-8. Hypotheses 3-8 through 3-14 inclusive are concerned with both interface and experience main effects, as well as interactions between the variables. ANOVA analyses, presented in tables 3-9 through 3-21 inclusive, were run for each dependent variable to test for these effects. A significant experience by interface interaction was expected for those hypotheses which predicted that the discrepancies would be greater under the active interface. Furthermore, since the tasks varied in their degree of structure and expertise is more important when tasks are unstructured, it was expected that the ANOVA analyses would reveal task by experience- and task by experience by interface interactions. As with Chapter 2, the ANOVA analyses were run using all three tasks as well as just the mandatory Cash and Park tasks. The two task analysis contained more subjects and hence had more degrees of freedom for the statistical tests, but generated principally the same results as the three task analysis. Hence, only the three level analysis is presented in these tables, and any differences between them and the two level analysis are mentioned in the text.

The chapter proceeds as follows. The next section discusses the results of the hypotheses, including the effects of task structure. This section also discusses the results of the manipulation checks. The third section discusses the robustness of the results using different measures of expertise. Finally, a discussion and conclusion is offered.

II. RESULTS

The first three hypotheses dealt with the extent and breadth of the auditors' information search under the different information search regimes. The first hypothesis that participants would request more information under the traditional interface, was supported. T tests demonstrated significant differences between the traditional and active interfaces for both Ncard and Net for all three tasks. However, as discussed in the appendix A, participants in the active interface may have asked questions for which they received no answer. Therefore, Ncard and Net may not have completely reflected the extent of the participants' *desired* information search under the active search regime. Therefore, the number of questions the participants asked that were not answered (Nasr) was added to the Ncard and Net variables. All differences were still highly significant except for revised Ncard in the cash task, which showed no significant difference.

The total number of alternatives generated by each participant (Nalt) was used to test hypothesis 3.2, which stated that participants under the active search regime would generate fewer alternatives than the traditional regime participants. This hypothesis was not confirmed: although the relationship was in the predicted direction for all three tasks, none of the differences were statistically significant.

Hypothesis 3.3 stated that participants under the active search regime would

search through fewer categories than participants under the traditional regime. This was tested by counting the total number of different goal categories from which each participant requested information (Ncat). This hypothesis was confirmed for all three tasks.

Hypothesis 3.4 predicted that participants under the active regime would demonstrate a closer correlation between their information search and their hypothesis generation. As discussed in Chapter 2, this was operationalized by the variables Corr, Hypnsrc and Srcnhyp. Corr measured the Spearman rank correlation between the ranking of the goal categories for each task based on the participants' assessment of the likelihood of the alternatives they generated and the proportion of information search centred on those categories. The variable Hypnsrc measured the number of goal categories from which a hypothesis was generated but no information was searched, and Srcnhyp counted the number of goal categories from which information was requested but no hypothesis was generated. Therefore, this hypothesis predicts that Corr will be higher under the active regime, and Hypnsrc and Srcnhyp will both be lower. There were no significant differences in the Corr measure for the two groups. Srcnhyp was significant in the expected direction for all three tasks, indicating that participants in the traditional interface more frequently requested information without a hypothesis in mind, perhaps taking advantage of the opportunity for data-driven information search. Hypnsrc was significantly different for the two groups in the Cash and Park tasks, but in the wrong direction: in both cases participants in the active interfaces generated more hypotheses for which they conducted no information search. This could possibly indicate how difficult

it is to conduct an organized information search without an information menu to facilitate the process.

Hypothesis 3.5 stated that participants under the two regimes would arrive at different conclusions. This hypothesis was not confirmed: there were no significant differences in the value of the cash account in the cash task (ValueC), whether it was fairly stated (FairC), in the value of the inventory in the park task (ValueP), the method used to account for it (MethodP), the assurance that would be provided (AssurP), nor whether the client had been overcharged in the Digger task (ChargeD).

Hypotheses 3.6 and 3.7 predicted that participants under the active regime would be less efficient in that they would spend more time per amount of information (Eff) and would perform more recursions (Rpeat). The active and traditional groups differed significantly on Eff in all three tasks but Rpeat was only significant in the Cash task.

The next group of hypothesis predicted interactions between experience and the interface. Hypothesis 3.8 predicted that the difference in the amount of information requested by the experienced and novice auditors would be greater under the active regime. As can be seen from tables 3-9 and 3-10, this hypothesis was not confirmed for either Ncard or Net, as there were no significant interface by experience or task by interface by experience interactions. The ANOVA analysis in both cases showed that there were significant main effects for the interface and for experience. Additionally, there was a significant task main effect and task by interface interaction, indicating that the difficulties associated with a less structured task were compounded by the active search regime as expected. The analysis was performed with the number of questions not

answered (Nasr) added to Ncard and Net to reflect the amount of desired information search, as discussed above. This resulted in the hypothesis being confirmed with the revised Net variable as it resulted in a significant interface by experience interaction in addition to the previous significant findings. The task by experience interaction also became significant. Results for Ncard were basically unaffected.

Hypothesis 3.9 stated that there would be a greater difference in the number of alternatives generated by experienced and novice auditors under the active regime. This hypothesis was not supported as can be seen from table 3-11.

Hypothesis 3.10 predicted a similar relationship for the number of categories of information searched (Ncat). As can be seen from the results presented in table 3-12, results followed a similar pattern as with Ncard: there were no significant interactions between experience and interface nor between experience, task and interface so the hypothesis was not supported. There were highly significant main effects for interface, task and experience. Also, there was again a significant main effect between task and interface, indicating that the difficulties with unstructured task were compounded by the information search regime.

There was strong support for Hypothesis 3.11 which predicted that the disparity in the correlation between experienced auditors and novices would be greater under the active interface. As with hypothesis 3.4, this was operationalized using Corr, Hypnsrc and Srcnhyp. When Corr was used as the dependent variable the ANOVA analysis

shown in table 3-13[15] indeed demonstrated a significant interface by experience effect. Under the active interface, the means across tasks for novices and experienced auditors were .56 and .65 following the expected pattern; under the traditional interface the pattern was reversed as the means of the novice and experienced group were .63 and .57 respectively. Corr also showed significant interface and task main effects. Hypnsrc and Srcnhyp, shown on tables 3-14 and 3-15, both had significant interface effects, consistent with the t test results of hypothesis 3.4. Hypnsrc also showed significant task by interface and task by experience effects. When Srcnhyp was analyzed using just the Cash and Park tasks the results were quite strong: there were significant interface by experience and task by interface by experience interactions, as well as a task main effect.

Tables 3-16 and 3-17[16] demonstrate that there was no support for hypothesis 3.12 which predicted that the goal and method categorization (Goal and Meth) distinctions between experienced auditors and novices would be more pronounced under the active interface.

There was strong support for hypothesis 3.13, which predicted that the time per

---

[15]The degrees of freedom in the ANOVA analyses for Corr, Srcnhyp and Hypnsrc are lower than for other variables because of the 34 participants who performed all three tasks, 19 did not state any hypotheses for at least one of those three tasks. Hence, it was not possible to calculate values for Corr, Srcnhyp or Hypnsrc in these cases.

[16] the ANOVA analyses for Meth and Goal contained fewer degrees of freedom because participants were excluded from the analysis if all the information items they requested were within only one category for at least one of the tasks. This exclusion was done to avoid artificially inflating the Meth and Goal scores because the values for these participants would have been 1 (perfect categorization). This resulted in the exclusion of 13 participants for Goal and 10 participants for Meth out of the 34 participants who performed all three tasks.

information card variable (Eff) would be more disparate between experts and novices under the active search regime. The results on table 3-18 indicate a highly significant task by interface by experience effect, as well as main effects for interface, experience and task and a task by interface interaction.

As can be seen from table 3-19, there was no support for hypothesis 3.14 in that there were no significant differences in the number of recursions between the various groups.

Hypothesis 3.15 and 3.16 were tested using the t statistics presented on tables 3-4, 3-6 and 3-8. The hypotheses were not supported in the Digger task, where participants in the active interface did rate the information as being less complete than the participants under the traditional search regime. However, the hypotheses were supported for the Cash and Park tasks: there were no significant differences in the participants' assessment of the completeness of the information, nor in their confidence in their decisions, despite the fact that participants in the active interface received far less information for making their decisions. This would indicate that subjects indeed are insensitive to the information they may be missing. ANOVA analyses in tables 3-20 and 3-21[17] also confirm that level of experience did not affect the results. In fact, according to the ANOVA analysis there were no main effects for interface or task either. However, since this was a no-effects hypothesis the same results could have occurred due to a lack of statistical power.

---

[17]The degrees of freedom in the ANOVA analyses of Comp and Conf are lower than other variables because, out of the 34 participants performing all three tasks, 10 did not answer the manipulation question regarding Comp in at least one task and 11 did not answer the manipulation question for Conf in at least one task.

The findings for all these hypotheses are summarized on table 3-22. The hypotheses regarding the main effect of the interface had the strongest support. There was also evidence indicating that experienced auditors performed differently on some dimensions of information search than novices, and there was limited support for the hypotheses proposing an interaction between experience and the information search regime.

MANOVA analyses were also run for each of the three tasks to jointly test the hypotheses. Each participant had a vector for each task representing his or her values of Totnet, Nalt, Ncat, Corr, Srcnhyp, Hypnsrc, Goal, Meth, Eff and Rpeat. The results from these analyses, shown on table 3-23 generally support the observations above: the interface effect was very strong for all three tasks. The experience effect was weaker, only being statistically significant for the Digger task. The interaction effect was not supported in the MANOVA analysis.

The results of the manipulation checks on table 3-2 indicate that the findings discussed in this section were not due to systematic differences between the active and traditional interface groups. The two groups did not differ in how easy they found the computer program to use (Easy), how interesting they found the experiment (Interest), how long they felt the experiment was (Long), how much they felt the computer program interfered with their natural thought processes (Interfere), or their performance on a typing test (Typetest). Similarly, the two groups for the most part did not differ in how complete they thought the information was for each of the three tasks (Comp), or how realistic they found the tasks (Real). Exceptions to this were that participants in the

traditional interface thought that the Park task was more realistic and the information presented in the Digger task was more complete than the participants in the active interface did. There was no significant difference between the difficulty rating (Diff) of the two groups for the Cash and Digger tasks, although the traditional interface group rated the Park task as more difficult than the active interface group did.

III. IMPACT OF DIFFERENT MEASURES OF EXPERTISE

The results in the previous section grouped participants according to their experience. The regression results on individual dependent variables in Chapter 2 suggested that other measures may provide better proxies for expertise. In Chapter 2, the results were re-run with classifications based on the participants' score on four questions from the problem solving section of the Graduate Management Admissions Test (Gmatscor), and the number of hours spent per week reading business related literature (Hourread). These measures were designed to proxy for general problem solving ability and general business knowledge. Chapter 2 results were also re-run classifying participants on the basis of their self assessed levels of expertise in each individual task (Sim). The ANOVA analyses for this chapter were similarly re-run using Gmatscor and Hourread to classify participants, although it was not possible to run the analysis using Sim to classify the participants as participants would vary as to their novice-expert classification for each task. Indeed, no participant ranked him- or herself as an expert on all three tasks.

The comparisons of the ANOVA results using the different measures to classify participants are presented in Table 3-24. Not surprisingly, the ANOVA effects that did

not involve expertise were generally invariant to the classification system employed. This discussion focusses on the expertise effect, its interaction with the interface, with task, and with interface and task together.

The experience measure and Gmatscor both provided significant results, although as with Chapter 2, Gmatscor was a stronger predictor overall. Hourread provided the weakest results of the three. Interestingly, when experience was the measure used there was rarely an interaction with the interface, indicating that the predicted patter of larger performance discrepancies between the "expert" and novice groups under the active interface did not occur. However, when Gmatscor was the measure used the interaction with the interface was relatively more common. It appears that general problem solving ability imparts the greatest advantages when participants must perform an active information search. In contrast, the type of knowledge acquired through general experience seems to be less advantageous. For instance, Ncard, Net and Ncat all measured the breadth of information search. There was a significant main effect for all three variables when experience was used. Keeping in mind that the number of hypotheses (Nalt) and Srcnhyp was not significantly different under any expertise measure, it appears that experienced auditors seemed to generate more complete search for each alternative they generate than the novices do, and this finding is not affected by the interface. However, for all three of these variables there were significant interface by expertise effects (as well as main effects in Ncard and Net) when Gmatscor was used. It is possible that individuals with greater problem solving ability have better problem solving strategies that they can apply to all sorts of situations, regardless of their specific

knowledge in the area. The existence of such strategies is helpful under the active information search regime. Indeed, in addition to performing more complete search for each alternative they generated, Gmatscor experts also performed fewer recursions (Rpeat) under both interfaces. Interestingly, though, the Eff variable was only significant when the experience measure was used. This is consistent with the Gmatscor experts having problem solving *strategies* but not necessarily having particular *schema* for the tasks which told them what specific information to look for. Hence, compared to experienced auditors, they were somewhat slower in determining what to look for. Experienced auditors might have had more specific schema and so spent less time planning what to do next and more time receiving information.

IV. DISCUSSION AND CONCLUSION

In general, the results indicate that the information search regime affected the information search behaviour of the participants, and in many cases the effect was more pronounced as the tasks became less structured. Participants in the active information search regime conducted a much shorter and narrower information search. They also spent more time per amount of information, probably indicating that they had to spend more time planning their next step. The fact that they also performed more recursions indicated how difficult it was to follow an organized, forward problem solving procedure. Indeed, more participants generated hypotheses for which they did not conduct any information search in the active interface than in the new one.

One particularly interesting result was that the number of alternatives generated by the participants was not significantly different among the two interfaces. It appears,

then, that the participants were able to generate hypotheses early on and perhaps did not continue to generate more hypotheses as they saw more information.

Overall, then, it appears that the greatest obstacle in the active search regime was that the omission of the information menu made the strategy of information search more complex. Organized information search and problem solving were more difficult. Participants were still able to generate the hypotheses but tended to conduct inadequate search to confirm or disconfirm them.

It appeared that the experienced auditors were able to compensate for the active search regime in some respects. As expected, the differences between experienced auditors and novices was indeed more pronounced in the active interface. Interface by experience interactions were found for the net number of information items searched (revised to reflect the number of questions not answered by the active interface), the correlation between priority of hypotheses and the amount of search devoted to them, as well as for the amount of time spent per item of information. These results are consistent with the experienced auditors under the active information search regime invoking a problem solving schema that allowed them to search more completely and were able to spend proportionately less time planning their approach and more time actually retrieving information. Furthermore, results showed that "experts" as determined by their problem solving ability (Gmatscor) had general problem solving strategies that enabled them to conduct more complete information search for the alternatives they generated and perform fewer recursions.

Consistent with previous research, the participants, regardless of experience, were

in general relatively insensitive to the amount of information missing from their analysis. There were few significant differences in the assessment of the completeness of the information of the confidence in their decision between the two information search regimes.

Table 3-1. List of Variables

Descriptive Variables and General Manipulation Checks:	
VARIABLE	DESCRIPTION
Exp	classification based on experience: 1=3 Yrs or more, 0=less than 3 yrs
Gmatscor	Number of correct responses to GMAT questions (max=4)
Age	Age of participant
Hourread	Number of hrs spent per week reading business journals etc.
Interfac	Information Search Regime (1=active, 2=traditional)
Easy	Ease of interface to use (1=hard, 5=easy)
Interest	How interesting experiment was (1=not, 5=very)
Long	How long experiment was (1=too long, 5=too short)
Interfere	How much interface interfered with natural thought processes (1=a lot, 5=not at all)
Typetest	Number of seconds to complete typing test

...continued

Table 3-1 (continued). List of Variables

Task Variables:	
VARIABLE	DESCRIPTION
Ncard	Number of information cards requested (repeats included)
Net	Number of net information cards requested (repeats eliminated)
Nalt	Number of alternative hypotheses advanced by participant
Ncat	Number of categories searched
Corr	Correlation between priority of hypothesis and amount of search devoted to it
Hypnsrc	Number of categories from which a hypotheses was generated but from which no information was retrieved
Srcnhyp	Number of categories from which information was retrieved but from which no hypothesis was generated
FairC	Whether cash in cash task is fairly presented (1=yes, 2=no)
ValueC	Value of cash in cash task
AssurP	Assurance level in park task (1=clean, 2=qualified as to quantity, 3=qualified as to value, 4=qualified as to both, 5=adverse)
MethodP	Inventory valuation method recommended in park task (1=historical, 2=market, 3=nominal amount)
ValueP	Value of inventory in park task
ChargeD	Whether client was overcharged in digger task (1=yes, 2=no)
Meth	Index of Methodological Category Clustering
Goal	Index of Goal Category Clustering
Time	Time in minutes to complete task
Eff	Efficiency (time/number of cards requested)
Rpeat	Number of recursions (cards seen more than once)

...continued

Table 3-1 (continued). List of Variables

Task Descriptive Variables and Manipulation Checks:	
VARIABLE	DESCRIPTION
Comp	How complete information provided was (1=not, 5=very)
Conf	How confident participant was regarding conclusion (1=not, 5=very)
Diff	How difficult task was (1=easy, 5=hard)
Real	How realistic task was (1=not, 5=very)
Assgn	Number of years experience person assigned to task should have
Sim	Familiarity of task (5=very similar and recent, 4=very similar but not recent, 3=somewhat similar and recent, 2=somewhat similar but not recent, 1=never seen anything like it)
CashC	Familiarity with cash sections (same coding as Sim)
LivestkP	Familiarity with accounting for and auditing livestock (same coding as Sim)
NonhcP	Familiarity with accounting for and auditing assets valued on a basis other than historic cost (same coding as Sim)
CostD	Familiarity with auditing cost-plus contracts (same coding as Sim)
SpecialD	Familiarity with special audits (same coding as Sim)

Table 3-2. T tests: Descriptive Variables and General Manipulation Checks

Variable	Active Interface			Traditional Interface			T
	N	Mean	S.D.	N	Mean	S.D.	
Exp	30	0.53	0.51	22	0.46	0.52	0.55
Gmatscor	29	2.14	0.99	22	2.55	1.01	-1.44
Age	28	27.79	4.32	20	25.90	3.14	1.75
Hourread	28	6.77	3.82	22	4.77	2.83	2.12**
Easy	29	3.36	1.22	21	3.81	1.03	-1.40
Interest	29	3.28	0.96	21	3.48	0.68	-0.86
Long	29	3.21	0.62	21	3.43	0.75	-1.11
Interfere	29	3.59	1.12	21	2.57	1.21	0.04
Typetest	30	139.63	32.38	20	162.75	60.16	-1.57

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$

Table 3-3. T tests: Cash Task Variables

Variable	Active Interface			Traditional Interface			T
	N	Mean	S.D.	N	Mean	S.D.	
Ncard	28	7.25	3.30	21	11.33	3.18	-4.38**
Net	28	4.54	1.45	21	10.43	2.67	-9.19**
Nalt	28	2.71	2.11	21	3.10	1.45	-0.75
Ncat	30	1.80	0.93	22	2.59	0.80	-3.30**
Corr	23	0.72	0.23	21	0.73	0.16	-0.17
Hypnsrc	23	0.44	0.66	21	0.05	0.22	2.65**
Srcnhyp	23	1.00	0.85	21	1.43	0.68	-1.86*
FairC	28	1.00	0.00	21	1.00	0.00	NA
ValueC	27	42728	292.15	21	42659	333.31	0.74
Time	28	25.32	9.68	21	24.05	9.23	0.47
Eff	28	4.17	2.63	21	2.25	0.92	3.59**
Rpeat	28	2.71	2.31	21	0.91	1.30	3.48**

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$
NA denotes insufficient data for test

Table 3-4. T tests: Cash Task Descriptive Variables and Manipulation Checks

Variable	Active Interface			Traditional Interface			T
	N	Mean	S.D.	N	Mean	S.D.	
Comp	28	3.32	1.09	21	3.52	1.37	-0.56
Conf	28	3.43	1.26	21	3.91	1.09	-1.41
Diff	27	2.17	0.93	21	2.00	0.84	0.65
Real	28	3.95	1.11	21	3.95	1.36	-0.02
Assgn	28	0.89	0.55	21	1.05	0.45	-1.09
Sim	27	3.41	0.74	20	3.35	0.73	0.11
CashC	28	3.91	1.28	21	4.05	1.02	-0.42

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$

Table 3-5. T tests: Park Task Variables

Variable	Active Interface			Traditional Interface			T
	N	Mean	S.D.	N	Mean	S.D.	
Ncard	29	9.10	5.56	22	22.82	10.87	-5.41**
Net	29	5.79	3.05	22	20.09	8.19	-7.79**
Nalt	29	3.10	1.50	22	3.68	1.73	-1.25
Ncat	30	2.83	1.29	22	4.27	1.03	-4.47**
Corr	29	0.52	0.29	20	0.59	0.28	-0.83
Hypnsrc	29	0.69	0.71	20	0.15	0.49	3.14**
Srcnhyp	29	1.24	0.95	20	1.80	0.89	-2.09**
AssurP	26	2.35	1.06	19	2.32	0.82	0.11
MethodP	28	1.25	0.59	20	1.35	0.49	-0.64
ValueP	26	1134038	614381	16	1268750	609678	-0.69
Time	29	37.76	14.17	21	43.67	17.63	-1.27
Eff	29	5.79	3.86	22	1.91	0.74	5.28**
Rpeat	29	3.31	3.60	22	2.73	3.68	0.57

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$

Table 3-6. T tests: Park Task Descriptive Variables and Manipulation Checks

Variable	Active Interface			Traditional Interface			T
	N	Mean	S.D.	N	Mean	S.D.	
Comp	28	2.86	1.24	21	2.39	1.23	-1.20
Conf	27	3.11	1.05	21	2.95	1.16	0.49
Diff	28	3.39	0.83	21	3.86	0.91	-1.83*
Real	28	2.80	1.02	21	3.71	0.90	-3.30**
Assgn	28	3.04	0.80	21	3.69	1.63	-1.69
Sim	27	1.07	0.39	20	1.40	0.82	-1.65
LivestkP	28	1.07	0.26	21	1.19	0.51	-0.97
NonhcP	27	2.22	1.37	21	1.62	0.92	1.82*

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$

Table 3-7. T tests: Digger Task Variables

Variable	Active Interface			Traditional Interface			T
	N	Mean	S.D.	N	Mean	S.D.	
Ncard	14	4.36	2.59	16	17.25	10.21	-4.88**
Net	14	3.14	1.92	16	15.63	8.27	-5.86**
Nalt	14	1.50	1.74	16	2.50	1.86	-1.52
Ncat	12	2.58	1.00	16	5.00	1.03	-6.25**
Corr	7	0.62	0.31	12	0.41	0.20	1.64
Hypnsrc	7	0.43	0.54	12	0.25	0.45	0.74
Srcnhyp	7	1.43	0.98	12	2.67	1.07	-2.57**
ChargeD	13	1.77	0.44	18	1.67	0.49	0.62
Time	13	21.92	7.16	16	27.50	9.67	-1.78*
Eff	13	5.28	3.18	16	1.91	0.74	3.74**
Rpeat	14	1.21	1.25	16	1.63	2.36	-0.61

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$

Table 3-8. T tests: Digger Task Descriptive Variables and Manipulation Checks

Variable	Active Interface			Traditional Interface			T
	N	Mean	S.D.	N	Mean	S.D.	
Comp	10	2.90	0.88	15	3.87	0.99	-2.56**
Conf	10	2.80	0.92	15	3.67	1.29	-1.96*
Diff	10	3.60	0.70	15	3.40	1.35	0.48
Real	10	3.90	0.88	15	4.33	0.82	-1.24
Assgn	10	3.05	1.01	15	3.13	0.99	-0.20
Sim	10	1.20	0.42	15	1.07	0.26	0.89
CostD	10	1.50	0.97	15	1.73	1.16	-0.54
SpecialD	9	2.00	1.00	15	2.13	1.46	-0.27

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$

Table 3-9. Group Means and ANOVA Results for Ncard

	Group Means (N)							
Task	Active Interface				Traditional Interface			
	All	Novice	Expert	Diff	All	Novice	Expert	Diff
Cash	7.3	6.5	7.9	1.4	11.3	10.7	12.1	1.4
	(28)	(13)	(15)		(21)	(12)	(9)	
Park	9.1	8.1	10.0	1.9	22.8	21.3	24.7	3.4
	(29)	(14)	(15)		(22)	(12)	(10)	
Digger	4.4	3.0	5.1	2.1	17.2	12.4	23.4	11.0
	(14)	(5)	(9)		(16)	(9)	(7)	

Diff denotes the expert mean less the novice mean

ANOVA Results				
Source	SS	DF	MS	F
Between Subjects:				
Interface	2589.7	1	2589.7	61.5**
Exp	353.0	1	353.0	8.4**
Interface x Exp	98.9	1	98.9	2.4
Error	1052.6	25	42.1	
Within Subjects:				
Task	649.8	2	324.9	7.2**
Task x Interface	572.4	2	286.2	6.3**
Task x Exp	109.0	2	54.5	1.2
Task x Interface x Exp	90.5	2	45.2	1.0
Error	2259.6	50	45.2	

* (**) denotes statistical significance at p<.10 (.05)

Table 3-10. Group Means and ANOVA Results for Net

Task	Group Means (N)							
	Active Interface				Traditional Interface			
	All	Novice	Expert	Diff	All	Novice	Expert	Diff
Cash	4.5 (28)	4.2 (13)	4.9 (15)	0.7	10.4 (21)	10.1 (12)	10.9 (9)	0.8
Park	5.8 (29)	4.8 (14)	6.7 (15)	1.9	20.1 (22)	18.7 (12)	21.8 (10)	3.1
Digger	3.1 (14)	1.8 (5)	3.9 (9)	2.1	15.6 (16)	11.9 (9)	20.4 (7)	8.5

Diff denotes the expert mean less the novice mean

ANOVA Results				
Source	SS	DF	MS	F
Between Subjects:				
Interface	2689.6	1	2389.6	106.3**
Exp	247.6	1	247.6	9.8**
Interface x Exp	62.7	1	62.7	2.5
Error	632.5	25	25.3	
Within Subjects:				
Task	461.6	2	230.8	10.1**
Task x Interface	364.3	2	182.1	7.9**
Task x Exp	93.1	2	46.6	2.0
Task x Interface x Exp	55.4	2	27.7	1.2
Error	1147.5	50	22.9	

* (**) denotes statistical significance at p<.10 (.05)

Table 3-11. Group Means and ANOVA Results for Nalt

Task	Group Means (N)							
	Active Interface				Traditional Interface			
	All	Novice	Expert	Diff	All	Novice	Expert	Diff
Cash	22.7 (28)	2.6 (13)	2.8 (15)	0.2	3.1 (21)	3.4 (12)	2.7 (9)	-0.7
Park	3.1 (29)	2.6 (14)	3.6 (15)	1.0	3.7 (22)	4.1 (12)	3.2 (10)	-0.9
Digger	1.5 (14)	1.4 (5)	1.6 (9)	0.2	2.5 (16)	1.9 (9)	3.3 (7)	1.4

Diff denotes the expert mean less the novice mean

ANOVA Results				
Source	SS	DF	MS	F
Between Subjects:				
Interface	38.3	1	38.8	14.9**
Exp	0.7	1	0.7	0.3
Interface x Exp	0.1	1	0.1	0.1
Error	65.3	25	2.6	
Within Subjects:				
Task	20.6	2	10.3	4.0**
Task x Interface	0.8	2	0.4	0.2
Task x Exp	2.9	2	1.4	0.6
Task x Interface x Exp	7.1	2	3.6	1.4
Error	129.6	50	2.6	

* (**) denotes statistical significance at p<.10 (.05)

Table 3-12. Group Means and ANOVA Results for Ncat

Task	Group Means (N)							
	Active Interface				Traditional Interface			
	All	Novice	Expert	Diff	All	Novice	Expert	Diff
Cash	1.8 (30)	1.6 (14)	1.9 (16)	0.3	2.6 (22)	2.7 (12)	2.5 (10)	-0.2
Park	2.8 (30)	2.7 (14)	2.9 (16)	0.2	4.3 (22)	4.1 (12)	4.5 (10)	0.4
Digger	2.6 (12)	1.7 (3)	2.9 (9)	1.2	5.0 (16)	4.7 (9)	5.4 (7)	0.7

Diff denotes the expert mean less the novice mean

ANOVA Results				
Source	SS	DF	MS	F
Between Subjects:				
Interface	68.7	1	68.7	79.0**
Exp	13.6	1	13.6	15.6**
Interface x Exp	1.9	1	1.9	2.2
Error	20.9	24	0.9	
Within Subjects:				
Task	30.8	2	15.4	22.9**
Task x Interface	7.7	2	3.9	5.8**
Task x Exp	0.9	2	0.4	0.7
Task x Interface x Exp	0.4	2	0.2	0.3
Error	32.2	48	0.7	

* (**) denotes statistical significance at p<.10 (.05)

Table 3-13. Group Means and ANOVA Results for Corr

Task	Group Means (N)							
	Active Interface				Traditional Interface			
	All	Novice	Expert	Diff	All	Novice	Expert	Diff
Cash	.72 (23)	.69 (11)	.74 (12)	.05	.73 (21)	.72 (12)	.73 (9)	.01
Park	.53 (29)	.44 (14)	.60 (15)	.16	.59 (20)	.60 (12)	.57 (8)	-.03
Digger	.62 (7)	.74 (2)	.57 (5)	-.17	.41 (12)	.50 (6)	.32 (6)	.18

Diff denotes the expert mean less the novice mean

ANOVA Results				
Source	SS	DF	MS	F
Between Subjects:				
Interface	0.07	1	0.07	13.5**
Exp	0.02	1	0.02	3.4
Interface x Exp	0.09	1	0.09	16.7**
Error	0.02	3	0.00	
Within Subjects:				
Task	0.82	2	0.41	4.5*
Task x Interface	0.42	2	0.21	2.3
Task x Exp	0.24	2	0.12	1.3
Task x Interface x Exp	0.03	2	0.02	0.2
Error	0.54	6	0.09	

* (**) denotes statistical significance at p<.10 (.05)

Table 3-14. Group Means and ANOVA Results for Hypnsrc

Task	Group Means (N)							
	Active Interface				Traditional Interface			
	All	Novice	Expert	Diff	All	Novice	Expert	Diff
Cash	0.44 (23)	0.64 (11)	0.25 (12)	-.39	0.05 (21)	0.08 (12)	0.00 (9)	-.08
Park	0.69 (29)	0.86 (14)	0.53 (15)	-.33	0.15 (20)	0.25 (12)	0.00 (8)	-.25
Digger	0.43 (7)	0.50 (2)	0.40 (5)	-.10	0.25 (12)	0.17 (6)	0.33 (6)	.16

Diff denotes the expert mean less the novice mean

ANOVA Results				
Source	SS	DF	MS	F
Between Subjects:				
Interface	1.50	1	1.50	10.5**
Exp	0.04	1	0.04	0.3
Interface x Exp	0.16	1	0.16	1.1
Error	1.57	11	0.14	
Within Subjects:				
Task	0.44	2	0.22	1.5
Task x Interface	1.47	2	0.74	5.2**
Task x Exp	0.74	2	0.37	2.6*
Task x Interface x Exp	0.44	2	0.22	1.5
Error	3.13	22	0.14	

* (**) denotes statistical significance at p<.10 (.05)

Table 3-15. Group Means and ANOVA Results for Srcnhyp

Task	Group Means (N)							
	Active Interface				Traditional Interface			
	All	Novice	Expert	Diff	All	Novice	Expert	Diff
Cash	1.0 (23)	0.9 (11)	1.1 (12)	0.2	1.4 (21)	1.3 (12)	1.6 (9)	0.3
Park	1.2 (29)	1.4 (14)	1.1 (15)	-0.3	1.8 (20)	1.5 (12)	2.3 (8)	0.8
Digger	1.4 (7)	0.5 (2)	1.8 (5)	1.3	2.7 (12)	2.7 (6)	2.7 (6)	0.0

Diff denotes the expert mean less the novice mean

ANOVA Results				
Source	SS	DF	MS	F
Between Subjects:				
Interface	4.8	1	4.8	3.9*
Exp	3.6	1	3.6	2.9
Interface x Exp	0.6	1	0.6	0.5
Error	13.5	11	1.2	
Within Subjects:				
Task	4.3	2	2.2	2.5
Task x Interface	2.7	2	1.4	1.6
Task x Exp	0.7	2	0.3	0.4
Task x Interface x Exp	3.3	2	1.6	1.9
Error	19.1	22	0.9	

* (**) denotes statistical significance at p<.10 (.05)

Table 3-16. Group Means and ANOVA Results for Meth

Task	Group Means (N)							
	Active Interface				Traditional Interface			
	All	Novice	Expert	Diff	All	Novice	Expert	Diff
Cash	-.03 (24)	-.23 (11)	.14 (13)	.37	.19 (21)	.23 (12)	.15 (9)	-.08
Park	.12 (23)	.11 (9)	.12 (14)	.01	.13 (22)	.14 (12)	.12 (10)	-.02
Digger	.06 (9)	-.33 (2)	.17 (7)	.50	.24 (16)	.23 (9)	.25 (7)	.02

Diff denotes the expert mean less the novice mean

ANOVA Results				
Source	SS	DF	MS	F
Between Subjects:				
Interface	0.05	1	0.05	0.2
Exp	0.12	1	0.12	0.7
Interface x Exp	0.10	1	0.10	0.6
Error	3.66	20	0.18	
Within Subjects:				
Task	0.04	2	0.02	0.1
Task x Interface	0.15	2	0.07	0.4
Task x Exp	0.13	2	0.07	0.4
Task x Interface x Exp	0.11	2	0.06	0.3
Error	7.19	40	0.18	

* (**) denotes statistical significance at p<.10 (.05)

Table 3-17. Group Means and ANOVA Results for Goal

Task	Group Means (N)							
	Active Interface				Traditional Interface			
	All	Novice	Expert	Diff	All	Novice	Expert	Diff
Cash	.08 (18)	-.07 (8)	.20 (10)	.27	.32 (21)	.37 (11)	.26 (9)	-.11
Park	.47 (24)	.98 (10)	.11 (14)	-.87	.03 (22)	.07 (12)	-.01 (10)	-.08
Digger	.27 (9)	-.33 (2)	.44 (7)	.77	.13 (15)	.10 (8)	.16 (7)	.06

Diff denotes the expert mean less the novice mean

ANOVA Results				
Source	SS	DF	MS	F
Between Subjects:				
Interface	0.44	1	0.44	2.2
Exp	0.01	1	0.01	0.0
Interface x Exp	0.00	1	0.00	0.0
Error	3.46	17	0.20	
Within Subjects:				
Task	0.51	2	0.26	1.8
Task x Interface	0.05	2	0.02	0.2
Task x Exp	0.15	2	0.08	0.5
Task x Interface x Exp	0.18	2	0.09	0.7
Error	4.75	34	0.14	

* (**) denotes statistical significance at $\rho<.10$ (.05)

Table 3-18. Group Means and ANOVA Results for Eff

Task	Group Means (N)							
	Active Interface				Traditional Interface			
	All	Novice	Expert	Diff	All	Novice	Expert	Diff
Cash	4.2 (28)	5.0 (13)	3.5 (15)	-1.5	2.3 (21)	2.4 (12)	2.0 (9)	-0.4
Park	5.8 (29)	7.2 (14)	4.5 (15)	-2.7	1.9 (22)	2.2 (12)	1.5 (10)	-0.7
Digger	5.3 (13)	4.8 (4)	5.5 (9)	0.7	1.9 (16)	2.3 (9)	1.4 (7)	-0.9

Diff denotes the expert mean less the novice mean

ANOVA Results				
Source	SS	DF	MS	F
Between Subjects:				
Interface	166.9	1	166.9	31.5**
Exp	22.1	1	22.1	4.2*
Interface x Exp	3.1	1	3.1	0.6
Error	127.2	24	5.3	
Within Subjects:				
Task	14.7	2	7.4	2.7*
Task x Interface	17.2	2	8.6	3.1*
Task x Exp	13.3	2	6.6	2.4
Task x Interface x Exp	19.0	2	9.5	3.4**
Error	132.8	48	2.8	

* (**) denotes statistical significance at p<.10 (.05)

Table 3-19. Group Means and ANOVA Results for Rpeat

Task	Group Means (N)							
	Active Interface				Traditional Interface			
	All	Novice	Expert	Diff	All	Novice	Expert	Diff
Cash	2.7	2.4	3.0	0.6	0.9	0.7	1.2	0.5
	(28)	(13)	(15)		(21)	(12)	(9)	
Park	3.3	3.4	3.3	-0.1	2.7	2.6	2.9	0.3
	(29)	(14)	(15)		(22)	(12)	(10)	
Digger	1.2	1.2	1.2	0.0	1.6	0.6	3.0	2.4
	(14)	(5)	(9)		(16)	(9)	(7)	

Diff denotes the expert mean less the novice mean

ANOVA Results				
Source	SS	DF	MS	F
Between Subjects:				
Interface	0.95	1	0.95	0.16
Exp	9.32	1	9.32	1.59
Interface x Exp	4.12	1	4.12	0.70
Error	146.32	25	5.85	
Within Subjects:				
Task	23.03	2	11.51	1.76
Task x Interface	23.90	2	11.95	1.83
Task x Exp	5.20	2	2.60	0.40
Task x Interface x Exp	5.53	2	2.76	0.42
Error	327.03	50	6.54	

* (**) denotes statistical significance at p<.10 (.05)

Table 3-20. Group Means and ANOVA Results for Comp

Task	Group Means (N)							
	Active Interface				Traditional Interface			
	All	Novice	Expert	Diff	All	Novice	Expert	Diff
Cash	3.3 (28)	3.2 (13)	3.4 (15)	0.2	3.5 (21)	3.3 (12)	3.8 (9)	0.5
Park	2.9 (28)	2.8 (13)	2.9 (15)	0.1	3.3 (21)	3.4 (12)	3.1 (9)	-0.3
Digger	2.9 (10)	2.5 (2)	3.0 (8)	0.5	3.9 (15)	3.9 (8)	3.9 (7)	0.0

Diff denotes the expert mean less the novice mean

ANOVA Results				
Source	SS	DF	MS	F
Between Subjects:				
Interface	4.9	1	4.9	2.4
Exp	1.0	1	1.0	0.5
Interface x Exp	0.4	1	0.4	0.2
Error	41.7	20	2.1	
Within Subjects:				
Task	1.9	2	1.0	0.9
Task x Interface	1.8	2	0.9	0.9
Task x Exp	1.0	2	0.5	0.5
Task x Interface x Exp	0.6	2	0.3	0.3
Error	41.7	40	1.0	

* (**) denotes statistical significance at p<.10 (.05)

Table 3-21. Group Means and ANOVA Results for Conf

Task	Group Means (N)							
	Active Interface				Traditional Interface			
	All	Novice	Expert	Diff	All	Novice	Expert	Diff
Cash	3.4 (28)	3.6 (13)	3.3 (15)	-0.3	3.9 (21)	3.9 (12)	3.9 (9)	0.0
Park	3.1 (27)	2.5 (13)	3.6 (14)	1.1	3.0 (21)	2.7 (12)	3.2 (9)	0.5
Digger	2.8 (10)	2.5 (2)	2.9 (8)	0.4	3.7 (15)	3.0 (8)	4.4 (7)	1.4

Diff denotes the expert mean less the novice mean

ANOVA Results				
Source	SS	DF	MS	F
Between Subjects:				
Interface	2.9	1	2.9	2.9
Exp	1.2	1	1.2	1.2
Interface x Exp	2.9	1	2.9	2.9
Error	19.1	19	1.0	
Within Subjects:				
Task	2.9	2	1.5	1.0
Task x Interface	5.4	2	2.7	1.8
Task x Exp	8.1	2	4.0	2.7
Task x Interface x Exp	0.6	2	0.3	0.2
Error	57.2	38	1.5	

* (**) denotes statistical significance at p<.10 (.05)

Table 3-22. Summary of Significant Effects in ANOVA Analyses

Hypotheses Investigating Experienced Auditor vs. Novice Main Effect	Hypotheses Investigating Active vs Traditional Interface Main Effect	Hypotheses Investigating Experience by Interface Interaction
2.1 Number of items retrieved	3.1 Number of items retrieved	3.8 Number of items retrieved (totnet)
2.2 Number of hypotheses generated	3.2 Number of hypotheses generated	3.9 Number of hypotheses generated
2.3 Number of categories searched	3.3 Number of categories searched	3.10 Number of categories searched
2.4 Link between assessed likelihood and actual search	3.4 Link between assessed likelihood and actual search (srcnhyp)	3.11 Link between assessed likelihood and actual search (corr, srcnhyp -2)
2.5 Conclusion	3.5 Conclusion	
2.6 Categorical clustering of information retrieved		3.12 Categorical clustering of information retrieved
2.7 Time per information item	3.6 Time per information item	3.13 Time per information item
2.8 Number of recursions	3.7 Number of recursions	3.14 Number of recursions

☐ denotes that hypothesis was confirmed at $p < .10$

Table 3-23. MANOVA Results: Pillais Multivariate Tests of Significance

Cash Task

Effect	Value	Exact F	Hypoth D.F.	Error D.F.	Sig. of F
Exp	.24	.64	10	20	.76
Interface	.72	5.03	10	20	.00
Exp by Interfac	.26	.71	10	20	.71

Park Task

Effect	Value	Exact F	Hypoth D.F.	Error D.F.	Sig. of F
Exp	.12	.39	10	30	.94
Interface	.93	41.88	10	30	.00
Exp by Interfac	.20	.76	10	30	.66

Digger Task

Effect	Value	Exact F	Hypoth D.F.	Error D.F.	Sig. of F
Exp	.96	10.70	10	4	.02
Interface	.99	29.80	10	4	.00
Exp by Interfac	.90	3.41	10	4	.12

Variables included in analysis:

Totnet
Nalt
Ncat
Corr
Srcnhyp
Hypnsrc
Goal
Meth
Eff
Rpeat

Table 3-24. Comparison of ANOVA Results using Different Measures of Expertise

Variable	Expertise Measure	F statistic for Effect or Interaction						
		Interfac	Expert	Interfac xExpert	Task	Task x Interfac	Task x Expert	Task x Expertx Interfac
Ncard	Exp	61.5**	8.4**	2.4	7.2**	6.3**	1.2	1.0
	Gmatscor	45.8**	5.6**	3.7*	5.8**	4.7**	0.6	0.5
	Hourread	34.9**	0.7	2.0	5.2**	4.4**	0.3	0.4
Net	Exp	106.3**	9.8**	2.5	10.1**	7.9**	2.0	1.2
	Gmatscor	77.1**	3.9*	4.0*	7.7**	5.8**	0.4	0.7
	Hourread	58.8**	0.6	0.6	7.3**	5.3**	0.2	0.2
Nalt	Exp	14.7**	0.3	0.1	4.0**	0.2	0.6	1.4
	Gmatscor	15.2**	0.3	0.5	5.6**	0.1	0.0	1.7
	Hourread	14.1**	0.9	1.2	5.3**	0.4	0.9	0.3
Ncat	Exp	79.0**	15.6**	2.2	22.9**	5.8**	0.6	0.3
	Gmatscor	43.1**	0.0	2.9*	31.4**	4.2**	3.8**	0.3
	Hourread	34.4**	1.3	0.0	23.4**	5.6**	0.1	0.8
Corr	Exp	13.4**	3.44	16.9**	4.5*	2.3	1.3	0.2
	Gmatscor	NA	NA	NA	NA	NA	NA	NA
	Hourread	NA	NA	NA	NA	NA	NA	NA
Hypnsrc	Exp	10.5**	0.3	1.1	1.5	5.2**	2.6*	1.5
	Gmatscor	10.3**	0.6	0.5	2.9*	3.4*	2.0	1.8
	Hourread	11.5**	1.7	2.0	2.4	4.6**	0.3	0.4
Srcnhyp	Exp	3.9*	2.9	0.5	2.5	1.6	0.4	1.9
	Gmatscor	1.3	0.1	0.2	4.9**	0.1	3.6**	2.1
	Hourread	1.7	2.3	0.4	2.6*	1.1	0.6	1.9
Meth	Exp	0.2	0.7	0.6	0.2	0.4	0.4	0.3
	Gmatscor	0.3	3.2*	1.0	0.1	0.2	0.7	1.3
	Hourread	0.3	6.2**	6.5**	0.2	0.1	3.1*	1.5
Goal	Exp	2.2	0.0	0.0	1.8	0.2	0.5	0.7
	Gmatscor	2.2	1.1	0.6	2.9*	1.8	1.6	0.3
	Hourread	2.4	0.5	2.3	3.2	1.3	0.4	0.5

...continued

* denotes statistical significance at p<.10

** denotes statistical significance at p<.05

NA denotes insufficient information for analysis

Table 3-24 (continued). Comparison of ANOVA Results using Different Measures of Expertise

Variable	Expertise Measure	F statistic for Effect or Interaction						
		Interfac	Expert	Interfac xExpert	Task	Task x Interfac	Task x Expert	Task x Expertx Interfac
Time	Exp	6.2**	0.1	0.5	11.8**	0.6	0.1	0.5
	Gmatscor	4.1*	0.2	0.1	10.6**	0.4	0.7	0.0
	Hourread	5.7**	0.7	0.7	10.4**	0.5	0.1	0.0
Eff	Exp	31.5**	4.2*	0.6	2.7*	3.1*	2.4	3.4**
	Gmatscor	20.1**	2.7	0.5	1.6	1.8	0.4	0.6
	Hourread	21.2**	0.0	0.3	2.4	2.6*	0.6	1.4
Rpeat	Exp	0.2	1.6	0.7	1.8	1.8	0.4	0.4
	Gmatscor	1.1	4.9**	0.8	1.4	1.3	0.9	0.2
	Hourread							
Comp	Exp	2.4	0.5	0.2	0.9	0.9	0.5	0.3
	Gmatscor	0.1	2.5	3.4*	1.3	1.2	1.1	0.7
	Hourread	2.9	3.6*	0.0	2.5*	1.1	0.4	1.0
Conf	Exp	2.9	1.2	2.9	1.0	1.8	2.7*	0.2
	Gmatscor	2.7	0.2	1.7	0.0	4.6**	2.6*	0.4
	Hourread	2.4	0.0	0.0	0.5	3.7**	0.2	0.9

* denotes statistical significance at $p<.10$
** denotes statistical significance at $p<.05$

Chapter 4. Discussion and Conclusion

I. SUMMARY OF FINDINGS AND THEIR IMPLICATIONS

The purpose of this research was to examine the impact of a different information search regime on the information search behaviour of experienced and novice auditors. The research used two different information search regimes: the traditional information search regime allowed participants to retrieve information using a menu of cues, and replicated the search environment typically used in research on information search. The active information search regime required that participants determine their own information requirements and was designed to feature a more realistic environment where an exhaustive list of the possible information to select from is not available.

The results indicated that the information search regime indeed affected the performance of the participants. The impact of the regime was greatest for the unstructured tasks, as expected. Participants in the active information search regime performed less extensive information search and restricted their information search to fewer categories of information, despite the fact that they generated the same number of hypotheses. They were also more likely to not devote any search to confirm or disconfirm a particular hypothesis. It appeared that participants had difficulty developing an information search strategy that would allow them to thoroughly investigate each hypothesis they generated.

There was also evidence to suggest that, as expected, participants under the traditional information search were less cognitively involved. Participants under the traditional search regime requested information for which they had no underlying

hypothesis more often than participants under the active information search regime. This result held in all three tasks.

The active interface was also more successful in uncovering differences between experienced and novice auditors than the traditional interface was. Under the active information search regime, the differences in the depth and breadth of information search were more pronounced. Experienced auditors were more efficient in terms of the time they spent per information card. They were also more effective in that there was a closer correlation between the likelihood they assigned to a particular hypothesis and the extent of information search that they devoted to it. These findings were consistent with experienced auditors having pre-existing problem solving schema that guided their specific information search.

These results imply that the ability to conduct effective information search appears to be part of the professional judgment possessed by experienced auditors. However, when professional judgment is assessed conventionally the information search component is virtually ignored, or is examined in a manner that changes the cognitive nature of the information search task. That is, all the relevant information is usually provided to the subjects up front, or made readily available such as in information search experiments using the traditional information search regime. This is generally the case in experimental research on auditor judgment. Professional judgment is also routinely assessed in educational settings as it is considered to be an essential trait of members of the profession. For example, the Uniform Final Examination written in Canada contains questions that typically provide all the information that can and/or will be used to arrive

at a judgment. The questions then focus on the information integration and evaluation phases of the judgment process. The results of this research imply that the ability to identify and search for information is a component of judgment expertise, and it is more difficult to follow a comprehensive information search strategy when all the information is not presented initially. Thus it is possible that an important area of professional judgment is not being assessed in this educational setting. This would suggest that traditional question formats could be supplemented by questions that focused on information search. For example, participants could be given an initial problem and asked to map out an information search strategy: the type of information they would require, how they would acquire that information and how the results of their initial information search would be evaluated and would lead to further information requirements.

Similarly, when professional judgment is assessed in a litigation setting the expert assessing the auditor's performance is typically provided with all the relevant information up front. That is, the expert is given all the information that the original auditor gathered, and perhaps additional information that, with hindsight, was relevant. In this way, the information search demands of the experts' judgment task is different from the information search demands faced by the original auditor. Rather than determining what information is relevant, the expert only has to integrate and evaluate all the information he is provided. Again, since information search is a critical component of judgment, and removing the necessity for information search simplifies the judgment process, then comparing the expert's judgment to the original auditor's judgment may be invalid and may in fact stack the odds against the original auditor. In that case, then, the expert's

judgment would only be a valid benchmark if the original task, including the information search demands, were replicated. The expert would have no prior knowledge of the case and would be given the same original problem, and be asked to determine what information he would require and how that information would be evaluated.

This research also found that auditors were relatively insensitive to the amount of information missing from their analysis. This would suggest that auditors encountering real world problems where they must determine their own information requirements should be particularly careful in planning their problem solving approach. Their hypotheses should be carefully specified, and the information gathered should be matched against those hypotheses to ensure that each one has been adequately investigated. Furthermore, it would be prudent to ensure that relatively experienced auditors are assigned to the more unstructured tasks.

Finally, this research found that general problem solving ability was a critical ingredient to effective information search. There was some correlation between general problem solving ability and experience: this may indicate that general problem solving ability is improved throughout an auditors' career, or it may indicate that individuals with greater problem solving ability are more likely to advance in a Chartered Accounting firm. In either case, it appears that general problem solving ability is an important asset. To the extent that it can be identified, it should be considered an attractive feature in potential recruits. Also, the development of this ability should be stressed in on the job training and professional development courses.

II. LIMITATIONS AND EXTENSIONS

There are a number of limitations that should be considered when evaluating this study. First, although the participants rated the experimental tasks as quite realistic, some features of the real world task environment were removed from the experimental setting, as is the case with all experimental research. For example, the information for the computer tasks was presented on computer screens. Although computers are being used very extensively, perhaps the information in the real world would be in hard copy. Also, in the course of the experiment the participants did not consult with their colleagues. Similarly, if they wished to consult outside sources of information they questioned the computer for the information rather than physically going to the actual sources themselves. It is also possible that the subjects may have felt driven by different incentives than they would in the course of their normal jobs. This list represents only a few of the factors that may have been affected.

Secondly, as was discussed in Chapter 1, this study was conducted on members from only one accounting firm, and used only three experimental tasks. It would be interesting to see if similar results would be found with other firms and with other tasks. However, although it was advanced that the active interface provided a more realistic information search environment for the unstructured tasks of this study, it can not be assumed that it would represent a more realistic environment for *all* experimental information search tasks. The active information search regime is probably a more realistic representation of the environment for those tasks where there would be little external guidance available regarding what information is relevant and the decision maker

must exercise considerable judgment over the information search process. Examples of such auditing tasks could be designing an audit program for non-typical balance sheet items, analytical review procedures, disclosure or materiality decisions, or going concern assessments. On the other hand, with some auditing judgments the information required is often well specified and the information search is aided by items such as audit firm questionnaires. An example of such a decision would be internal control evaluation. In such a case this experimental interface would be less realistic as auditors do not have to perform an "unguided" information search in real life.

A third problem with this study in particular involved the performance of the active interface. Although the active interface performed generally well considering the diversity in the way people will phrase questions, there were still on average between two and three questions posed by each subject for each task that were not answered. These unanswered questions were taken into account for the analyses regarding the extent of information search. However, it is possible that the answer to one of those questions may have triggered additional questions in the auditors' minds. Hence, the number of actual information cards seen plus the number of unanswered questions may still have underestimated the amount of information search had the active interface worked perfectly. Furthermore, it is difficult to assess the extent of the understatement, although it is hopefully minimized by two factors. First, the responses to the questions asked by the subjects quite often were not included in the interface as they had not occurred to me, to the original auditors who performed the tasks in real life, or to the twenty pilot subjects. It could be that the questions were irrelevant to the outcome of the task, or

were the result of a somewhat idiosyncratic problem solving approach. The second mitigating factor is, as can be seen from the information cards in Appendix B, the information items in general are self-contained results of individual procedures. Thus, in many cases seeing one additional card would not prompt extensive additional search. Nevertheless, improving the interface would be a laudable goal - however, no amount of pilot testing would guarantee that all questions would be answered.

A final cautionary note involves the use of proxies for the different types of expertise. First of all, the types of expertise required (eg. general problem solving ability, experience with valuing assets on a non-historic cost basis) were determined based on the Bonner and Lewis (1990) study, discussions with the auditors who originally performed the tasks, the pilot subjects, and my own conjectures. Although the participants in the experiment did not suggest any other types of experience or abilities that would have been valuable for performing the tasks, that does not mean that the list of abilities and experiences specified was complete and that all the items were relevant. Furthermore, the measures used to proxy these types of expertise may have been inaccurate. Finally, each of the measures was tested individually. It is possible that some composite measure of the various types of expertise would provide the best classification of true "experts". The development of a theoretically sound composite measure of expertise, although an interesting endeavour, is beyond the scope of this thesis.

At this point, approaching the study of information search using different methodologies would provide useful additional information. Specifically, gathering the protocols of participants performing the experiments, or indeed gathering protocols from

auditors actually performing a real life auditing task, may yield further valuable insights into a number of questions: Do auditors actually and consciously generate hypotheses? At what point do they do so? Do they actually use those hypotheses to guide their search, and do they have strategies in place to ensure that all hypotheses are systematically investigated? Do they consider the relative likelihood of those hypotheses when they perform their information search? How do experienced subjects and novices differ?

Bibliography

Bonner, S.E. and B.L. Lewis, "Determinants of Auditor Expertise," Journal of Accounting Research, Vol 28, (supplement 1990), 1-20.

Appendix A. Development of Interfaces and their Performance

I. DEVELOPMENT OF INTERFACES

The goal of the active interface was to allow participants to enter their own information requests rather than selecting the information from a menu of cues. This entailed developing a computer program that could interpret requests phrased by the participants in natural language. The difficulty was obviously that individuals phrase the same question in many different ways and it is nearly impossible to design a program that would contain all possible ways of phrasing any particular information request (Brucks, 1988). Brucks (1985) had subjects enter their information requests on a computer which was relayed to an experimenter in another room. The experimenter then interpreted the request and relayed the information back to the subject. There were a number of disadvantages to this approach. There would be some delay for the subjects between the time that they entered the question and receiving the information, which could be frustrating and tedious. Also, there could be some bias introduced by the way the experimenter interpreted the information request, particularly if the experimenter knew what experimental group the subject was in. Finally, only one subject could be run at a time which could limit the feasible sample sizes.

A second way of approaching the problem would be to have subjects retrieve information based on key words. This would eliminate the problem of subjects phrasing questions differently. However it could be frustrating and may feel unnatural to the subjects, hampering their performance. Nevertheless, this approach formed the basic logic of the computer program designed for this research.

Generally speaking, although there are many ways of phrasing a particular information request there will frequently be a few key words present. Each of the experimental tasks had a number of information screens available corresponding to each possible information request. These screens were each identif[illegible] key words. Whenever the participant entered a question containing tho[illegible] words that information screen was presented to him or her.

The operation of the program was quite simple. Once the participant entered their question, the computer searched through the sentence, discarded any words that it did not recognize as key words and used the remaining key words to select the appropriate information screen. The key words were not case sensitive and the computer could identify key words that deviated in small ways from its own list of key words. The computer could still [illegible] match key words containing minor typographical errors or ending with differen[illegible] and so on. Ther[illegible] were two buttons at the bottom of each information screen presented which corresponded to whether the information presented was what the participant had requested or not. Participants clicked on one of those buttons before leaving the information screen. If the computer did not contain an information item with the same key words presented a screen telling the participant to try again as the information they requested was not available. The program also had a feature that accumulated a list of the information items that the participant had already seen in the experimental session. This allowed the participant to easily [illegible] back and review this information again without having to re-type the entire information request.

The computer took approximately 2 seconds to process an information request

entered on a Macintosh SE. The computer maintained a transcript of the entire session. The transcript contained all the questions asked by the participant, the information screens presented by the computer in response, the participant's assessment of whether the information presented correctly corresponded to their question, the time the session began and ended, their conclusion, hypotheses, and their responses for the demographic information.

The program was written within Hypercard and was designed to run on a Macintosh. The creator of Hypercard describes it as "an authoring tool and an information organizer. You can use it to create stacks of information to share with other people or to read stacks of information made by other people. So it's both an authoring tool and sort of a cassette player for information" (Goodman, 1988). Hypercard was well suited to the experiment for several reasons. It allowed the information items to be created, stored, and retrieved like a traditional database. However, the format of each information item could vary in terms of its length and appearance, allowing full flexibility in terms of the type of information that could be made available to the participant. However, unlike a traditional database that would present a list of all the information contained within the database (and is thus similar to the traditional interface used for information search studies) a program could be written within Hypercard to search the questions entered by the subjects for key words in the manner described above. The Hypercard also allows the programmer to make the interface very user friendly with the use of mouse-driven buttons and icons. Finally, the program is very flexible in that it is easy to change what information is presented to the subjects. The database can be easily

modified for future experimental manipulations.

The traditional interface contained exactly the same information as was available in the new interface. However the traditional interface provided participants with a menu of all the information cues in alphabetical order and the participants made their information selections from that menu. Figure A-1 contains the screens that were presented to the participants in the active interface to clarify how the participants requested their information. Figure A-2 contains an example of the information retrieval screens presented to the participants in the traditional interface.

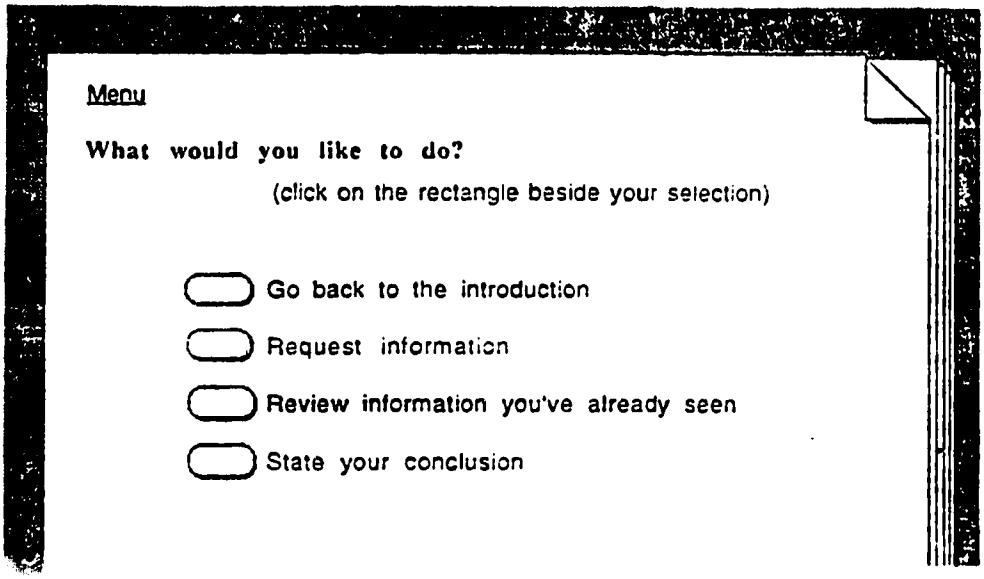
II. PERFORMANCE OF INTERFACES

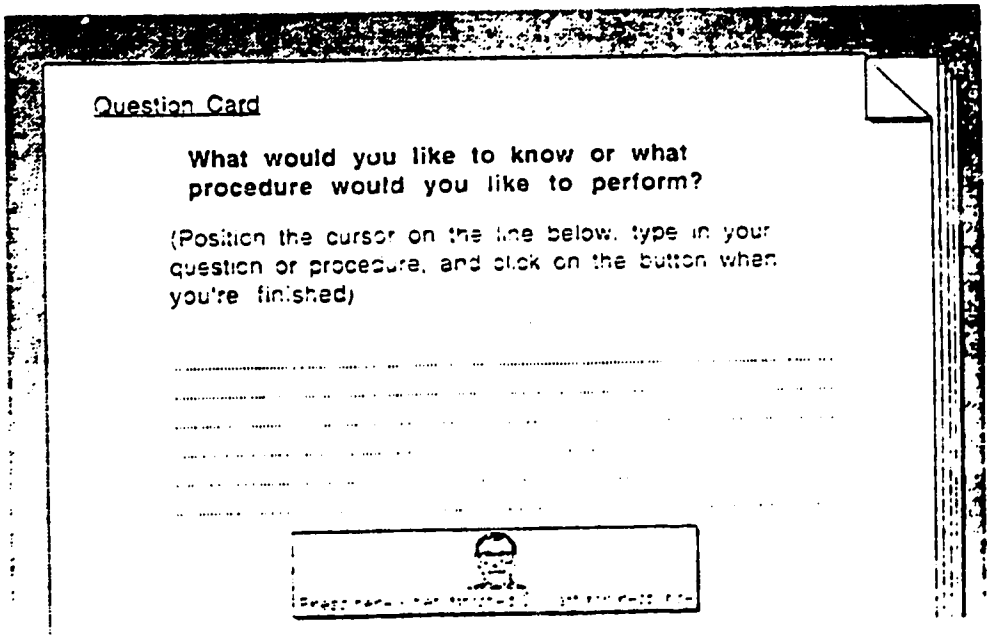
The active interface performed quite well in general. The potential problems were that participants would use key words that were not entered in the computer, would receive information that did not answer their questions (if by using only the key words the computer misinterpreted the questions), or would ask unexpected questions that were not available in the interface. Table A-1 contains the variables that were used to measure the program's performance. The descriptive statistics are shown on Table A-2. Participants on average asked between 2.1 and 3.2 questions which the interface was unable to answer. Participants were told to rephrase a question a maximum of three times, and thereafter to assume that the information was not available. Therefore, the number of times that the participants received the "sorry, information not available" screen was greater than the number of questions not answered as Ninfo included the multiple phrasings of the same unanswered question. The program answered a question with the incorrect response (Xinfo) relatively rarely. Finally, there were no systematic

differences between the performance of the active interface for the experienced auditors and the novices.

There were no difficulties in the operation of the traditional interface.

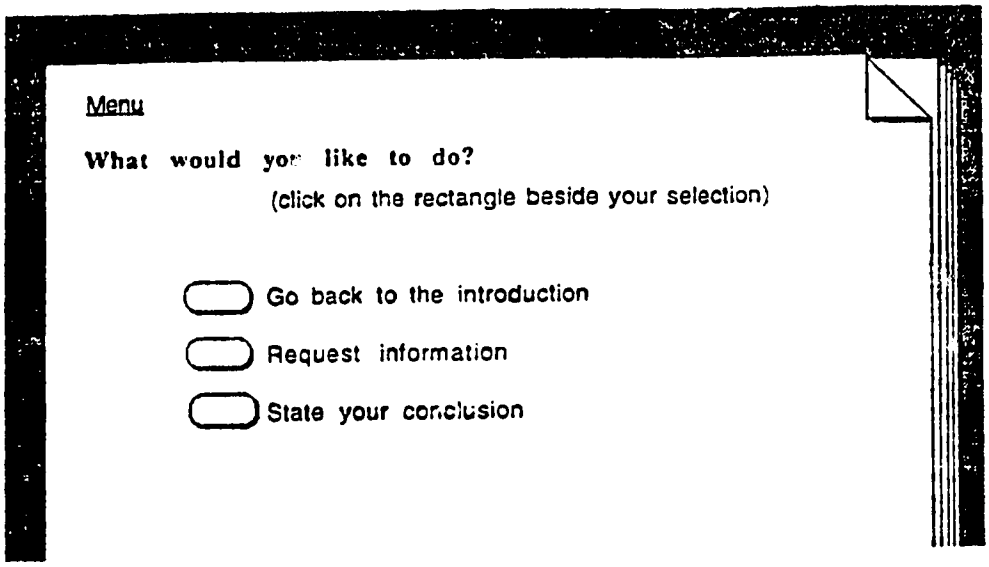
Figure A-1. Information Retrieval Screens Presented to Participants in the Active Interface

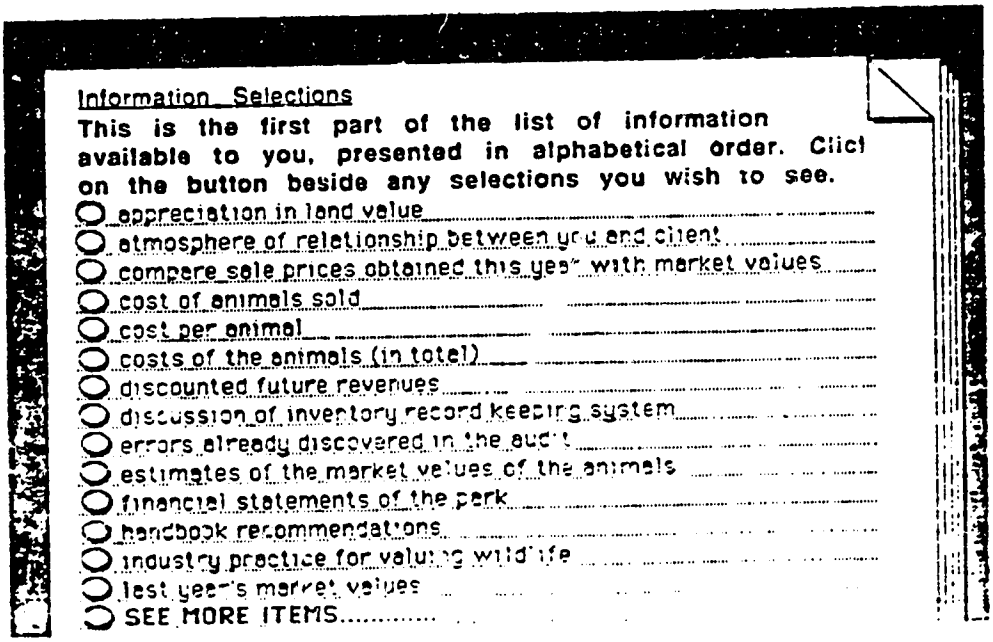




This figure is a reproduction of computer screens which form part of a computer software program copyrighted to the author of this thesis.

Figure A-2. Information Retrieval Screens Presented to Participants in the Traditional Interface





This figure is a reproduction of computer screens which form part of a computer software program copyrighted to the author of this thesis.

Table A-1. List of Variables: Performance of Active Interface

VARIABLE	DESCRIPTION
Nasr	Number of different questions asked by participant that were not answered
Xinfo	Number of times the participant checked box indicating that information received was not what they had requested
Xprop	Proportion of times the participant checked box indicating that information received was not what they had requested
Ninfo	Number of times participant received "sorry, information not available" screen in response to a question

Table A-2. Descriptive Statistics: Performance of Active Interface

Variable	Task	N	Min	Max	Mean	S.D.
Nasr	Cash	28	0.0	7.0	2.4	1.8
	Park	30	0.0	7.0	3.2	2.3
	Digger	11	0.0	4.0	2.1	1.3
Xinfo	Cash	28	0.0	6.0	1.4	1.5
	Park	30	0.0	10.0	1.9	2.3
	Digger	12	0.0	3.0	0.9	1.3
Xprop	Cash	28	0.0	0.5	0.2	0.2
	Park	29	0.0	0.7	0.2	[illegible]
	Digger	12	0.0	0.7	0.2	[illegible]
Ninfo	Cash	28	0.0	18.0	5.0	[illegible]
	Park	30	0.0	28.0	9.1	[illegible]
	Digger	12	0.0	10.0	4.5	[illegible]

Table A-3. T tests: Performance of Active Interface

Variable	Task	Novices			Experienced			T
		N	Mean	S.D.	N	Mean	S.D.	
Nasr	Cash	13	2.54	2.07	15	2.20	1.61	0.48
	Park	14	2.57	2.28	16	3.69	2.33	-1.33
	Digger	3	2.33	2.08	8	2.00	1.07	0.26
Xinfo	Cash	13	1.23	1.36	15	1.53	1.73	-0.52
	Park	14	1.43	1.60	16	2.25	2.79	-1.00
	Digger	3	1.00	1.73	9	0.89	1.27	0.10
Xprop	Cash	13	0.16	0.16	15	0.18	0.18	-0.41
	Park	14	0.17	0.17	15	0.21	0.20	-0.57
	Digger	3	0.25	0.43	9	0.13	0.17	0.48
Ninfo	Cash	13	4.69	4.72	15	5.20	4.46	-0.29
	Park	14	8.71	6.17	16	9.50	7.42	-0.32
	Digger	3	4.33	4.04	9	4.56	3.09	-0.09

* would be used to denote statistical significance at $p<.10$

** would be used to denote statistical significance at $p<.05$

Appendix B. Experimental Tasks

This appendix shows all the information available to the participants of the experiment. The introduction of each task was provided to all participants in both interfaces up front. Following the introductions are the individual information items that subjects could request in the manner dictated by the interface to which they were assigned. Each of these items was presented on a separate screen. Following the information items for each task are the screens that were presented to each participant where they entered their conclusions, the hypotheses they considered, the likelihood of those hypotheses, and the demographic information that was used to determine each participant's specific expertise level.

I. CASH TASK

A. Information Cards

Introduction:

You are on your way to the audit of a small client, Student Painting Inc. This client has just completed its first year of operations and requires an audit as a condition of its government loan. Although the rest of the audit staff will be joining you tomorrow, you will be out at the client by yourself today. Your job is to complete the audit of the cash section. The senior has already reviewed the correspondence files and the minutes and said there are no issues affecting the cash section.

Student Painting Inc. operates in Kingston, Ontario, which enjoys a relatively stable economy. The company is owned by one man and employs 15 3-person painting crews. The company also employs two full time office managers. One manager, Bob, takes all the phone calls, schedules the work and prepares a two part work order. Bob keeps one copy and forwards the other to the second manager, Lynn, who files the work orders by date. Once the work is completed, Lynn prepares a 3 part invoice which is reviewed by Bob. One part is filed with the work order, a second is kept in Lynn's alphabetic file until payment is received, and the third is sent out to the customer. Unmatched work orders for which no invoice has been generated and unpaid invoices are followed up on regularly. Bob opens the mail, stamps cheques "for deposit only", deposits the cheques, and sends a list of the receipts to Lynn. Lynn removes the corresponding invoice from her alphabetic file of unpaid invoices, stamps them paid and files them with the work order. Bob maintains the listing of Accounts Payable and payroll. When invoices arrive for payment he ensures the goods have been received, records the payment in the A/P ledger and forwards the invoice to Lynn. She prepares the cheques and signs those under $500. Cheques over $500 are signed by the owner. Invoices are stamped paid and filed alphabetically.

The business uses a well recognized accounting package with a personal

computer. It generates a G/L, cash receipts listing, cash disbursements listing, A/R listing and A/P listing monthly. The program requires each user to have a password and restricts each user's access to those areas over which they have responsibility. The owner reconciles the bank account monthly.

The company began with $50,000 invested by the owner and a 10 year, $50,000 6% loan from the government. The loan imposes no covenants or restrictions on the use of cash. Payments are interest only for the first 3 years. The money was used to buy equipment ($5,000), with the cash remainder used to cover first two months' expenses (primarily payroll and leasing 5 vans), promotion, and overhead. Paint is provided by the customer.

On the way to the client's you realize you forgot to bring along your firm's audit approach plans. Instead of going back you decide to work on the cash section without them, and fill them out later. Your task is to CONDUCT PROCEDURES to determine if the company's year end cash balance is fairly stated. You may ignore cut-off procedures, and no cash is kept on the premises. You can ask questions of the staff, carry out procedures, or have any schedules prepared that you consider necessary. You must gather enough information and documentation to support your judgment in accordance with GAAS.

Add client bank reconciliation:

The client has prepared the following bank reconciliation:

Balance per bank		43075
Deduct outstanding cheques:	#118	(1500)
	#121	(2500)
Add outstanding deposit:	Dec 31	2775
Book Balance		42750

You have noted that there are no addition errors in this reconciliation.

Agree balance per reconciliation to book balance:

The client has prepared the following bank reconciliation:

Balance per bank		43075
Deduct outstanding cheques:	#118	(1500)
	#121	(2500)
Add outstanding deposit:	Dec 31	2775
Book Balance		42750

You have agreed the book balance to the general ledger.

Atmosphere of relationship between you and the client:

The owner of the business has been very cooperative and seems to be very competent in general business as well as accounting. You anticipate that he will be a valuable client in the future.

Check bank statement:

The balance in the bank at year end, according to the bank statement, was $43,075. No unusual items such as debit memos etc. were noted on the bank statement.

Check outstanding cheques and deposits to January statement:

The client has prepared the following bank reconciliation:

Balance per bank		43075
Deduct outstanding cheques:	#118	(1500)
	#121	(2500)
Add outstanding deposit:	Dec 31	2775
Book Balance		42750

All outstanding cheques and deposits were agreed to January's statements and to the cash receipts and cash disbursements listings.

Confirm bank balance:

You have sent out a standard confirmation and received it back from the bank. According to the confirmation, the bank balance was $43,075. There were no other unusual items noted on the confirmation.

Errors already discovered in the audit:

You are the first person out to the client's, so no errors have been discovered so far and there does not appear to be any contentious areas. Also, since this is the first year of the client's operations there are no opening errors.

Financial Statements:

Unaudited Balance Sheet at end of year 1 (with opening figures)

	opening	end of yr 1
Cash	$35000	42750
A/R	0	80000
Equip (net)	5000	4250
Total Assets	40000	127000
A/P	0	12000
Income Tax Payable	0	3000
Govt. Loan	50000	50000
S/H Capital	50000	50000
Retained Earnings	0	12000
Total Liab and S/H Equity	40000	12700

Unaudited Income statement for year 1 :

Painting and Misc. Revenue		810000
Expenses:		
Salaries	750000	
Depn (=CCA rates, 1/2 yr rule)	750	
Overhead	12000	
Promotion	5250	
Interest	3000	
Lease Expense-Vehicles	24000	
Total Expenses	795000	
Net Income before tax		15000
Income tax (20%)		3000
Net Income after tax		12000
Closing Retained Earnings		12000

Interest received:

The $810,000 revenue on the unaudited financial statements includes interest revenue of $2,000. The business maintained an average monthly cash balance of approximately $40,000 and the account paid interest between 4% and 6% throughout the year.

Internal Controls:

The system of cash receipts and disbursements operates as described in the introduction and no compliance deviations were noted.

Materiality:

The senior on the job has set materiality at $1,000.

Obtain client bank reconciliation:

The client has prepared the following bank reconciliation:

Balance per bank			43,075
Deduct outstanding cheques:	#118	(1,500)	
	#121	(2,500)	
Add outstanding deposit:	Dec 31	2,775	
Book balance			42,750

Review books of account:

You have reviewed the various books of accounts and have noted no unusual items. The cash account ending balance in the general ledger was $42,750.

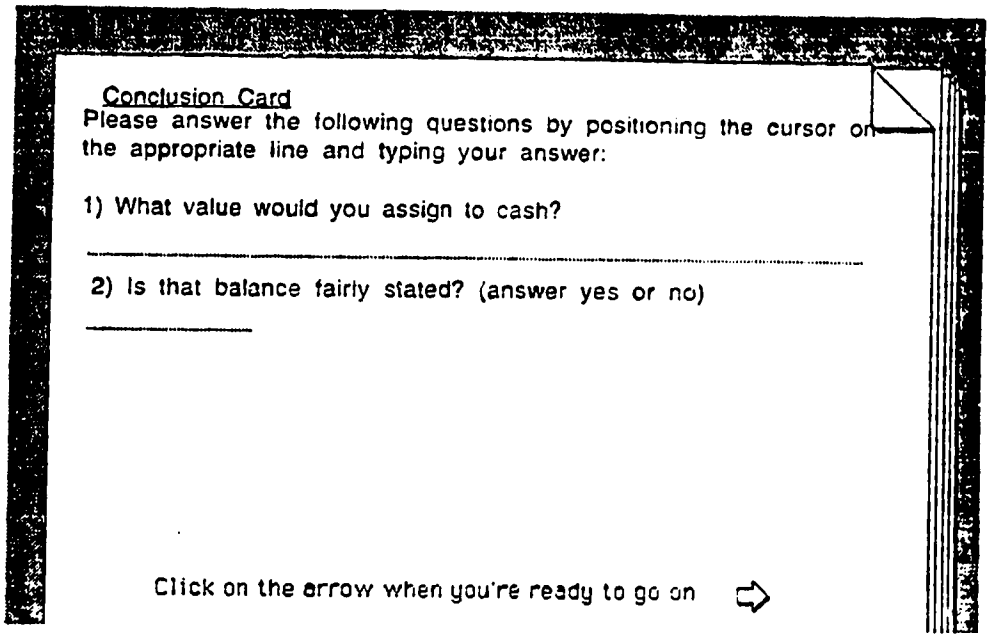
Risks of the business:

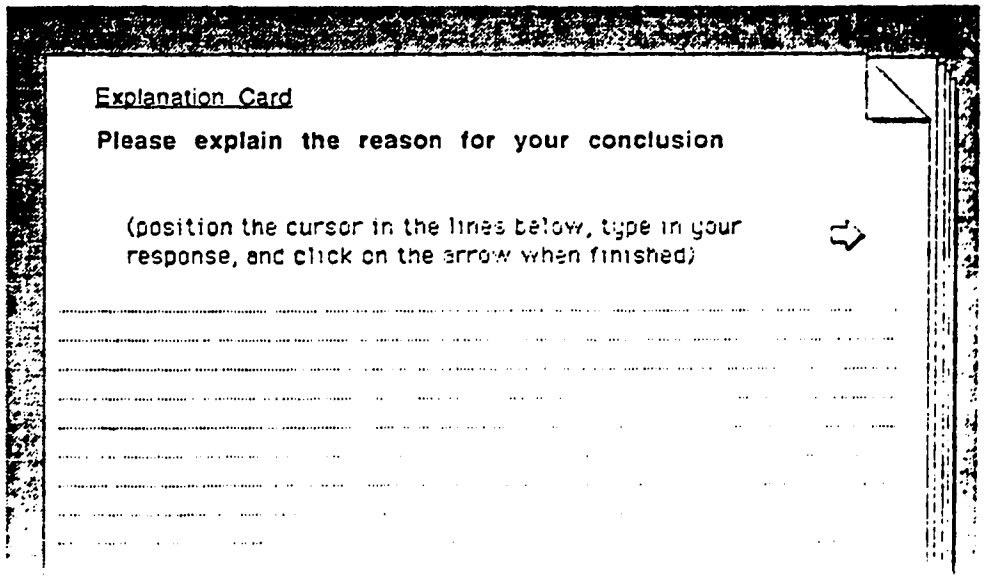
The business risk associated with Student Painting Inc. is fairly low. Since the economy of Kingston is fairly stable, income prospects are good, although the business is by nature seasonal. The level of competition is moderate.

Volume of Transactions:

Aside from payroll, the volume of transactions is fairly low. Approximately 50 cheques are written each month. You may ignore petty cash. Also, approximately 70 cheques are received from customers each month. This volume is fairly consistent from month to month, although it tends to increase over the summer.

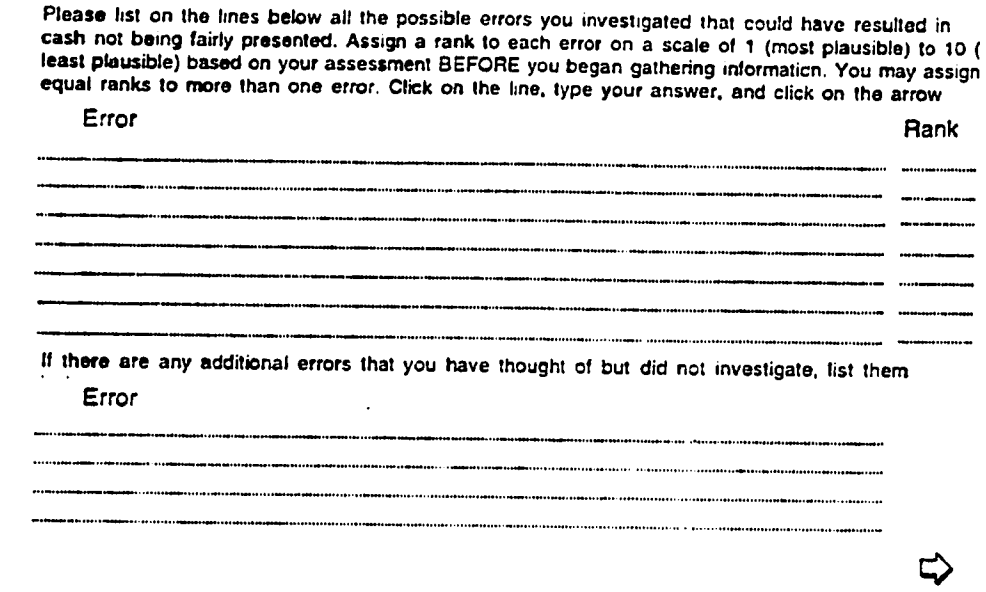
B. Screens Presented to Participants at End of Cash Task

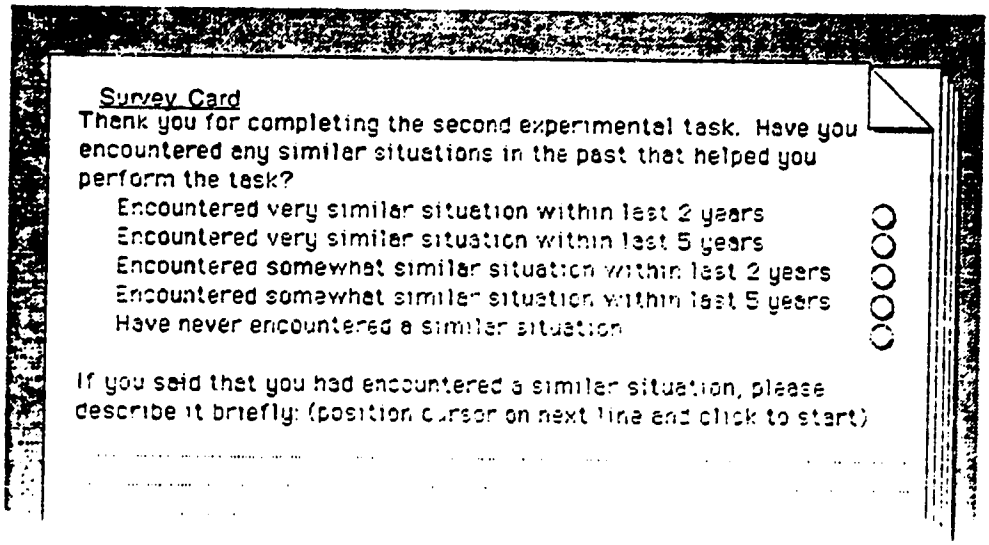




This is a reproduction of computer screens which form part of a computer software program copyrighted to the author of this thesis.

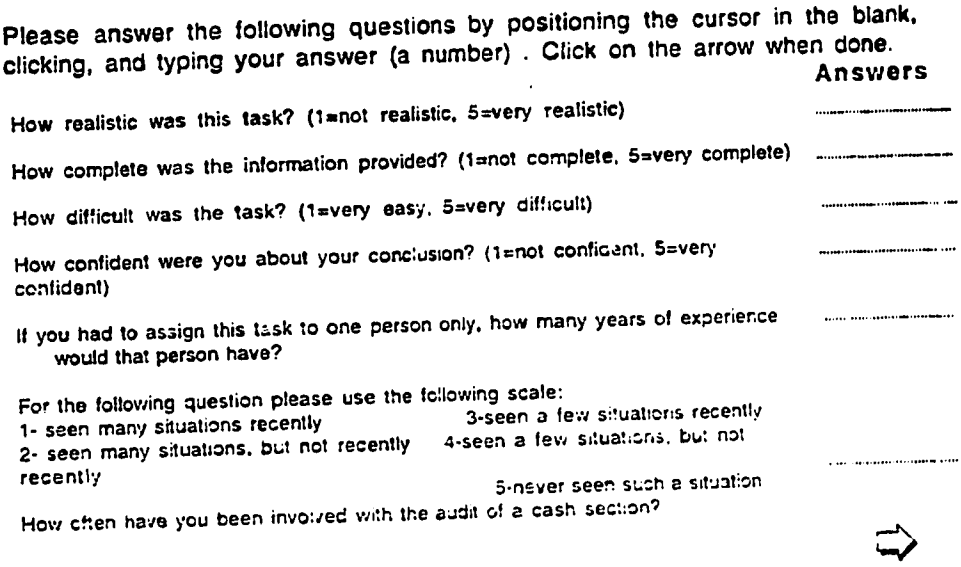
B. Screens Presented to Participants at End of Cash Task (continued)





This is a reproduction of computer screens which form part of a computer software program copyrighted to the author of this thesis.

B. Screens Presented to Participants at End of Cash Task (continued)



This is a reproduction of computer screens which form part of a computer software program copyrighted to the author of this thesis.

II. PARK TASK

A. Information Cards

Introduction:

Your new client owns and operates Ferocious Animal Wildlife Park. The park covers 3,000 acres subdivided into 4 enclosures. The animals are free to roam within each enclosure. Visitors remain in their cars and drive through the enclosures to view the animals.

The park has been in operation for 3 years. The land and about half of the animals were originally purchased 3 years ago for $3.5 million. At that time, the land alone was worth $2.5 million.

A significant portion of the park's revenues are received from the provincial government. The government may discontinue these grants once the guaranteed period elapses unless the park can demonstrate its viability. The park owner wishes to value the inventory at market value as he is very proud of the park's breeding record and feels historical cost does not reflect the true value of the animals.

The client has provided you with the following schedule of animals on hand at year end:

	Year 1		Year 2		Year 3	
Species	#	total Purchase Price	#	total Purchase Price	#	total Purchase Price
aardvark	1	700	1	700	1	700
antelope	10	5000	12	5000	16	4500
buffalo	16	18000	20	18000	20	12000
cougars	0	0	4	10000	5	10000
deer	10	9000	20	14000	27	14000
eagles	0	0	0	0	2	4500
...						
total	600	700000	750	600000	1100	750000

For its first two years of operation the park was audited by another accounting firm. That firm valued the inventory at historic cost (ie. the purchase price of any animals bought) and provided a clean opinion, but the owner is dissatisfied with that treatment. He is willing to accept a qualified opinion if the inventory is valued at market.

Your task is to 1) decide what basis of valuation you will recommend for the animal inventory, 2) CONDUCT PROCEDURES to arrive at a value for that inventory and 3) specify the level of assurance you would provide. You can ask questions of the staff, carry out procedures, or have any schedules prepared that you consider necessary. You must gather enough information and documentation to support your judgment in accordance with GAAS. Note that although the inventory includes both animals and birds, the term "animals" will refer to both.

Appreciation in land value:

The land in the surrounding area has not appreciated significantly over the last 3 years. There is no reason to suppose that the value of the park land has changed significantly since its purchase, and no significant improvements have been made.

Atmosphere of relationship between you and the client:

Generally, the owner is a good client and you are anxious to keep his business. He owns several businesses which could generate substantial audit fees. The owner appears to be rather creative regarding the accounting policies he wishes to adopt,particularly if there are few standards to go by.

Compare sale prices obtained this year with market values:

You have compared the prices obtained on sales of the animals over the past year to the market prices obtained through confirmation. The following results were obtained:

value of animals sold this year	630,000
market value according to confirmation	720,000
difference	90,000

(note: $450,000 of the animals had a market value greater than the sale value by 150,000, and $180,000 of the animals had a market value less than the sale value by 60,000, resulting in the net 90,000 discrepancy between sale prices and market values at year end).

Cost of animals sold:

According to the client's records, the cost of the animals sold was as follows:

	yr 1 (audited)	yr 2 (audited)	yr 3	total
total sales proceeds	(500,000)	(770,000)	(830,000)	(2,100,000)
original purchase price of animals sold	300,000	600,000	350,000	1,250,000
gain on sale	200,000	170,000	480,000	850,000

Cost per animal:

You calculate the average cost per animal to be as follows:

	yr 1	yr 2	yr 3
cost of net animals purchased	1,166	857	750
feed	1,000	964	900
care	167	285	200
total	2,333	2,106	1,850

The cost of net animals purchased is based on the purchase price of animals bought from outside sources since the park began, less the original purchase price of any animals sold or known to have died. The average is obtained by dividing this number by the average total number of animals. The average declines as more animals are born within the park as they have no historic cost associated with them.

Costs of the animals:

According to the client's records, the following costs have been incurred since inception (including the original purchase of animals in the park):

	yr 1	yr 2	yr 3	total
total purchases	1,000,000	500,000	500,000	2,000,000
sales proceeds	(500,000)	(770,000)	(830,000)	(2,100,000)
feed	600,000	675,000	900,000	2,025,000
care	100,000	200,000	200,000	500,000
total	1,200,000	605,000	770,000	2,425,000

Discounted Future Revenues:

The management of the park wants to continue operations and plans to follow the same basic strategies that they have for the last few years, continuing their emphasis on breeding.

The management of the park lacks the expertise to generate an accurate forecast of future revenues. However, they feel that the park's future results will be at least as good as the level of performance they have achieved in the past. They are hopeful that they will be able to generate more revenues from the sales of animals bred in the park, and also that admissions may increase with the increase in animals. _

Discussion of inventory record keeping system:

The park has begun to implement a record keeping system to keep track of the animals. However, it is not complete and is therefore unreliable. It is difficult to maintain accurate perpetual records due to births and deaths of the animals. Dead animals may not be found and/or are fed to other animals. Death certificates are not issued as this would be prohibitively expensive.

All animals that have been purchased and some of the animals born in the park have tatoos or tags to identify them. There are invoices to support when animals are bought or sold. Controls over purchases/payables/payments and sales/receivables/receipts are adequate.

There are few physical controls over the animals since they roam freely within the large enclosures.

Errors already discovered in the audit:

Aside from the inventory, no significant problems or errors arose in the course of the audit. Controls over purchases/payables/payments and sales/receivables/receipts were adequate.

Estimates of the market value of animals:

Animals can be sold to other zoos, hunting farms and exotic animal ranches. However, there is no market available for some of the animals. Many of the zoos will trade animals rather than setting a price for them. There are several determinants of the value of the animals. The rarity of the species, the difficulty of raising or breeding in captivity, the potential uses of the animal (hunting ranches, furs, meat and so on), the breeding rates of the animal in captivity, the number of offspring the animal has had, and the general health and temperament of the animal are all important.

There are market value estimates for most of the animals. According to the gamekeeper, who remains in close contact with many people in the industry, the market value of the inventory (including birds) is about $2.3 million.

Financial Statements:

Unaudited Balance Sheet at end of year 3 (with audited comparative figures)

	year 1	year 2	year 3
Cash and Investments	580,000	950,000	1,190,000
Inventory (cost)	700,000	600,000	750,000
Land and Bldg (net)	2,470,000	2,440,000	2,410,000
TOTAL ASSETS	3,750,000	3,990,000	4,350,000
A/P	10,000	15,000	25,000
Loan	1,000,000	1,000,000	1,000,000
Share Capital	2,500,000	2,500,000	2,500,000
R/E	240,000	475,000	825,000
Total	3,750,000	3,990,000	4,350,000

Unaudited Income statement for year 3 (with comparative figures)

	year 1	year 2	year 3
Provincial Grant	800,000	800,000	800,000
Admissions and Donations	500,000	700,000	800,000
Sales	500,000	770,000	830,000
TOTAL REVENUE	1,800,000	2,270,000	2,430,000
COGS	(300,000)	(600,000)	(350,000)
Salaries, Admin, Depn	(300,000)	(300,000)	(300,000)
Animal Feed and Care	(700,000)	(875,000)	(1,100,000)
Interest	(100,000)	(100,000)	(100,000)
INCOME BEFORE TAX	400,000	395,000	580,000
Tax	(160,000)	(160,000)	(230,000)
INCOME AFTER TAX	240,000	235,000	350,000
Opening R/E	0	240,000	475,000
Closing R/E	240,000	475,000	825,000

Handbook Recommendations:

Section 3030 of the handbook ("Inventories") states that inventory should be valued at cost. Section 3400 of the handbook ("Revenue") states that Revenue from sales should be recognized when: -the seller of the good has transferred to the buyer the significant risks and rewards of ownerships, in that all significant acts have been completed and the seller retains no continuing managerial involvement in, or effective control of, the good transferred to a degree usually associated with ownership; and -reasonable assurance exists regarding the measurement of the consideration that will be derived from the sale of goods, and the extent to which goods may be returned and ultimate collection is reasonably assured.

Industry Practice for valuing wildlife:

There are very few financial statements publicly available for zoos or wildlife parks as they are usually owned and operated by the government. You were able to obtain the financial statements of one local municipally-operated zoo which valued its animals at $1 and contained a scope limitation.

You were unable to find any textbooks or pronouncements recommending a valuation practice.

Last year market values:

The gamekeeper estimates that the market value last year was about $1.6 million

Lifespan of the animals:

The lifespan of the animals range from 3 years to 30 years, depending on the species. For computational simplicity for this task, you may assume that all species have an average lifespan of 10 years and that the first year of the animals' lives has just elapsed.

Location where animals are fed (to facilitate a count):

About one-third of the animals are indigenous to the province and do not need any supplemental food in the summer months when this audit is taking place. The remaining animals are fed at staggered times throughout the day at feeding stations located within the enclosures. The animals do tend to congregate around the stations at feeding time, so this is the time when a count will be the most accurate.

Materiality:

Materiality for the audit has been set at $30,000.

Nature of the grant guarantees:

The government grants are guaranteed at the same level for 5 years (therefore, there are two years left). It is not absolutely certain that they will be renewed: the fact that the park is considered educational as well as generating tourism revenue is a point in the park's favour. However, the government is very concerned about deficit spending and may cut down or eliminate grants if the park is consistently unprofitable. The park's management believes there is a 70% chance that the grants will be renewed at current levels.

Owner opinion about using historical cost as valuation basis:

The owner is not happy about using historical cost as a valuation basis as there would be little or no value assigned to the animals that have been born since the park began. The owner has placed a lot of emphasis on the breeding program and the breeding track record and feels it is misleading to not value those animals. The owner wishes to value the animals at their fair market value.

Quality of animals at year end:

At the time of the count, the gamekeeper said there were no sickly or injured animals. You have not noted any animals that appeared sick or injured while touring the park.

Reliability of the gamekeeper:

The gamekeeper appears to be very competent and experienced and has no obvious incentive to misstate either the quantities or the values of the animals. He is an employee of the park and has been there since the park began operation.

Results of confirming market values:

You have sent a list of the animals to all the parties the park has dealt with in the past for buying and selling animals. You have asked them to give estimates of the values of each type of animal. Using these estimates and the client's estimates of the quantities of each animal, you arrive at a value of $1.8 million for the animals. However, in arriving at this number you assigned a value of zero to approximately 10% of the animals as you did not receive any estimates of their market values from any of the confirmations. The purchase price is known for some of these "zero-value" animals (ie. those that were acquired from outside sources rather than being born in the park, and who are still alive). The purchase price of those animals is $100,000.

Results of previous audit:

The previous audits, covering the first two years of the park's operation, resulted in clean opinions except for a scope limitation over inventory because of the difficulties involved in auditing quantities. The previous auditors used historical cost to value the inventory (capitalizing only the purchase price).

The company performing those audits is a small operation, but is in good standing with the Institute of Chartered Accountants and has a good reputation locally. You communicated with these auditors who indicated that there were no problems with the audit. However, they are unable to provide you with any working papers because the files were destroyed in an office fire.

Results of you performing the count:

By accompanying the gamekeeper through the park you were able to verify the following counts:

Species	Client Estimate	Your count	Difference
sheep	7	5	(2)
buffalo	20	11	9
timber wolf	4	5	1
.....			
total	1100	800	(300)

The client will not change their estimates to your count, since you did not see some of the species and it is quite likely that you would have missed some of the animals.

Review of veterinary bills around year end:

There were no unusual veterinary bills around year end to indicate the presence of sickly or injured animals.

Risks of the business:

This is the only wildlife park in the province and has enjoyed a steady, but seasonal, business so far. Because visitors stay in their cars, business is mostly unaffected by hot and cold temperatures, although rainy weather is bad for business. Income from the sale of surplus animals has been steady and the outlook remains favourable.

Schedule of number of animals:

An accurate physical count of the animals would take several days to complete since they roam over a large area. The birds in particular would be very problematic. However, most animals stay in herds so the gamekeeper has a good idea of the numbers.

The client does have a list broken down by species, but only the totals are reported here. He estimates the following:

	year 1	year 2	year 3	total
total opening	0	600	750	0
# bought	750	350	300	1400
# sold	(200)	(300)	(350)	(850)
plug (births, deaths)	50	100	400	550
ending	600	750	1100	1100

There are no adding mistakes in the schedule.

Types of animals in the park:

There are approximately 115 different species of wildlife in the park. They include various type of sheep, zebras, giraffes, water buffalos, deer, lions, bears, wolves, and birds.

Valuation policy on past audits:

The previous auditors used historical cost to value the inventory (capitalizing only the purchase price) and issued a scope limitation because of the difficulties in auditing the quantities of animals.

Value of difference between your count and client estimates:

The total dollar value of the difference between your count and the client's count is: (assume there are no errors in computation)

Species	difference	total market value	historic cost
sheep	(2)	150	80
buffalo	9	10,000	4,000
timber wolf	1	300	180
.....			
total	(300)	(400,000)	(250,000)

The historic cost is based on the average historic cost per animal times the number of animals, since it is not known which specific animals were missed from the count. Average cost is arrived at by dividing the purchase price of all animals of a species (ie. those animals purchased from outside and still on hand) by the total number of the species (including those born in the park).

Vouch costs:

According to the client's records, the following costs have been incurred since inception:

	year 1 (audited)	year 2 (audited)	year 3	total
purchases	1,000,000	500,000	500,000	2,000,000
feed	450,000	675,000	900,000	2,025,000
care	100,000	200,000	200,000	500,000
total	1,550,000	1,375,000	1,600,000	4,525,000

For the current year (year 3) you have traced a sample of costs back to the supporting invoices. No errors or irregularities were noted. Controls over purchases/payables/payments are adequate.

Vouch sales:

According to the client's records, the cost of the animals sold was as follows:

	year 1 (audited)	year 2 (audited)	year 3	total
sales proceeds	(500,000)	(770,000)	(830,000)	(2,100,000)
original purchase price of animals sold	300,000	600,000	350,000	1,250,000
gain on sale	200,000	170,000	480,000	850,000

For the current year (yr 3) you have traced a sample of sales back to the supporting sales invoices. No errors or irregularities noted. Controls over sales/receivables/receipts are adequate.

Whether outside sources to verify market prices are available:

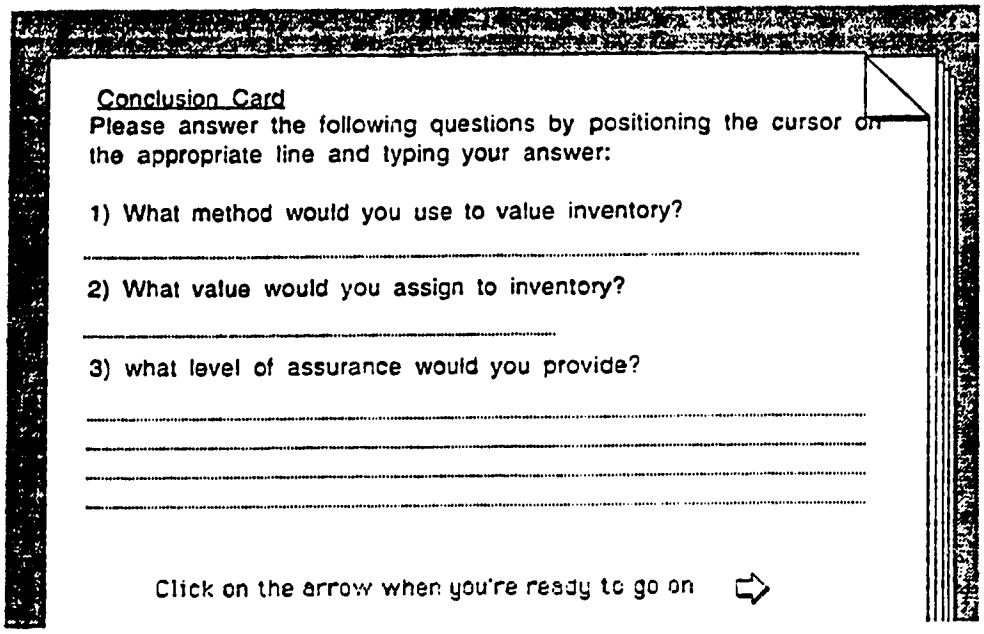
There is only a limited market available for many of these animals. The industry is a small one, and most of the curators and gamekeepers know one another. As a result, purchases, sales and trades are usually conducted by tapping into the personal networks of these people ie. the gamekeeper will tell his peers which animals they wish to buy or sell.

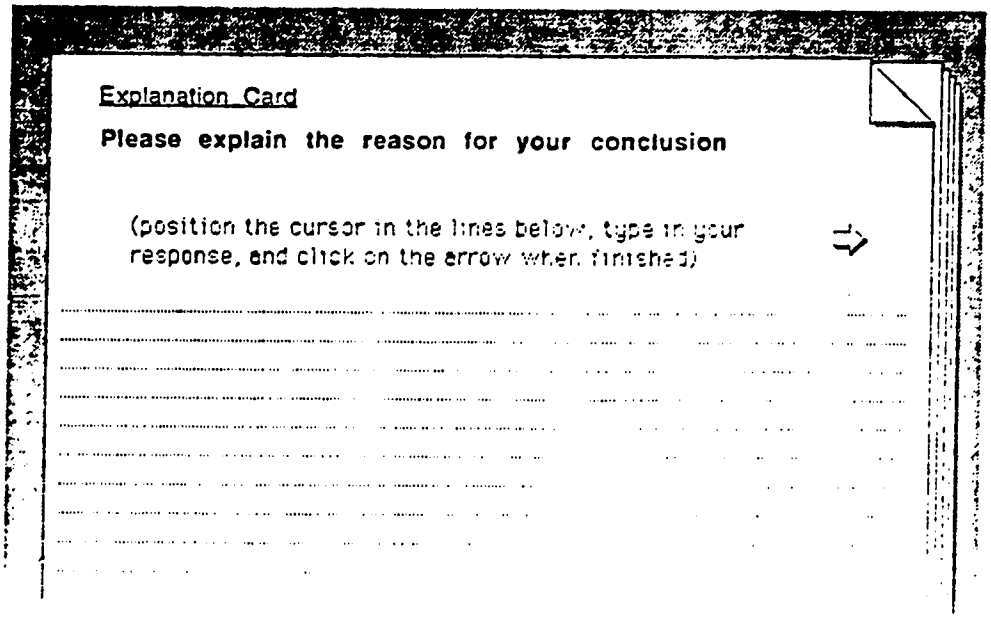
The gamekeeper suggests that you could send out confirmations of market value to all the zoos and game farms that the park has ever sold animals to or bought animals from as this information is kept in a file of mailing addresses.

Who owns the park:

The park is owned by a small group of entrepreneurs who have both debt and equity interests in the park. Financial Statements are also provided to the government as a condition of the grants.

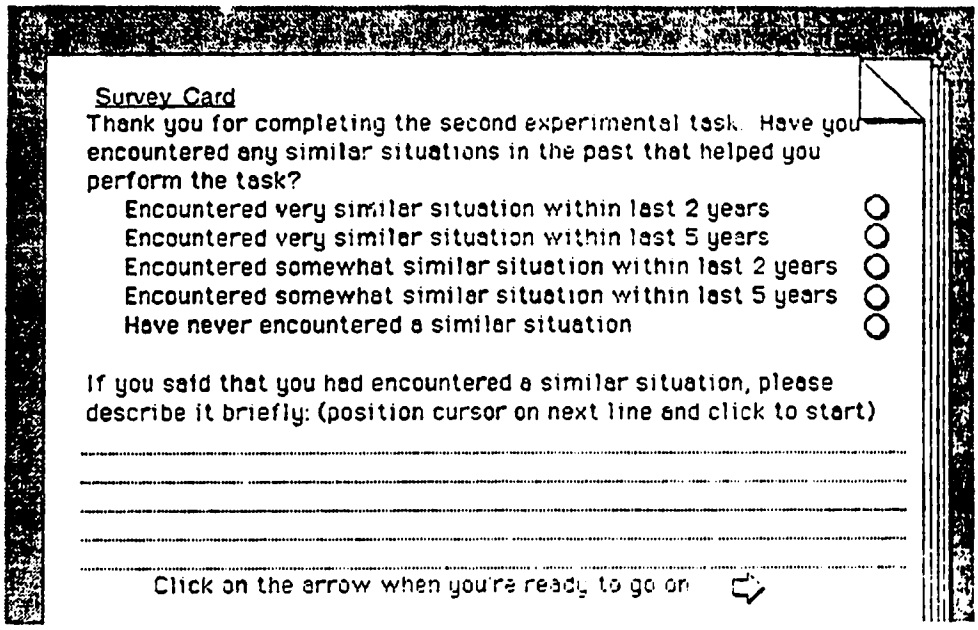
B. Screens Presented to Participants at End of Park Task





This is a reproduction of computer screens which form part of a computer software program copyrighted to the author of this thesis.

B. Screens Presented to Participants at End of Park Task (continued)



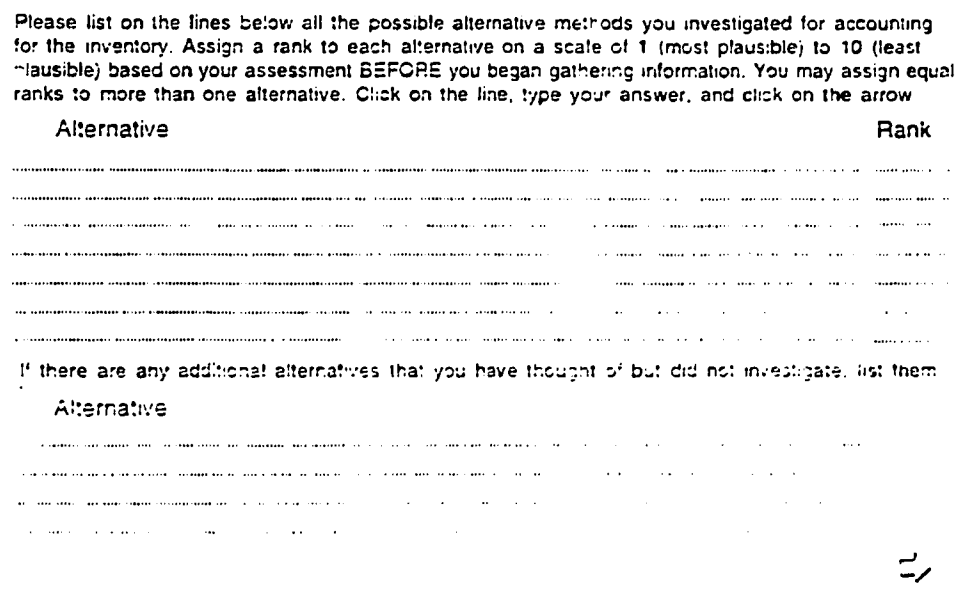
Survey Card

Thank you for completing the second experimental task. Have you encountered any similar situations in the past that helped you perform the task?

- Encountered very similar situation within last 2 years ○
- Encountered very similar situation within last 5 years ○
- Encountered somewhat similar situation within last 2 years ○
- Encountered somewhat similar situation within last 5 years ○
- Have never encountered a similar situation ○

If you said that you had encountered a similar situation, please describe it briefly: (position cursor on next line and click to start)

Click on the arrow when you're ready to go on



Please list on the lines below all the possible alternative methods you investigated for accounting for the inventory. Assign a rank to each alternative on a scale of 1 (most plausible) to 10 (least plausible) based on your assessment BEFORE you began gathering information. You may assign equal ranks to more than one alternative. Click on the line, type your answer, and click on the arrow

Alternative	Rank

If there are any additional alternatives that you have thought of but did not investigate, list them

Alternative

This is a reproduction of computer screens which form part of a computer software program copyrighted to the author of this thesis.

B. Screens Presented to Participants at End of Park Task (continued)

Please answer the following questions by positioning the cursor in the blank, clicking, and typing your answer (a number) . Click on the arrow when done.

Answers

How realistic was this task? (1=not realistic, 5=very realistic) .....

How complete was the information provided? (1=not complete, 5=very complete) .....

How difficult was the task? (1=very easy, 5=very difficult) .....

How confident were you about your conclusion? (1=not confident, 5=very confident) .....

If you had to assign this task to one person only, how many years of experience would that person have? .....

For the following two questions please use the following scale:
1- seen many situations recently
2- seen many situations, but not recently
3-seen a few situations recently
4-seen a few situations, but not recently
5-never seen such a situation

How often have you been involved with companies holding livestock inventory? .....

How often have you been involved with companies valuing assets on a basis other 

This is a reproduction of computer screens which form part of a computer software program copyrighted to the author of this thesis.

III. DIGGER TASK

A. Information Cards

Introduction:

A 50% owned subsidiary of your client, Digger Ltd., entered into a contractual agreement with Boom Ltd. Digger Ltd. is a mining company, and Boom Ltd. manufactures explosives. The contract provided that Boom Ltd. would be the exclusive supplier of explosives to Digger Ltd. for a six year period. The contract allowed Boom Ltd. to raise the price charged to Digger Ltd. for the explosives annually as Boom's cost of the main ingredient (called powder) increased. The contract came into effect on Nov 1, 1985, and allowed annual increases starting Jan 1, 1986. The contract allows for audits of these price increases at the option of either party.

You are now in the sixth year of the contract. Digger Ltd. has asked you to audit these price increases as they feel the size of the increases that have occurred since the inception of the contract are excessive. Specifically, the price charged by Boom to Digger for the explosives has increased about 60%. This seems odd given that the price of the main ingredient, powder, has only risen by about 20% over the contract period.

The explosives are made up of 94% powder with the other 6% being an odd assortment of ingredients including gasoline and egg whites. Since the remaining ingredients represent a trivial portion of the cost, the contract was written so that increases in the price of explosives are based just on increases in the price of powder. Any changes in the prices of the other ingredients are ignored in the price increase formula. The original selling price of the explosives therefore includes the cost of the powder, the other ingredients, overhead, plus a reasonable profit for Boom Limited. The original selling price is revised upward as prices of current powder escalate.

As specified in the contract, price increases passed on to Digger Ltd. are calculated as follows:

Original selling price of explosives, set in the contract
*Boom's current price for powder at the date of the increase
/Boom's base price for powder at Nov 1, 1985 (date of contract)
= Current price of explosives

"Base Price" and "Current Price" of powder are defined as the invoice cost for Boom to purchase the powder plus the freight charged to transport the powder to Digger's mine site. The original selling price set in the contract is a schedule of prices which vary depending on the volume of explosives purchased by Digger Ltd. in each contract year. Each year, all prices in the schedule are adjusted by the price increase factor to arrive at the current prices at each volume level.

The client has prepared the following schedule for you based on the price escalation notices they received:

Contract Year	1986	1987	1988	1989	1990
Volume Bought	32,000	35,000	40,000	28,000	31,500
Original Selling Price	42.00	41.50	39.00	44.00	42.50
Current Price of Powder	25.60	26.10	28.00	30.50	31.50
Base Price of Powder	20.00	20.00	20.00	20.00	20.00
Current/Base	1.28	1.31	1.40	1.53	1.58
Current Explosive Price	53.76	54.16	54.60	67.10	66.94

For the two month period from Nov 1, 1983 to Jan 1, 1984 the current explosive price was the original selling price. Therefore, since Nov 1, 1985, the price has increased from 42.00 to 66.94, or 60%.

Boom owns the other 50% of the mine purchasing explosives and enjoys a cordial relationship with Digger. Originally, this explosives contract was held by an arm's length company, Gunpowder Ltd. Although Digger was happy with Gunpowder they felt that the contract should be offered to Boom to "keep it in the family". To encourage this, Boom was shown Gunpowder's bid and undercut it so that Boom's original selling prices given in the contract were slightly lower than the prices offered by Gunpowder.

As stated earlier, the price increases charged to Digger by Boom are based on Boom's cost of the main ingredient, powder. Boom buys this ingredient from Gunpowder Ltd.

You have been appointed by Digger to determine if they have been overcharged over the first five years of the contract . You have access to all Digger's records and Boom has also agreed to allow access to their records. You can perform procedures, ask for schedules or ask the staff of either company questions. When asking questions about prices, be sure to specify whether you mean the current price, the base price or the original selling price. Also, make sure you specify whether you mean the price of powder (the ingredient) or the price of explosives (the product).

Agree base price of powder to invoice:

Price of powder at Nov 1/85 (agreed to invoice)	21.00
Freight costs (agreed to invoice)	4.80
less freight equalization (agreed to invoice)	(5.80)
Total	20.00
Base price per Boom Ltd.	20.00
Difference	0

Agree current prices of powder to invoice:

Current Price per Boom	Price per invoice	freight cost	freight equalization	Difference
25.60	22.60	4.30	(1.30)	0
26.10	23.10	4.30	(1.30)	0
28.00	25.00	4.30	(1.30)	0
30.50	25.00	6.80	(1.30)	0
31.50	26.00	6.80	(1.30)	0

This worksheet showed the buildup of the current prices used by Boom to calculate the price increases. All the current prices were agreed to invoices nearest to the date of the increase.

Freight costs are actually paid to CN Railways by Gunpowder. The Equalization is set by agreement between Gunpowder and Boom. Both the freight and equalization are reported as separate line items on the invoices from Gunpowder.

Boom's attitude towards this audit:

Boom Ltd. has been very cooperative and receptive to being audited. The relationship between Boom Ltd. and Digger Ltd. has been amicable in the past.

Boom's income statements:

Boom Ltd. is a huge, diversified, multinational company. Its financial statements indicate that the company has always been profitable and at similar levels with other companies in the same industries. However, since the explosives division represents such a small part of the entire organization reviewing Boom's financial statements provides little information about the explosives division and its operations. Boom refuses to provide their internal statements for the explosives division as they feel it is outside the scope of their audit and Digger's account only represents a small portion of that division's business. You have consulted with Digger's legal counsel and they feel that Boom's position in this regard is defensible.

Boom's internal controls:

A complete review of Boom's internal controls is beyond the scope of your audit. However, the controls over their purchases/payables/payments systems appear to be adequate and you have not encountered any evidence of compliance deviations in the course of your testing.

Check prices around base date:

Checked prices on invoice around the base date to determine if the invoice price used for the base price escalation was unusual. No unusual price changes were noted although prices jumped significantly approximately two months after the base date, at the beginning of the next calendar year.

Check prices around increase dates:

Checked prices on invoice around the date of the price escalation to determine if the invoice price used for the price escalation was unusually high. No unusual price changes were noted.

Client record of audit fee payment:

Digger Ltd. is one of your best and most valued clients. They have generally provided 90-100% recovery and have paid their fees promptly. Although you primarily provide them with audit and tax services, you have occasionally provided miscellaneous consulting and management advisory services. You have not agreed upon a fee in advance for this audit, however, in all likelihood Digger Ltd will pay the entire fee without any misgivings.

Composition of Explosives:

Boom Ltd. keeps a stock pile of powder at Digger's minesite. At this point, the powder still belongs to Boom Ltd. When Digger Ltd. requires explosives, the necessary amount of powder is measured and mixed with additional ingredients to make the required amount of explosives. At this point Digger Ltd. is charged for the volume of explosives provided.

The powder comprises 95% of the explosives by volume. The cost of the additional 5% of the ingredients is negligible. For this reason, the price escalation of the explosives is based solely on the escalations in the price of powder.

Confirm current prices of powder with Gunpowder:

Current Price per Boom	Price per Gunpowder	freight cost	freight equalization	Difference
25.60	22.60	4.30	(1.30)	0
26.10	23.10	4.30	(1.30)	0
28.00	25.00	4.30	(1.30)	0
30.50	25.00	6.80	(1.30)	0
31.50	26.00	6.80	(1.30)	0

This worksheet showed the buildup of the current prices used by Boom to calculate the price increases. All the current prices were agreed to confirmations provided by Gunpowder. Freight costs are actually paid to CN Railways by Gunpowder . The Equalization is set by agreement between Gunpowder and Boom. Both the freight and equalization are reported as separate line items on the invoices from Gunpowder.

Date of inventory count and details of count:

Boom Ltd. keeps a stock pile of powder at Digger's minesite. At this point, the powder still belongs to Boom Ltd. When Digger Ltd. requires explosives, the necessary amount of powder is measured and mixed with additional ingredients to make the required amount of explosives. At this point Digger Ltd. is charged for the volume of explosives provided.

Boom Ltd. performs an inventory count monthly to ensure that the amount of powder on hand corresponds with their perpetual records. No discrepancies have ever been noted. Additionally, both Boom and Digger periodically verify the accuracy of the measurement equipment. No problems have ever been noted.

Details of previous audits:

There has been no audit of the contract provisions in the past.

Details of prior contract:

This is the first explosives contract with Boom Ltd. The previous contract for explosives was held by Gunpowder Ltd. Digger Ltd. had no problems with them and were satisfied with the execution of the contract.

Digger financial statements:

Digger Ltd. Consolidated Financial Statements Income statement for the year ended December 31, 1990: (000,s)

	1988	1989	1990
Sales	60,000	75,000	61,000
Interest and Other Income	5,000	4,000	9,000
Depn and Depletion	(44,000)	(53,000)	(42,000)
Salaries	(4,000)	(4,500)	(4,500)
Other Expenses (includes explosives)	(8,000)	(8,500)	(8,000)
Income before taxes	9,000	13,000	15,500
Taxes	(4,500)	6,500	7,750
Net Income	(4,500)	6,500	7,750
Opening R/E	57,000	61,500	68,000
Closing R/E	61,500	68,000	75,750

Consolidated Balance Sheet as at December 31, 1990 :

	1988	1989	1990
Cash, Temp. Invest and A/R	12,000	14,000	18,000
Inventory	3,000	5,000	3,500
Land and Equip. (net)	200,000	230,000	220,000
TOTAL ASSETS	215,000	249,000	241,500
A/P	2,000	2,500	2,500
Bank Loan	141,500	168,500	153,250
Share Capital	10,000	10,000	10,000
Retained Earnings	61,500	68,000	75,750
TOTAL LIAB and EQUITY	215,000	249,000	241,500

Digger materiality:

Over the last five years Digger's average materiality level for the external audit was $500,000.

Gunpowder income statements:

Gunpowder Ltd. is a huge, diversified, multinational company. Its financial statements indicate that the company has always been profitable and at similar levels with other companies in the same industries. However, since the explosives division represents such a small part of the entire organization reviewing Gunpowder's financial statements provides little information about the explosives division and its operations.

Other suppliers of explosives:

According to the management of Digger Ltd, Boom and Gunpowder are the only suppliers of explosives.

Ownership of Boom:

Boom Ltd. is a huge, diversified, multinational company. Its shares are widely held and publicly traded on major exchanges.

Ownership of Gunpowder:

Gunpowder Ltd. is a huge, diversified, multinational company. Its shares are widely held and publicly traded on major exchanges.

Prices charged to other customers:

The explosives are not sold on the open market. Boom Ltd. does have contracts with several other customers. However, Boom Ltd. refuses to divulge the prices they charge on these contracts. The terms of the contract with Digger Ltd. and the audit clause do not entitle Digger Ltd. to this information.

Quality of powder purchased:

The powder sold on the open market and the powder purchased by Boom all come from the same source-Gunpowder Ltd is the only company that produces the product. The quality of the powder purchased by Boom is identical to the quality of the product sold elsewhere.

Reason why Boom holds contract:

Although Digger Ltd. was happy with the contract held previously by Gunpowder Ltd, there had been pressure to sign a contract with Boom Ltd. since Boom owned the other 50% of the subsidiary mine. To ensure that Boom Ltd. would indeed get the contract, they undercut the bids from the previous supplier, Gunpowder Ltd. Gunpowder Ltd. was very disgruntled when they lost the contract.

Relationship between Boom and Gunpowder:

The relationship between Boom and Gunpowder is at arms' length. The majority of the business conducted between them consists of Boom purchasing powder from Gunpowder, since Gunpowder is the only supplier of the powder in Canada.

Schedule of freight costs by volume:

Freight costs included in the current price of powder are paid by Gunpowder Limited to CN Railway and are shown as a separate charge on the invoices they send to Boom. Freight equalization is set each year by agreement between Boom and Gunpowder. Freight and Freight Equalization charges do not vary with volume, but have increased over the term of the contract. They have been as follows:

Year	Freight	Freight Equalization
1985 (base)	4.80	(5.80)
1986	4.80	(1.30)
1987	4.80	(1.30)
1988	4.80	(1.30)
1989	6.80	(1.30)
1990	6.80	(1.30)

Terms of contract:

Relevant excerpts of the contract are as follows: "...This contract is between Digger Ltd. (the "purchaser") and Boom Ltd. (the "vendor")....The contract covers the period from Nov. 1, 1985 to December 31, 1991.....During the contract period Digger Ltd. shall buy any and all its explosives solely from Boom Ltd....The price to be charged shall be computed in accordance with Appendix E (This is the calculation shown in the introduction)....The prices for the explosives are to be revised annually on January 1 in accordance with Appendix E....The prices charged may be subjected to an audit by a mutually agreed upon auditor at the request of either party to the contract.

On the next screen you will see the schedule of original selling prices by volume which were contained in Appendix D of the contract. This is the schedule of original selling prices by volume contained in Appendix D of the contract. As explained in Schedule E, the price escalation factor based on the increase in the current price of powder is applied to these original selling prices.

Volume Range per year	Original Selling Price
less than 28,000	45.00
28,000-29,999	44.00
30,000-31,999	42.50
32,000-33,999	42.00
34,000-35,999	41.50
36,000-37,999	40.00
over 38,000	39.00

Test if increase calculated correctly:

Increase date	Original Selling Price	Base Powder Price	Current Powder Price	Current Selling Price	Calculated as per contract	Computed correctly
1/1/86	42.00	20.00	25.60	53.76	yes	yes
1/1/87	41.50	20.00	26.10	54.16	yes	yes
1/1/88	39.00	20.00	28.00	54.60	yes	yes
1/1/89	44.00	20.00	30.50	67.10	yes	yes
1/1/90	42.50	20.00	31.50	66.94	yes	yes

The data for this worksheet was gathered from the price increase notices provided from Boom to Digger. No significant errors were found.

Test if original selling price correct:

Contract year	Volume bought per Boom	Volume bought per Digger	Correct Original Selling Price	Original Selling Price per notice	Difference
1986	32,000	32,000	42.00	42.00	0
1987	35,000	35,000	41.50	41.50	0
1988	40,000	40,000	39.00	39.00	0
1989	28,000	28,000	44.00	44.00	0
1990	31,500	31,500	42.50	42.50	0

For this worksheet, total volumes purchased in the year were reconciled between Boom and Digger's records. For that annual volume, the original selling price used by Boom in the price notice (to which the escalations were applied) were compared to the original selling prices set out in the contract. No errors found.

Vouch freight:

Current Price per Boom	net Freight price per Boom	Freight cost per invoice	freight equalization per letter	Difference
21.00 (base price)	(1.00)	4.80	(5.80)	0
25.60	3.00	4.30	(1.30)	0
26.10	3.00	4.30	(1.30)	0
28.00	3.00	4.30	(1.30)	0
30.50	5.50	6.80	(1.30)	0
31.50	5.50	6.80	(1.30)	0

Freight costs are actually paid to CN Railways by Gunpowder so the invoices were obtained from Gunpowder. No differences were found. The Equalization is set by agreement between Gunpowder and Boom and was agreed to correspondence between them. What base price was: The base price of powder at the inception of the contract was $20.00. The contract did not specify an actual price, but just said that the base price of powder would be whatever price was in effect in November, 1985.

What freight equalization is:

Freight equalization is a refund given by Boom's suppliers to ship the powder directly to Digger's minesites. Boom then performs the final processing of powder into explosives on the site. The freight equalization is an averaging provision to spread the cost of transportation to different mines served by Boom. In effect, remote sites like Diggers' are subsidized by overcharging other mine sites. That is why the freight equalization for Digger reduced the costs of freight.

Where Digger information comes from:

Certain herbicides are made up almost entirely of exactly the same powder which is used to make the explosives. Digger's observation that the price of powder has only risen about 20 % since the beginning of the contract actually resulted from observing the price movement of these herbicides.

Who owns Digger:

Digger Ltd. is a privately owned company. Financial statements are produced for the owners and for the bank.

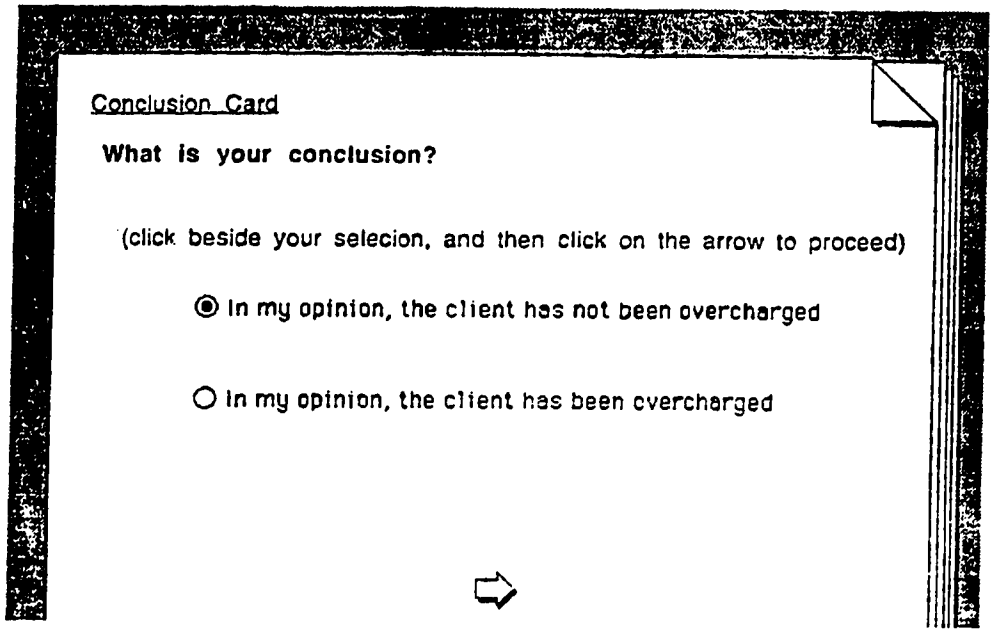
Who supplies Boom:

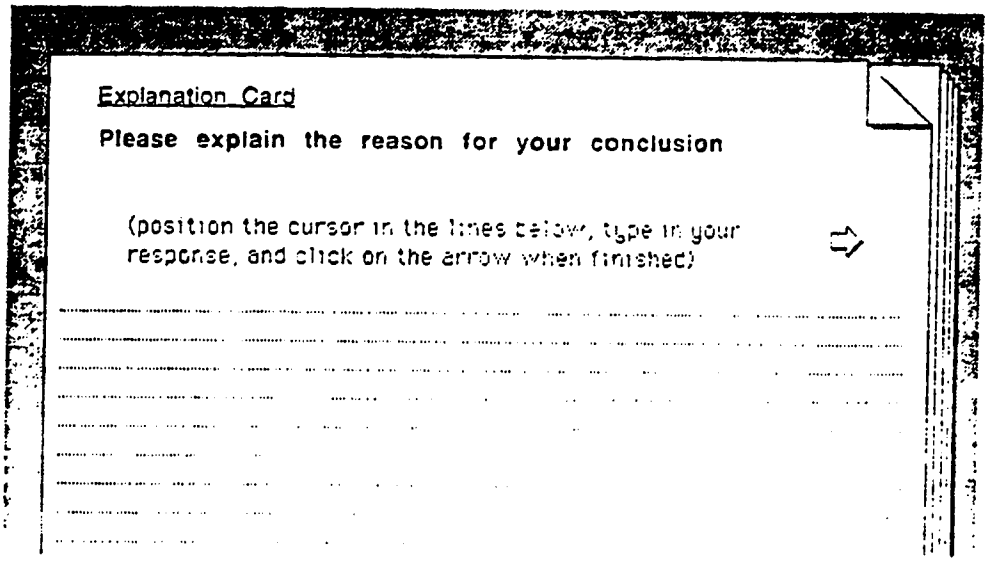
Gunpowder Ltd. is the only manufacturer of powder, so Boom Ltd. buys from them.

Why base freight equalization was high:

The base freight equalization was high due to an agreement between Boom Ltd. and its supplier, Gunpowder Ltd. There was a dispute over freight charges arising in 1984, the year prior to the contract between Boom Ltd and Digger Ltd. As a result of the dispute Gunpowder Ltd agreed that Boom Ltd had been overcharged by about 80,000. The parties agreed that the amount would be reimbursed to Boom Ltd in the form of increased freight equalization for purchases made in 1985, which included the first two months of the contract before the first price escalation on Jan 1, 1986. Because Boom Ltd only purchased a small amount of powder in 1985 (the contract started in November) that $80,000 equalization was prorated over a small volume of powder, resulting in a low price at the time the base price was calculated.

B. Screens Presented to Participants at End of Digger Task





This is a reproduction of computer screens which form part of a computer software program copyrighted to the author of this thesis.

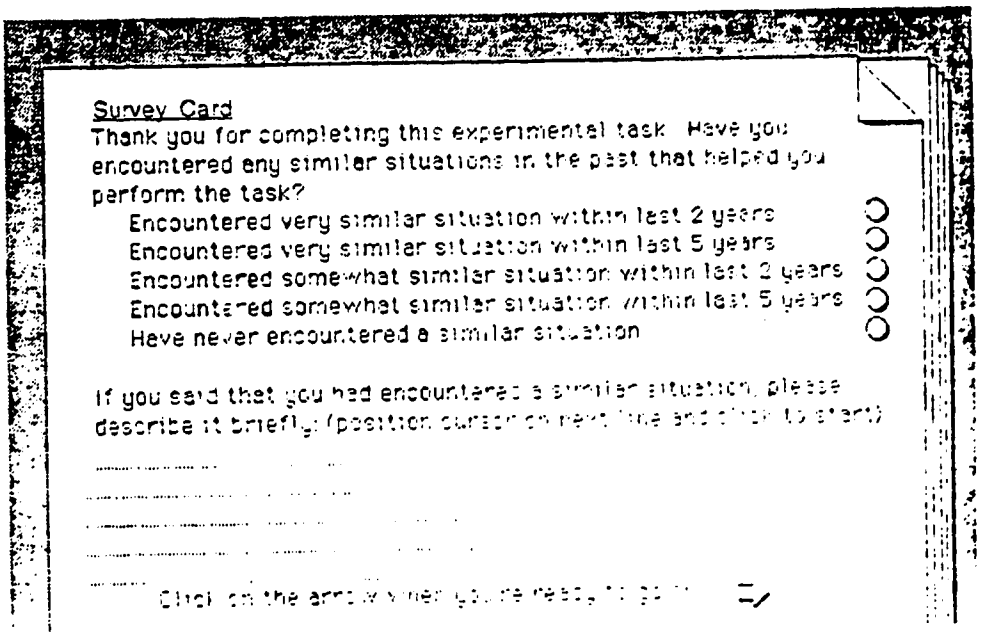
B. Screens Presented to Participants at End of Digger Task (continued)

Please list on the lines below all the possible causes you investigated for the price increases. Assign a rank to each cause on a scale of 1 (most plausible) to 10 (least plausible) based on your assessment BEFORE you began gathering information. You may assign equal ranks to more than one cause. Click on the line, type your answer, and click on the arrow when done.

Cause	Rank

If there are any additional causes that you have thought of but did not investigate, list them

Cause



This is a reproduction of computer screens which form part of a computer software program copyrighted to the author of this thesis.

B. Screens Presented to Participants at End of Digger Task (continued)

Please answer the following questions by positioning the cursor in the blank, clicking, and typing your answer (a number) . Click on the arrow when done.

Answers

How realistic was this task? (1=not realistic, 5=very realistic) .....

How complete was the information provided? (1=not complete, 5=very complete) .....

How difficult was the task? (1=very easy, 5=very difficult) .....

How confident were you about your conclusion? (1=not confident, 5=very confident) .....

If you had to assign this task to one person only, how many years of experience would that person have? .....

For the following two questions please use the following scale:
1- seen many situations recently
2- seen many situations, but not recently
3-seen a few situations recently
4-seen a few situations, but not recently
5-never seen such a situation

How often have you been involved with companies using "cost plus" contracts? .....

How often have you been involved with special audits or engagements? .....

This is a reproduction of computer screens which form part of a computer software program copyrighted to the author of this thesis.