THE EFFECTS OF GOAL FRAMING ON AUDITORS' USE OF A DECISION AID IN ENVIRONMENTS OF VARIED RISK

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(ABSTRACT)

An auditor performing analytical review must typically diagnose material variances of observed client data from his/her own expectations. The auditor may utilize a decision aid to help in generating potential explanations for a variance; it has, however, the capacity to provide many more explanations than are possible using other means. Under the circumstances of budgetary constraints and limited cognitive load for beginning an information search with these explanations, the auditor may consider the lengthy list and arrive at a more manageable sub-list of the most probable explanations. In doing so, the auditor either *eliminates those explanations that are less likely* or *includes those that are more likely* into a reduced list for further consideration. While the goal under either approach is the same—to reduce the list—studies in psychology have shown that those *including* will reduce the list to a much greater extent than those *eliminating*. If the auditor begins an information search with this reduced list of explanations, then whether the auditor uses *inclusion* or *elimination* may have effectiveness and efficiency implications for the remainder of the analytical review process.

The auditor must also contend with *risk* in the audit environment, which also may influence the manner in which the auditor reduces the lengthy list of explanations. A risky audit environment is generally related to heightened auditor skepticism and increased audit effort, as predicted by the audit risk model (SAS 47, AICPA 1983). Each of these translates into the desire to pursue a greater number of plausible explanations in a high risk environment than in a low risk environment. Therefore, an auditor would be

expected to reduce a decision-aid-provided list of explanations to a lesser degree in a high risk environment than a low risk environment.

The purpose of this dissertation was to investigate the occurrence of a goal framing effect at varied levels of client risk. Using a two-way between subjects design, auditors in this study either *eliminated* or *included* explanations from a decision-aid-provided list in a *low risk* or *high risk* analytical review setting. As suggested by the goal framing theory, auditors who *eliminated* concluded with significantly more explanations than those who *included*. Furthermore, as suggested by the audit risk model, auditors in a *high risk* environment concluded with significantly more explanations than auditors in a *low risk* environment.

Because previous auditing literature provides that auditor conservatism, which is heightened in periods of high risk, often mitigates biases and heuristics found in the general decision making or psychology literature, it was also predicted that in the high risk scenario, the influence of high risk in enlarging the set of explanations would overcome the influence of the inclusion goal framing in reducing the set of explanations. No support was found for this interaction.

The results of this study have implications for the implementation of decision aids in practice. This study advises that in various client risk settings, auditors evaluating a lengthy decision-aid-provided list of explanations by inclusion may arrive at a significantly smaller number of explanations than by elimination. Given that the subsequent step of analytical review—information search—is planned according to what the auditor believes are the plausible hypotheses, goal framing may have an impact on the overall efficiency and effectiveness of analytical review, in both high and low risk client scenarios.

DEDICATION

This dissertation is dedicated to my family. First, to my parents, Reverend and Mrs. H. M. Mueller, and my sister, Julie Renee Mueller, who have been constant sources of love and encouragement throughout my doctoral program. Second, to my dearest friend, Leann Hill, who never failed to build my confidence when I doubted myself. Finally, to my grandmothers, Mrs. Martha Edwards and Mrs. Opal Mueller, who I know would be so proud if they were here. I love each of you very much and thank you all from the bottom of my heart.

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CHAPTER 1
INTRODUCTION

Consider the common judgment scenario wherein one is given a large number of alternatives and must decide which of the alternatives is most likely correct. When the correct answer is not known, one will generally begin by reducing the longer list of alternatives to a shorter, more meaningful list of potentially correct answers. Ponder, for example, the judgment process that an eyewitness goes through in attempting to identify a criminal from the scene of a crime (Yaniv and Schul 1997).[1]

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[1] It is important to distinguish between *judgment* and *choice*. While they are sometimes treated synonymously, they are in fact two distinct operations. Judgment involves assigning a value or weight to each alternative leading up to a choice, whereas in a choice, a single alternative must be selected (Westenberg and Koele 1992). Einhorn and Hogarth (1981) note, however, that in some contexts, judgment and choice cannot be separated (e.g. diagnostic judgment and choice of treatment). Given the diagnostic nature of analytical review, the process of reducing a list of explanations given by a decision aid will be termed a decision, which encompasses the closely related judgment and choice processes.

The eyewitness is asked to filter through a large stack of photos and create a reduced set of likely suspects. The eyewitness may cognitively approach this task by either including likely photos or eliminating less likely photos from the larger set. A pertinent question is whether the same potential criminals will be submitted as suspects under either approach.

Note from the eyewitness example that the decision-maker's goal has been framed in two alternative ways—*include* or *eliminate*. The processes of elimination and inclusion are logically equivalent, i.e. those suspects eliminated under elimination should be exactly those suspects not included under inclusion. Regardless of whether one uses elimination or inclusion, s/he should arrive at the same reduced set of potential correct answers. However, a simple adjustment to the way in which the task is framed has been shown to have profound effects on the judgment process, and consequently, on the makeup of the reduced list (cf. Lichtenstein and Slovic 1973, Huber et al. 1987, Jaradat and Tollefson 1988, Medin et al. 1990, Westenberg and Koele 1992, Yaniv and Schul 1997, Levin et al. 1998, Prosansky and Levin 1999). Specifically, studies have shown that the inclusion (elimination) process leads to a reduced set that contains a smaller (greater) number of alternatives (cf. Huber et al. 1987, Yaniv and Schul 1997, Levin et al. 1998, Prosansky and Levin 1999).

Within auditing, the effects of goal framing have implications for certain judgments wherein an auditor must evaluate a lengthy list of alternatives. One such instance is the use of a decision aid in analytical review. A decision aid provides an auditor with a substantial number (e.g. 20) of potential causes for an unusual fluctuation in a ratio. In preparing for an efficient information search, an auditor may reduce the large number of potential explanations to a more manageable number of most likely alternatives. In reducing the list, an auditor may cognitively proceed by either eliminating those deemed least likely or including those deemed most likely, to

achieve a reduced set of explanations. Dissimilar reduced sets, caused by the two different approaches, will likely lead to different initial searches for information and perhaps different outcomes of the analytical procedure—one of which is likely to be less effective.

This study investigates an auditor's consideration of a lengthy list of explanations provided by a decision aid in analytical review. It examines whether the theoretical framework developed in psychology to explain goal framing effects (Yaniv and Schul 1997) is descriptive of auditors' judgment processes when using a decision aid in analytical review. Specifically, does goal framing impact the *size* of the reduced set of explanations (i.e. the number of explanations)?

This study also considers the size of the reduced set in the context of varied client risk, of particular concern when performing analytical review in the planning stages of the audit.[2] A risky audit environment is generally related to heightened auditor skepticism and increased audit effort, as predicted by the audit risk model. A result of the heightened skepticism may be an inclination to consider more of the feasible explanations from the lengthy list provided by the decision aid. Furthermore, a natural increase in audit effort that follows from high client risk translates into the pursuit of more explanations than in a low risk environment. Because varied risk in the audit environment is expected to influence the size of the reduced set and may also moderate the effect of goal framing on the size of the reduced set, varying levels of risk are studied.

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[2] *Client Risk* as used in this study refers to the inherent and control risks of an auditee, i.e. the uncontrollable components of audit risk.

The remainder of the dissertation is organized as follows. Chapter two presents a review of the literature and the development of the research hypotheses. Chapter three describes the research methodology followed by a discussion of the results in chapter four and conclusions in chapter five.

CHAPTER 2
LITERATURE REVIEW AND HYPOTHESES

The research hypotheses are developed in this chapter by examining the literature regarding the process of analytical review, risk, and goal framing. The theoretical framework developed by Yaniv and Schul (1997) to explain the decision processes underlying goal framing is also reviewed.

2.1 The Process of Analytical Review

Analytical procedures, which consist of examining plausible relationships among and within financial and nonfinancial data, are an important tool used by an auditor. Their use is required by generally accepted auditing standards (GAAS) at the planning and final review stages of an audit, and they are increasingly used as substantive procedures. In a field study to investigate auditors' use of analytical procedures, all auditors interviewed claimed to use analytical procedures to collect evidence (Hirst and Koonce 1996). Further, Norman R. Walker, a partner with the former Price Waterhouse, stated that analytical review procedures are "squarely at the top of the hierarchy of possible procedures" (Walker 1993, p.78). He refers to studies assessing the effectiveness of analytical procedures, such as Hylas and Ashton (1982)

and Wright and Ashton (1989), which show that analytical procedures have consistently accounted for a large percentage of errors detected and are more effective than some types of tests of details (Hylas and Ashton 1982).

Analytical review is viewed as a diagnostic, sequential, and iterative process consisting of four components: mental representation, hypothesis generation, information search, and hypothesis evaluation (Koonce 1993). Mental representation is the incorporation of all that is known about the problem, including the act of integrating information and comparing it to some preconceived expectation to determine whether a significant variation from this expectation exists (often referred to as an unusual fluctuation). After having identified an unusual fluctuation, hypotheses (potential explanations) are developed. This is an important component of analytical review, as these hypotheses will guide subsequent investigation of accounts related to the fluctuation. The investigation yields information to support/refute the hypotheses and the hypotheses are evaluated accordingly. The mental representation is iteratively updated to reflect the generation of hypotheses, results of information search, and evaluation of hypotheses until an auditor is satisfied that the fluctuation is explained.

This study focuses exclusively on the hypothesis generation phase of the process. It is important, therefore, to consider the significance of this phase in greater depth. Each hypothesis considered by the auditor undergoes a plausibility test wherein an auditor evaluates whether the hypothesis is consistent with information in the mental representation or the pattern of the fluctuation (Fisher et al. 1983). If a hypothesis fails the plausibility check, it will no longer be considered a potential explanation. However, each hypothesis that passes this check is considered to be a potential cause for the fluctuation, and is added to an auditor's hypothesis set.

Optimally, an auditor will also carry out a sufficiency check for each hypothesis to determine whether it alone can account for the magnitude of the fluctuation (Anderson and Koonce 1998). However, this check may or may not be possible at the initial hypothesis generation stage of analytical review, depending on whether an auditor can quantify the fluctuation at that point. Often, an auditor needs to collect additional evidence before this quantification is possible, which happens at a later phase of analytical review (evidence search).[3] Nonetheless, if the hypothesis is found to account for an amount smaller than the observed fluctuation, then either the hypothesis is not the cause or there are additional causes operating. The explanation will then no longer be considered or alternatively, will be considered as only one of several explanations. While the plausibility check is an unconscious process (Fisher et al. 1983), research has shown that an auditor may need to be prompted to carry out a sufficiency check for the hypotheses (Anderson and Koonce 1998).

Hypotheses come from various sources (Figure 1). An auditor develops hypotheses by referencing memory or by inheriting hypotheses from external sources such as the client, other audit team members, or decision aids (Koonce 1993, Hirst and Kooce 1996). Regarding memory, it has been shown that auditors generally have difficulty self-generating more than two or three hypotheses (Heiman 1990, Hirst and Koonce 1996).[4] In addition to these hypotheses, auditors often consider the client's

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[3] The sufficiency check may be much more likely to occur when analytical review procedures are used as substantive tests rather than as an audit planning tool. Auditors are less (more) likely to quantify the amount of the fluctuation in the planning (substantive testing) stage of the audit (Hirst and Koonce 1996).

[4] Arkes (1981) has pointed out the fallibility of memory and suggests that reducing reliance on memory is a strategy for improved judgment. "Hopefully a more humble view of one's own

explanation for the fluctuation; however, sometimes the client's explanation is considered exclusively (Hirst and Koonce 1996). That is, between these two sources (memory and the client) it is common for an auditor to evaluate only a few hypotheses, or alternatively, only the client's hypothesis (Hirst and Koonce 1996). Decision aids provide a means for auditors to initially consider a greater number of hypotheses. This is important to the diagnostic process, as an auditor will likely conclude with a cause selected from these initial hypotheses. Moreover, research has shown that even an optimal information search strategy cannot compensate for a poor hypothesis set (Asare and Wright 1998).

The hypothesis set affects both the effectiveness and efficiency of analytical review. Effectiveness is essentially the need for the set to contain the correct hypothesis, whereas efficiency is represented by the number of hypotheses that must be investigated (size of the set). Consider the following scenario, illustrating the classic trade-off between effectiveness and efficiency (Koonce 1993):

> An unusual fluctuation is identified for which there exists multiple possible hypotheses. Auditor A begins an information search with only two hypotheses. Alternatively, Auditor B begins an information search with six hypotheses. Auditor A may be ineffective in reaching the correct conclusion due to the absence of additional plausible explanations in the set. Auditor B risks being inefficient if information search costs rise each time s/he investigates an additional hypothesis that is not correct. However, Auditor B may be more likely to reach the correct explanation by having considered additional plausible explanations.

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memory will result in less of a need to be humble about the accuracy of one's own judgment" (Arkes, 1981, p.592).

The link between this trade-off and the different sources an auditor uses to generate hypotheses is that a decision aid yields a larger hypothesis set that is perhaps less efficient, yet more effective, than a set developed from other sources. Indeed, a thorough decision aid provides an auditor with substantially more explanations (e.g. fifteen to twenty explanations as in Anderson et al. 1997, 1995) compared to the number of explanations that could be self-generated by auditors (e.g. five to six explanations, or fewer, as in Hirst and Koonce 1996, Koonce 1993, Anderson et al. 1992). Given a larger hypothesis set than that generally considered, two issues arise that make it difficult for an auditor to begin an investigation with *all* hypotheses given by the decision aid—increased cognitive load and greater budgetary constraint.

Classic studies in cognitive capacity have examined the limitations of working memory when evaluating a large quantity of information for decision-making, and have concluded that decision makers generally scale back the amount of information considered to keep cognitive processing to a manageable level (Just and Carpenter 1992, Baddeley 1986). Time pressure, such as that resulting from budgetary constraints, reinforces the desire to scale back the volume of information actively considered. Research has shown that the most common way a decision maker copes with cognitive (or information) overload is a *filtration* strategy, whereby a decision maker screens information and subjectively identifies the most important information for further consideration (Miller 1960). Decision makers have been observed applying this strategy in a variety of decision settings (Payne et al.1988, Ben Zur and Breznitz 1981, Wright 1974), including accounting (Glover 1997, Spilker and Prawitt 1997). As a result of increased cognitive load and the effect of budgetary constraints on the consideration of the lengthy list, an auditor experiences the need to reduce the list to make it more manageable.

This study examines the manner in which an auditor narrows a large hypothesis set given by a decision aid in the initial hypothesis generation stage of analytical review. The auditor's judgment is examined in the context of a theoretical framework that models the screening process according to classical decision theory, then adjusts for the effects of goal framing.

2.2 Framing

Framing represents alternative descriptions of a task that do not alter the normative meaning of the task, but cause a change in the resulting decision (Huber et al. 1987, Jamal et al. 1995). Classical decision theory, concerned with consistent 'rational' decision making, would contend that the processes of inclusion and elimination are equivalent ways of *framing* the judgment procedure, and that the outcome (i.e. reduced hypothesis set) would be the same under either (White 1969, Tversky and Kahneman 1981). In other words, if an individual prefers option X over option Y in one context, s/he should not also prefer option Y over option X in a different yet equivalent context (von Neumann and Morgenstern 1947). However, human decision processing has been found to exhibit various biases and heuristics (see Kahneman et al. 1982 or Smith and Kida 1991 for review). Framing effects are labeled a bias, caused when frames highlight different aspects of the task, which bring out different considerations and result in different decisions (e.g. Ganzach and Schul 1995, Shafir 1993, Huber et al. 1987, Tversky and Kahneman 1981). Studies have reported judgment and decision differences caused by framing of *the choices* in a decision (e.g. Kahneman and Tversky 1979, Wallsten et al. 1993, Tversky and Koehler 1994, Koehler et al. 1997) and framing of the *decision context* (e.g. Tversky and Kahneman 1981, Bazerman et al. 1985, Neale et al. 1987). This study focuses on a type of framing effect attributable to the manner in which the *decision goal* is framed.

Various effects of goal framing have been found in prior studies. An education study by Jaradat and Tollefson (1988) examined the differences between types of scoring procedures on an examination. An indirect finding of the study relates to framing of the decision method. For each multiple choice question, students were instructed to either *circle right answers* or *cross out incorrect answers*. The results showed that these two procedures were only moderately correlated (.57). If these two selection methods are equivalent, as suggested by classical decision theory, then the correlation should be approximately 1. In other words, subjects reached different conclusions/answers due to the framing of the reduction method.

Medin et al. (1990) presented subjects with three drawings, a "standard" drawing and two drawings to be compared to the standard. Subjects in one treatment group were asked to indicate the object that was *similar* to the standard while subjects in another treatment group were asked to indicate the object that was *different* from the standard. According to classical decision theory, similarity and difference judgments mirror each other. In other words, the drawing that is similar would also be the drawing that is *not* different and the drawing that is different would also be the drawing that is *not* similar. However, subjects consistently chose the same drawing as being both different and similar. Medin et al. (1990) attributed much of this finding to the goal framing, which caused the similarity group to focus on certain dimensions for comparison and the difference group to focus on other certain dimensions for comparison.

While the aforementioned studies investigate the effects of goal framing, this study is specifically concerned with the size of the reduced set of alternatives due to the framing of the reduction task. Huber et al. (1987) found that interviewers chose to interview more applicants if they were asked to *reject* applicants not desired than if they were asked to *select* applicants desired. Prosansky and Levin (1999) extended

the findings from a positive "hire" context to a negative "fire" context. The results were consistent in that participants who were asked to *exclude* employees they didn't want to fire chose more employees to fire than those participants asked to *select* employees that they did want to fire. These findings are based on prospect theory which states that decision-makers treat the prospects of gains and losses differently: under gain conditions one will act in a risk-seeking manner, while under loss conditions one will act in a risk-avoiding manner (Kahneman and Tversky 1979). Selecting applicants (a positive frame) has an implicit tone of gains such that subjects will tend to be more risk averse and will select fewer applicants to interview. Alternatively, rejecting applicants (a negative frame) has an implicit tone of losses such that subjects will exercise risk-seeking behavior and will interview more applicants. In a more general decision context than hiring and firing employees, Levin et al. (1998) found that participants instructed to *eliminate* automobiles they would not consider purchasing retained more potential autos to purchase than participants instructed to *include* automobiles they would consider purchasing.

The research in psychology provides evidence of inconsistent decision making due to goal framing. Specifically, a goal framed as an exclusion procedure has resulted in a larger reduced set than a goal framed as an inclusion procedure.

2.2.1 Yaniv and Schul's Theoretical Framework for Goal Framing

Yaniv and Schul (1997) proposed a theoretical framework to explain how a decision-maker arrives at differing outcomes under alternative, but logically equivalent, decision goals. The framework explains the judgment process of reducing a list of alternatives in order to reach a correct answer when the correct answer is not known. The framework proposes a screening model consistent with classical decision theory and a modified model to account for the effects of goal framing.

The model consistent with classical decision theory predicts equivalent reduced sets under either goal frame, as they are logically equivalent methods to arrive at the same decision. Those alternatives included under *inclusion* should be exactly those hypotheses not eliminated under *elimination.* The model is defined as follows.

Let E_S represent the strength of evidence regarding an alternative, which takes on values along a continuum. In analytical review, E_S may be viewed as the participant's perceived likelihood of a potential explanation for an unusual fluctuation, in a given audit scenario. Also, let C_{Incl} represent the criterion value that E_S (the strength of evidence) in favor of a given alternative must surpass in order for that alternative to be included in the reduced set of alternatives. In other words, if a judge is using an *inclusion* approach, only alternatives for which $E_S > C_{Incl}$ will be in the reduced set. In analytical review, C_{Incl} represents a likelihood threshold. Therefore, if the participant considers the explanation to be *likely enough* to surpass the threshold, the explanation will be included in the reduced set.[5]

Now, let C_{Elim} represent the criterion value that E_S (the strength of evidence) in favor of a given alternative must fall below in order for that alternative to be eliminated from the reduced set. Thus, if a judge is using an *elimination* approach, alternatives for which $E_S < C_{Elim}$ will be eliminated leaving the remaining alternatives in the reduced set. In analytical review, as with C_{Incl}, C_{Elim} represents a likelihood threshold. If the participant considers the explanation to be *unlikely enough* to fall below the threshold, the explanation will be eliminated from the reduced set. If the screening model is to yield equivalent reduced sets under inclusion and elimination,

[5] A similar threshold criterion is described in Asare (1992), wherein auditors judged the likelihood that a client would continue as a going concern.

then C_{Incl} must equal C_{Elim} as illustrated in Figure 2. In terms of probability, the model states that the probability of an alternative being included and the probability of the same alternative being eliminated are complementary and sum to 1, giving the model the property of *complementarity*. In other words, a participant arrives at the same conclusion for an alternative regardless of the framing of the goal.

To model the findings of the goal framing literature, Yaniv and Schul (1997) proposed an adapted model, in which the criteria values are set apart. They concluded that the framing of the goal causes decision-makers to infer where the "burden of proof" lies, which in turn affects the setting of the criteria (C_{Incl} or C_{Elim}). For instance, under inclusion, the decision-maker feels as if s/he is accountable for including an explanation because leaving an explanation outside the decision set is the default. Alternatively, under elimination, the decision-maker must justify eliminating an explanation because the default is to leave explanations inside the decision set. Such inferences drawn from the framing cause the decision-maker to set inclusion and elimination criteria apart, as illustrated in Figure 3.

As before, an alternative will only be included if the strength of evidence, E_S, in its favor falls above C_{Incl} and an alternative will be eliminated only if the strength of evidence falls below C_{Elim}. However, with the criteria set apart, some alternatives will not have evidence at either extreme. For those 'in-between' alternatives, whether or not they are inside the choice set depends on the framing of the decision process. The inclusion participants will *not include* the "in-between" alternatives for lack of evidence to include them. However, under elimination, these very same alternatives will *not be eliminated* for lack of good reason to eliminate them, leaving them (by default) inside the choice set.

Yaniv and Schul (1997) call this the *sub-complementarity* model, as the probability of an alternative being included and the probability of the same alternative being eliminated sum to *less than* 1.[6] The prediction of the model is that the same participant can arrive at two different outcomes for a given alternative depending on the way the goal is framed. Specifically, elimination will lead to a larger reduced set of alternatives, as it will include the "in-between" alternatives that inclusion will not.

2.2.2 Application of Framework to Analytical Review

In the performance of analytical review, an auditor will hypothesize the cause(s) of any unexpected fluctuation in order to determine what type of and how much additional evidence is needed. A decision aid provides a means for auditors to generate and initially consider a greater number of alternatives than could otherwise be generated. However, due to increased cognitive load and time and cost

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[6] A third model in the Yaniv and Schul (1997) framework received the least support and possesses the property of *super-complementarity*. The criteria to either include or exclude become much less stringent, represented by the relationship $C_{Incl} < C_{Elim.}$ Participants in the inclusion method, therefore, require little evidence to include the alternatives in the choice set. Likewise, participants in the elimination method, require little evidence to exclude the alternatives from the choice set. Therefore, the same participant would be likely to both include and exclude the 'in-between' alternative under the two methods of selection. "Super-complementarity" is used to describe this model because the probabilities of inclusion and elimination for a given alternative sum to greater than 1. Results under this model are consistent with another bias found in the psychology literature called acquiescence bias, whereby individuals have the tendency to agree with whatever statement is given to them, either positive or negative (Schuman and Presser 1981, p.203, Matikka and Vesala 1997, McBrien and Dagenbach 1998). Very little support was found for this model.

constraints, an auditor will likely narrow down the list given by assessing the likelihood of the individual explanations on the full list.

Yaniv and Schul (1997) provide a framework to explain different judgments due to the manner in which the auditor's reduction goal is framed. The theoretical framework predicts that the likelihood threshold (how likely an explanation must be to make it into the reduced set) will be different under the inclusion and elimination frames. Inclusion will induce a higher, or stricter, threshold than will elimination. Therefore, fewer explanations will "make the cut" under the inclusion frame. The reduced set of explanations under the elimination frame will contain those that are somewhat less likely due to the lower threshold induced by that frame. As a result of the different thresholds, the inclusion frame will lead to a smaller reduced set than will the elimination frame.

Hypothesis 1: When using a decision aid in an analytical review task, auditors using an *inclusion* goal frame will conclude with a *smaller* set of explanations than auditors using an elimination goal frame.

2.3 Risk Environment

An auditor must contend with risk throughout the audit. However, in the early stage of an audit during analytical review, auditors are particularly concerned with the riskiness of a client while first attempting to determine required audit effort. Auditors are advised by the professional guidance to assess the risk of material misstatement in a client's financial statements in conjunction with analytical review in the planning stage of the audit (SAS 47, AICPA 1983 and SAS 56, AICPA 1988). Because this study investigates an auditor's judgment in this stage, it is desirable to consider the effects of client risk on the reduced list of explanations, in addition to the effects of goal framing.

Two highly related consequences of heightened risk might similarly impact the auditor's reduction of the lengthy list. Empirical evidence has shown that auditors are indeed sensitive to risk in audit planning, and will generally increase audit effort to counter heightened risk (e.g. Mock and Wright 1999, Davidson and Gist 1996, Bell et al. 1994, Biggs et al. 1988). This reaction is consistent with the prescription of the audit risk model, which calls for increased audit effort to counterbalance heightened inherent and controls risks if audit risk is to be held to a low level. In the analytical review stage of the audit, when an auditor is evaluating a lengthy list of explanations provided by a decision aid, increased effort might translate into investigation of a greater number of explanations, regardless of the manner in which the auditor's evaluation task (goal) is framed.

Secondly, heightened client risk may be related to an auditor's conservatism heuristic. Conservatism takes many forms depending on the audit context but is generally driven primarily by the substantial implications for audit failure (e.g., loss of reputation or legal liability). Conservatism serves as a functional heuristic used by an auditor to minimize economic losses (Smith and Kida 1991), and may go beyond the awareness called for by the standards (e.g. SAS 47). In terms of an auditor evaluating a lengthy list of explanations provided by a decision aid, conservatism may cause the auditor to be less inclined to discount *any* plausible explanation from the lengthy list, even if it is perhaps less likely than the others. The auditor may make this judgment regardless of the manner in which the evaluation task (goal) is framed.

Whether viewed in terms of increased audit effort as called for by SAS 47 or heightened conservatism motivated by an auditor's loss function, high risk may lead an auditor to retain a larger number of the explanations from the lengthy list than in low risk, regardless of the goal frame.

Hypothesis 2: When using a decision aid in an analytical review task, auditors in a *high risk environment* will conclude with a *larger* set of explanations than auditors in a low risk environment.

Risk may moderate the influence of goal framing on the size of the reduced set of explanations, tempering the main effect of goal framing. As presented earlier, a high risk scenario may prompt an auditor to act more conservatively, which may be described as a loss protection mechanism. Based upon a review of judgment heuristics and biases in auditing, Smith and Kida (1991) concluded that, in some cases, conservatism overrides heuristics and biases found in general judgment settings, if the task performed is analogous to a typical audit task. One such bias, studied in both psychology and auditing contexts, is the use of a confirmatory strategy. Under this strategy, one will be biased toward information that confirms a hypothesis being evaluated causing a lack of attention to information that disconfirms the hypothesis. In studies where the audit task was representative of an actual audit task, little or no evidence of confirmatory strategies was found (Trotman and Sng 1989, Anderson 1988, Kida 1984b). Consistent with conservatism, auditors attended to negative (or risky) information over positive information, regardless of whether the information was confirming or disconfirming.

Conservatism was also found to negate characteristics of the representativeness heuristic, neglect of base rates and insensitivity to source of information, found in the psychology literature. Conservatism reduced auditors' neglect of base rates in prediction of company failure (Kida 1984a), and heightened auditors' sensitivity to the reliability of the source of information in internal control judgments (Bamber 1983). As with the confirmatory strategy studies, the observation

of conservatism in these latter studies was attributed to subject familiarity with the experimental task (Smith and Kida 1991).

Conservatism has been shown in the auditing literature to mitigate the effects of biases and heuristics observed in the psychology literature (Smith and Kida 1991). Thus, despite the robustness of the goal framing effect in the psychology literature, *in a high risk environment*, an auditor's conservatism might be expected to lessen the effect of goal framing. Specifically, in a high risk/inclusion scenario, the influence of high risk in enlarging the set of explanations (conservatism) may overcome the influence of the inclusion goal frame in reducing the set of explanations (psychological phenomenon). This potential interaction is stated as follows:

Hypothesis 3: When using a decision aid in an analytical review task, the effect of an *inclusion goal frame* reducing the set of explanations will be *less* in a *high risk environment* than in a low risk environment.

CHAPTER 3
RESEARCH METHOD

This chapter presents the research design and methodology for testing the hypotheses. The variables are described, followed by a description of the participants, the case instrument and the methods used to analyze the hypotheses.

3.1 Independent Variables

The experiment was accomplished using a two-way between-subjects research design (Table 1). The first independent variable, *goal framing*, was manipulated at two qualitative levels: inclusion (INCL) and elimination (ELIM) of explanations. Participants in the inclusion condition were asked to reduce a lengthy list of potential explanations given by a decision aid by *including* explanations they believed were likely to be the correct explanations for the fluctuation. Participants in the elimination condition were asked to reduce the same list by *eliminating* explanations they believed were not likely to be the correct explanations for the fluctuation.

The second independent variable, *risk* associated with a client, was manipulated at two qualitative levels, high risk (HIGH) and low risk (LOW), using various inherent and control risk factors in the description of the audit client. The manipulation of this variable and the goal-framing variable created four treatment groups to which a participant may be assigned: Inclusion-High Risk, Inclusion-Low Risk, Elimination-High Risk, and Elimination-Low Risk. All remaining aspects of the experiment were identical for the four treatment groups.

3.2 Dependent Measures

The dependent measure, *reduced set size,* was used to test all hypotheses and is defined as the number of explanations in a participant's set after having reduced the full list of potential explanations provided. A similar measure has been used in psychology studies, to test for the effects of goal framing on decisions (cf. Huber et al. 1987, Yaniv and Schul 1997, Levin et al. 1998).

An additional dependent measure, *likelihood criterion*, was used for supplemental analysis to provide evidence of "how likely" participants required an explanation to be to included in (or not eliminated from) the reduced set of explanations. The likelihood criterion represents C_{Incl} and C_{Elim} for the inclusion and elimination participants, respectively, in Yaniv and Schul's (1997) goal framing framework. Similar critical values have been used in psychology studies (cf. Huber et al. 1987, Yaniv and Schul 1997) and in auditing research (cf. Asare 1992).

The likelihood criterion measure was created using the participants' likelihood assessments of the individual explanations. For each participant, the explanations in his/her reduced set were ranked according to his/her assessed likelihood of those

explanations. The lowest likelihood assessment from among those explanations was the likelihood criterion.[7]

3.2 Participants

Table 2 presents demographic information about the participants. Participants were auditors from various offices of four of the Big 5 CPA firms. Panel B of Table 2 shows that six separate offices of the four firms participated, but with no more than two offices from any one firm. There were no firm or office effects observed in the analysis.

Supplemental participant data was collected regarding general auditing experience and experience with material errors/irregularities and ratio analysis (Panel A of Table 2). The participant group had a mean level of experience of 54.2 months, ranging from staff to partner. On average, participants had experienced an accounting error or material inventory error within the past 10 months. Participants reported auditing manufacturing clients about twenty-three percent of the time. On average, they reported analyzing the inventory turnover ratio in preliminary audit planning with a frequency of 3 on a ten-point scale, and using any type of ratio analysis with a frequency of 5 on a ten-point scale. With the exception of auditors' *frequency of use*

[7] For elimination participants, in cases where there is a gap in likelihood assessments between explanations eliminated and those included (by default), two possible methods of establishing the likelihood criterion exist. One alternative is to use the greatest likelihood from among explanations eliminated while another is to use the lowest likelihood from among explanations included *by default*. The two methods were each evaluated and yielded similar results. The most conservative result (lowest F-statistic) is reported.

of ratio analysis, there were no significant effects of experience on the dependent measure.[8]

3.4 Case Instrument

Participants were randomly assigned to one of four case instruments containing an audit task adapted from Anderson et al. (1997), corresponding to the treatment conditions: inclusion-high risk, inclusion-low risk, elimination-high risk, and elimination-low risk. The case (presented in the Appendix) began with background information regarding a hypothetical client, which varied according to risk. The high-risk client was described using inherent and control risk 'red flags', whereas the low-risk client was described using 'white flags' (low risk) terminology (See Table 3). An identical set of prior year audited financial statements and current year unaudited financial statements were presented in all cases. The participant was informed that s/he was performing analytical review for planning purposes and that the inventory turnover ratio had significantly decreased from the prior year to the current year.

Following the client background data, participants were told about analytical procedures software that had been developed by their hypothetical audit firm. The software was described as having been designed according to actual error occurrence as documented in firm audit working papers over a period of 8 years along with the

[8] General auditing experience was tested various ways: (1) by using rank as a covariate in the analysis of variance, (2) by using months of experience as a covariate in the analysis of variance, (3) by using various groupings of participants according to rank as independent categorical variables in the analysis of variance, and (4) by using various groups of participants according to months of experience as independent categorical variables in the analysis of variance.

input of audit managers.[9] The extensive piloting process for the software was described in order to make the participants comfortable with the reliability of the software. Finally, the participants were informed that they had attended a training session on the use of the software and were comfortable with its use.

Participants were then told that the software had provided twenty potential explanations for the decrease in the inventory turnover ratio. The explanations evaluated in the case were generated by audit managers in a previous study (Anderson et al. 1992), and are also reported in previous research (Anderson et al. 1997, 1995). Participants were asked to mark the explanations that they considered either 'likely' or 'not likely' to be the correct explanations for the decrease in the inventory turnover ratio. The former represents the inclusion treatment and the latter, the elimination treatment. The responses from this task provided the dependent measure to test all hypotheses.

After the goal framing task, participants were once again presented the twenty explanations and were asked to evaluate how likely they believed each explanation to be, for the cause of the fluctuation in the inventory turnover ratio, on a 100-point Likert-type scale with endpoints labeled "Not Very Likely" and "Very Likely". Each subject, therefore, had twenty individual likelihood ratings, one for each of the explanations. The ratings were used to form the dependent measure *likelihood criterion* that was used for supplemental analysis of the goal framing hypothesis.

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[9] Similar methods for gathering information regarding material adjustments and causes can be found in Coakley and Loebbecke (1985) and Hylas and Ashton (1980).

The final part of the case instrument consisted of manipulation check and demographic questions. The case instrument is provided in the Appendix.

3.5 Analysis

A two-way analysis of covariance (ANCOVA) was used to test the hypotheses. The original analysis of variance model included two levels of goal framing (inclusion and elimination), two levels of client risk (high and low), and the interaction of goal framing and client risk. Although the subjects were randomly assigned to treatment conditions, auditors' *frequency of using ratio analysis* was not distributed evenly across the treatment conditions. Therefore, the model was adjusted by including this experience measure as a covariate. [10]

The first hypothesis was evaluated by comparing the reduced set sizes between the two goal framing treatment groups, inclusion and elimination. In order for hypothesis one to be supported, the elimination groups' reduced set sizes should be significantly greater than the inclusion groups' reduced set sizes. The second hypothesis was tested by comparing the reduced set sizes between the two client risk levels, high and low. Hypothesis two would be supported if the reduced set sizes were larger in the high risk condition than in the low risk condition. The third hypothesis, which predicts an interaction of goal framing and audit risk on the reduced set size, was tested by comparing the reduced set sizes for the inclusion and elimination groups within the high and low risk treatment conditions.

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[10] Other subject attributes related to the dependent measure that were suspected of being distributed unequally across the treatment conditions were originally included in the analysis of covariance; however, to achieve the best fitting model, the single significant covariate was included in the final model.

Finally, supplemental analysis provided an additional test of Yaniv and Schul's (1997) theoretical framework. According to Yaniv and Schul (1997), inclusion should prompt a higher likelihood criterion for admittance of an explanation into the reduced set than elimination (see Figure 3). An analysis of variance was used to evaluate this tenet of the framework by testing the impact of inclusion and elimination goal framing on participants' criterion values (C_{Incl} or C_{Elim}, respectively).

CHAPTER 4
RESULTS

This chapter discusses the results of the study in three sections: preliminary analysis, test of hypotheses, and supplemental analysis. Preliminary analyses include the tests of assumptions to determine the appropriateness of the ANCOVA statistical model and checks on the effective manipulation of the independent variables.

4.1 Preliminary analysis

In order to evaluate hypothesis one, there must be evidence that the goal frame manipulation was successful. For analysis of hypotheses two and three, there must be evidence that the client risk manipulation was also successful. Preliminary analysis was performed to check on these manipulations and to test the assumptions supporting the use of ANCOVA.

4.1.1 Manipulation Checks for Treatments

As a check on whether subjects used the goal frame prompted by the instrument, they were asked in a debriefing questionnaire to mark the statement that best described how they evaluated the list provided by the decision aid. Subjects were provided two choices to the question, one associated with each goal frame manipulation. Of the subjects in the inclusion group, all but one (a member of the low risk condition) correctly identified the goal frame that was presented in the case. However, in the elimination group, five subjects failed to correctly identify their goal frame (four from the high risk condition and one from the low risk condition). These subjects were eliminated from the analysis because there was doubt as to whether or not they used the goal frame prompted by the experimental case.

After eliminating the six subjects described above, there were 59 total subjects remaining, 29 in the high risk condition and 30 in the low risk condition. Of the high risk subjects, 16 experienced the inclusion goal frame and 13 experienced the elimination goal frame. Of the low risk subjects, 16 experienced the inclusion goal frame and 14 experienced the elimination goal frame.

As a check on the risk manipulation, subjects were asked following the experiment to rate the "riskiness" of the hypothetical client on an 11-point Likert-type scale with endpoints labeled "very low audit risk" and "very high audit risk". A visual inspection of the subjects' responses to this question revealed that subjects in the high risk condition unanimously marked above the midpoint of the scale and likewise, subjects in the low risk condition unanimously marked below the midpoint of the scale. A univariate analysis of variance verified the manipulation of client risk as the mean (standard deviation) "riskiness" ratings were 8.58 (0.93) and 3.48 (1.57) for the high and low risk groups, respectively. These ratings are significantly

different (F = 252.40, p = .000). Thus, the client risk manipulation was deemed successful.

4.1.2 Tests of Statistical Assumptions

In addition to assessing the manipulation of the independent variables, the assumptions underlying the statistical method of choice were assessed. Analysis of covariance assumes the same sample error term characteristics as analysis of variance (normal distribution, and common variance), and in addition, assumes parallel slopes of the treatment regression lines (Neter et al. 1990, p. 878). The latter assumption essentially means that the covariate does not significantly interact with the treatment variables in affecting the dependent measure.

Graphical representations of the data were initially used to assess the assumption of normality. Although inspection led to the conclusion that the data were approximately normal, the Komolgorov-Smirnov Normality Test was performed to corroborate this conclusion. The assumption of normality was supported (p-values greater than .15).

To address the assumption of common variance, Bartlett's Test for Homogeneity of Variance was used. Bartlett's test (as well as Cochran or Hartley) is an appropriate procedure when the data are found to be normal (Keppel 1982, p. 97). The samples were found to have homogeneous variances for the dependent measure, reduced set size, in all treatment conditions (p-value of .682).

Finally, to test for parallel slopes, the interactions of the covariate with the goal framing and risk treatments were observed. These interactions were not significant (F = 0.09 and F = 0.61, respectively); therefore, the assumption of parallel

slopes was supported. In summary, analysis of covariance was determined to be an appropriate statistical method to test the hypotheses, given that the assumptions made by the analysis were supported.

Tests of statistical assumptions were also performed for the dependent measure, likelihood criterion, used in supplemental analysis of variance. As a result of the Komolgorov-Smirnov test, the data were found to be normal (p-value greater than 0.15). Furthermore, Bartlett's Test for Homogeneity of Variance revealed that the treatment cells had homogeneous variances (p-value = .838). Based on the results of these tests, analysis of variance was deemed an acceptable statistical procedure for the likelihood criterion dependent measure.

4.2 Tests of Hypotheses

A two-way analysis of covariance (ANCOVA) was used to test the hypotheses. The originial analysis of variance (ANOVA) model included two levels of goal framing (inclusion and elimination), two levels of client risk (high and low), and the interaction of goal framing and client risk. Although the subjects were randomly assigned to treatment conditions, auditors' frequency of using ratio analysis was not distributed evenly across the experimental cells. *Frequency of using ratio analysis* was measured by asking how frequently the subject uses ratio analysis in the planning stage of the audit. Subjects responded on an 11-point Likert-type scale with endpoints labeled "Not Frequently" and "Very Frequently". Panel C of Table 4 shows the unbalanced distribution of this subject attribute in the treatment conditions ($F = 8.24$, $p = 0.006$). It is present to a greater extent in the inclusion cells than in the elimination cells and ranges from a mean of 4.5 in the elimination/high risk condition to 5.8 in the inclusion/high risk condition (as measured on a scale from 0 to 10). Therefore, the model was adjusted by including this experience measure as a

covariate in the analysis.[11] The test statistics resulting from the ANCOVA were very similar to those resulting from the original ANOVA.

4.2.1 Hypothesis One

It was predicted in hypothesis one that participants experiencing the inclusion goal frame would conclude with a smaller reduced set of explanations than those participants experiencing the elimination frame, in the task of reducing a lengthy list of explanations provided by a decision aid. A significant main effect for goal framing was found (Panel A of Table 4, $F = 23.0$, $p < .001$). Descriptive statistics (Panel B of Table 4) reveal that participants experiencing the inclusion goal frame concluded with about 8 explanations while those experiencing elimination concluded with approximately 13 explanations. Thus, goal framing caused the elimination participants to purge fewer explanations from the lengthy list than the inclusion participants, resulting in significantly smaller reduced sets for the inclusion participants. This result supports hypothesis one.

4.2.2 Hypothesis Two

Hypothesis two predicted that a high risk audit environment would lead to a larger reduced set of explanations than a low risk audit environment. An inspection of the descriptive statistics, in Panel B of Table 4, discloses that high risk participants had approximately 12 explanations, whereas low risk participants had approximately 9 explanations in their reduced sets. This difference is statistically significant (Panel A of Table 4, $F = 5.06$, $p = 0.029$), supporting hypothesis two.

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[11] Other participant attributes were examined as covariates but were insignificant.

4.2.3 Hypothesis Three

Hypothesis three addressed the interaction of goal framing and risk, predicting that the riskiness of the audit environment would moderate the effects of goal frame on the size of the reduced set of explanations. Specifically, the effects goal framing were expected to be greater in a low risk audit environment than in a high risk environment. In a high risk environment, the difference in reduced set sizes of inclusion and elimination should be significantly less distinct as even the inclusion participants should have a large reduced set. Treatment means (Panel B, Table 4) for the set sizes of the inclusion and elimination groups, in the *high* risk condition, are 9.3 and 14.8, respectively—a difference of about 5.5 explanations. Treatment means (Panel B, Table 4) for the set sizes of the inclusion and elimination groups, in the *low* risk condition, are 6.7 and 12.2—a difference of 5.5 explanations. There was no significant statistical interaction (Panel A, Table 4, $p = .523$) and therefore, the effect of goal framing in the high risk condition was essentially the same as in the low risk condition. Hypothesis three is not supported.

4.3 Supplemental Analysis

Yaniv and Schul's theoretical framework (1997) suggests that participants set thresholds for inclusion or elimination of the explanations according to the burden of proof (or default action) inferred from the goal frame. Inclusion implies that the default is to leave explanations outside the reduced set unless they are likely enough to be included. Elimination implies that the default is to leave explanations inside the reduced set unless they are unlikely enough to be eliminated. Inclusion should, therefore, result in a higher criterion value than elimination, such that explanations would have to be assessed as more likely to be in the reduced set under the former (as shown in Figure 3).

Using the dependent measure *likelihood criterion,* supplemental analysis was conducted to gain insight regarding the criterion values, C_{Incl} and C_{Elim}, being used by inclusion and elimination participants, respectively. Recall that these likelihood criteria represent the minimum likelihood of an explanation, required by a participant, for admittance into the reduced set. In order for Yaniv and Schul's framework to be supported, the likelihood criterion for inclusion participants ("C_{Incl}") should be higher than the likelihood criterion for elimination participants ("C_{Elim}"). A t-test of the likelihood criterion values revealed that participants in the inclusion treatment required the explanations to be significantly more likely than participants in the elimination treatment, as shown by the respective mean likelihood criterion values of 47.7 and 31.2 ($T = 2.92$, $p = 0.0026$). [12]

[12] Of the 59 participants available for analysis, four were removed, as their criterion values were inconsistently applied as cutoff values to all twenty explanations evaluated. The first subject, for example, established a criterion value of 20% such that all explanations rated *at least 20% likely* by the participant should be in the reduced set. If the participant fails to include explanations at least 20% likely, then the criterion value is invalid because it was not applied to all explanations consistently.

CHAPTER 5
DISCUSSION, IMPLICATIONS AND LIMITATIONS

This chapter discusses the results of hypothesis testing presented in the previous chapter. Discussion and implications of the results are reviewed along with future research questions, followed by limitations of the study.

5.1 Discussion and Implications

The application of analytical review is now "pervasive in the audit process" (Biggs et al. 1995, p.110). Costs associated with litigation and loss of reputation, not to mention the professional guidance, demand that auditors be effective in the application of analytical review. However, effectiveness may presently be hampered as auditors are known to initially consider only two or three hypotheses for a given unexpected fluctuation (see Hirst and Koonce 1996 for survey evidence, Heiman 1990 for empirical evidence), sometimes each of which comes from the client (Hirst and Koonce 1996). Auditors are expected to be somewhat skeptical of assertions given by management, especially in the case of analytical review wherein the client has the prerogative to offer non-error explanations for an unusual fluctuation.

Auditors have the opportunity to aid the application of analytical procedures with technology. A decision aid is an example of technology that can provide auditors with a more complete listing of potential explanations for a fluctuation, reducing the reliance on the client and on memory, which is admittedly fallible (cf. Arkes 1981 p.592, Smith and Kida 1991, Nesca 1997). Furthermore, a decision aid can provide these explanations independently of the client. In order for decision aids to be effective, however, they must be implemented without the introduction of (or at a minimum, with an awareness of) problematic decision-making biases, such as the *goal framing* bias investigated in this study.

Bamber et al. (1995, p.75) point out that "the mixed results on effectiveness of decision aids are not surprising given the lack of theory to guide their development and implementation." This study attempts to lend guidance by investigating the effects of a psychological phenomenon called *goal framing* on an auditor's use of a decision aid. The phenomenon results when a decision-maker is attempting to reduce a lengthy list of alternatives (as a decision aid would be expected to provide) to arrive at a reduced list of more likely alternatives (as an auditor would most likely need in order to begin an information search). A theory developed in psychology predicts that an elimination goal frame will lead to fewer of the original explanations being removed from consideration than an inclusion goal frame (Yaniv and Schul 1997). Thus, the decision-maker will take a larger number of the original alternatives *into further consideration* if experiencing an elimination goal frame.

In this study, all auditors began with a list of 20 explanations for a decrease in the inventory turnover ratio. As predicted, those experiencing an *inclusion* goal frame were found to derive a significantly smaller reduced set of alternatives (about 8 explanations) than auditors experiencing an *elimination* goal frame (about 13 explanations), due to the higher likelihood criterion value imposed by the former.

Thus, the elimination auditors would be expected to begin their information search with essentially five more explanations than the inclusion auditors.

Determining which group of auditors is most likely to reach the correct explanation is outside the scope of this study and remains for future research. One may speculate at this point, given prior research regarding hypothesis generation and information search (Asare and Wright 1998, Asare et al.1997), that the elimination strategy might lead to a more effective analytical review, in that information search is begun with more "potentially correct" explanations. Future research could empirically address which of the set sizes leads to a more effective information search and what efficiency tradeoffs are made. Auditors may need to be prompted by the decision aid to use a "standard" strategy (Jamal et al. 1995) or trained on the decision aid using a particular strategy, in order to mitigate the effects of goal framing.

Future research could also address the fate of the "abandoned" explanations—those that do not make it into the reduced set. Although prior research has addressed this question or explored it post hoc, evidence is inconsistent (Asare and Wright 1997, Bedard and Biggs 1991, Johnson et al. 1991). Furthermore, the question has not been addressed in the setting of a lengthy list of explanations provided by a decision aid. Whether or not the abandoned hypotheses are once again considered may impact the effectiveness and/or efficiency of the analytical review under the two goal framing approaches.

In addition to the effects of goal framing on the auditor's use of a decision aid, a more familiar influence was also addressed—risk. This study evaluated the impact of client risk, defined as the combination of inherent and control risk, on the auditor's evaluation of the lengthy list. Auditors in the high risk scenario retained 12 of the 20 explanations, whereas those in the low risk scenario retained only 9 of the 20. These

results are consistent with the audit risk model, which stipulates an increase in audit effort for an increase in inherent and/or control risk for a given level of audit risk (SAS 47, AICPA 1983). Furthermore, the results are in line with the concept of conservatism, which implies that auditors may be less inclined to discount a plausible explanation for an unusual fluctuation when the audit environment is risky than when it is not.

Finally, it was hypothesized that the client risk effect would overcome the goal framing effect. It was expected that auditors in the inclusion/high risk condition would not reduce the list to the degree that would be expected under inclusion due to the influence of conservatism and the need to increase audit effort in a period of high risk. The results showed no significant interaction. Goal framing effects were very similar at each level of risk—even in high risk. Thus, the goal framing effect was sufficiently robust to overcome conservatism and the call for increased audit effort during high risk when these were needed. The implication of this finding is that caution should be exercised in a high risk scenario *if an inclusion frame is used*. The original list may be reduced to a greater degree than desirable (because of the effect of the inclusion frame), as *more* explanations may deserve further consideration in the high risk environment. Future research should test whether effectiveness of the analytical review is hindered in the high risk / inclusion scenario.

A secondary finding of the study is additional information on auditor's consideration of hypotheses. Auditors using the decision aid created a set, on average, of about 8 explanations—more than has been found possible relying on memory and the client (Hirst and Koonce 1996, Koonce 1993, and Anderson et al. 1992). This finding suggests that decision aids may indeed be useful as a means for considering a greater number of plausible explanations.

In summary, this study is an initial step in investigating the effects of goal framing on the use of a decision aid. The finding of goal framing effects across varied levels of client risk, and the additional questions mentioned above, should be considered in the implementation of decision aids.

5.2 Limitations

This research is subject to certain limitations. The external validity of a laboratory experiment is limited to the degree that it abstracts a scenario from the real world. As an experiment, this study placed auditors in a simulated audit environment without the ability to consult other information sources (e.g. other audit team member, firm policy, client, professional guidance, etc.). It is also important to note that this study examined only the judgment in the initial hypothesis acquisition of analytical review; it did not consider the iterations of information search and modification to the hypothesis set nor the final conclusion made by an auditor regarding the fluctuation. This may be viewed as a limitation because the study cannot definitively make conclusions regarding whether an auditor eventually reaches the "correct" diagnosis. This is an area outside the scope of this study and a topic for future research.

FIGURES

FIGURE 1

PROCESS OF ANALYTICAL REVIEW

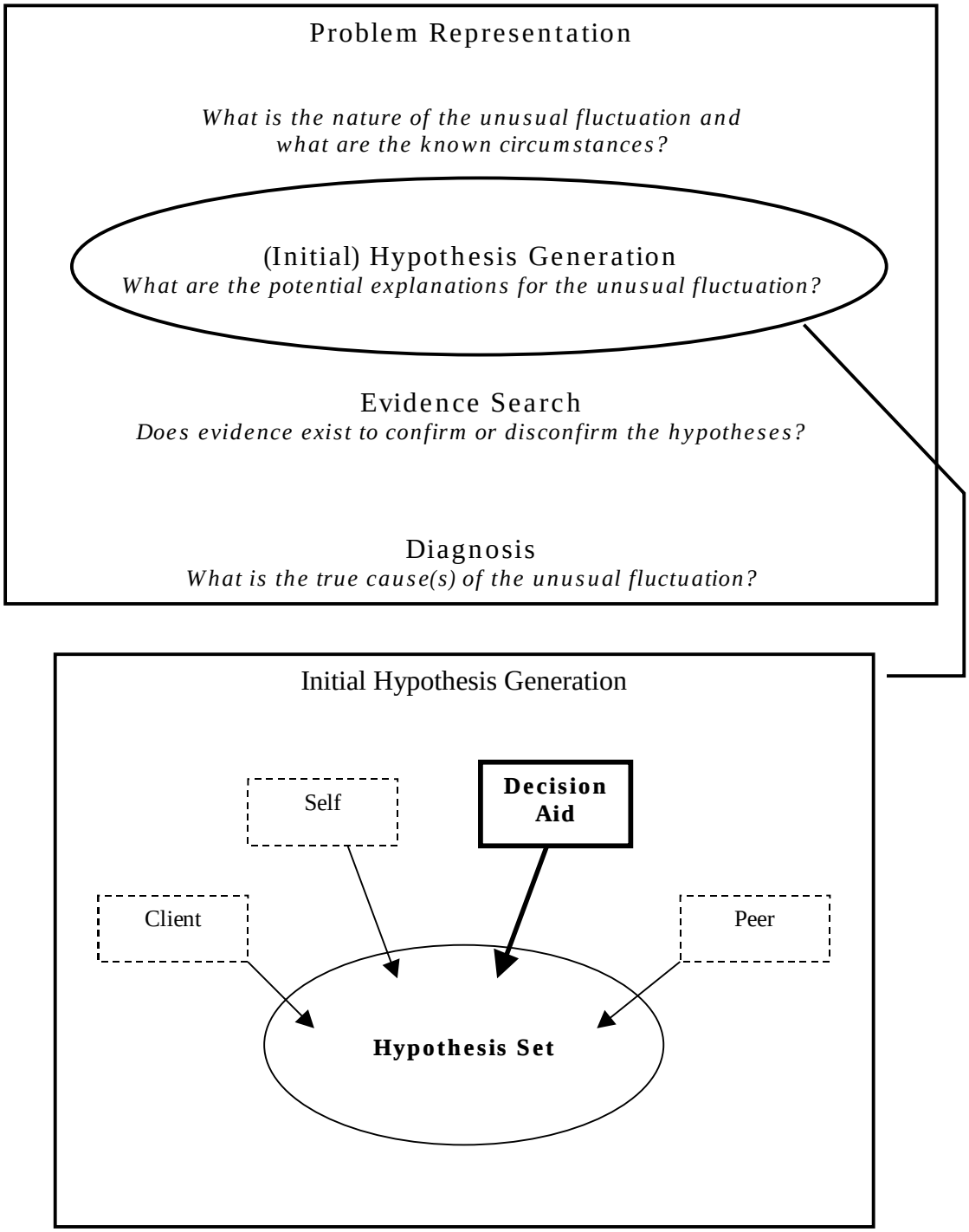
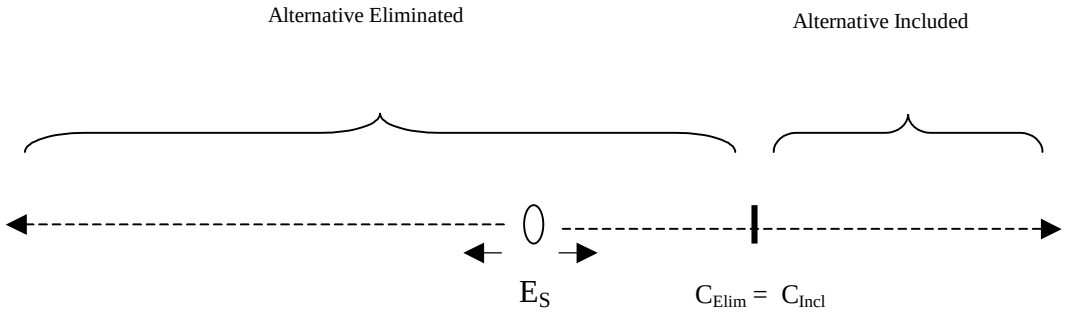


FIGURE 2

YANIV AND SCHUL'S COMPLEMENTARITY MODEL



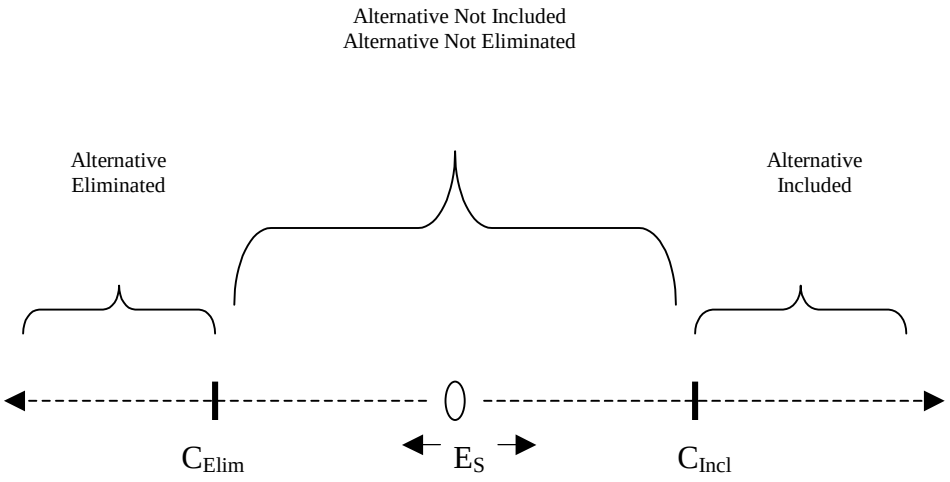
where E_s = strength of evidence

C_{Elim} = value of criterion for elimination of alternative

C_{Incl} = value of criterion for inclusion of alternative

FIGURE 3

YANIV AND SCHUL'S SUB-COMPLEMENTARITY MODEL



where E_s = strength of evidence

C_{Elim} = criterion for elimination of alternative

C_{Incl} = criterion for inclusion of alternative

TABLES

TABLE 1
Research Design

		Goal Framing	
		Inclusion	Elimination
Client Risk	High		
	Low		

TABLE 2
Demographic Data for Subjects

Panel A: Continuous Measures

Attribute	Scale	N	Mean	Std Dev	Min	Q1	Med	Q3	Max
Auditing Experience	Months	65	54.2	49.7	2.0	14.0	38.0	74.0	280.0
Frequency of Use of Ratio Analysis	Likert-type (0 - 10)	65	5.1	3.0	0.0	2.0	6.0	8.0	10.0
Frequency of Analysis of Inventory Turnover Ratio	Likert-type (0 - 10)	65	3.3	3.1	0.0	0.0	2.0	6.0	10.0
Months Since Experienced any Material Accounting Error	Months	65	10.2	21.8	0.0	1.0	3.0	6.0	120.0
Number of Material Inventory Errors During Past Two Years	Number	65	0.9	1.6	0.0	0.0	0.0	1.0	7.0
Months Since Experienced Material Inventory Error	Months	65	10.0	23.0	0.0	0.0	0.0	8.0	120.0
Percentage of Time Involving Manufacturing Clients	Percentage	65	23.5	27.5	0.0	0.0	10.0	50.0	95.0

Panel B: Discrete Measures

Attribute	Level	N
Rank within Firm[A]	Staff	19
	Senior	15
	Supervising Senior	5
	Manager	7
	Senior Manager	13
	Partner	2
		61
Firm / Office	Firm I	9
	Firm II	6
	Firm III	
	Office A	9
	Office B	10
	Firm IV	
	Office A	22
	Office B	9
		65

[A] Four subjects did not indicate rank within the firm.

TABLE 3

Client Risk Factors

Factor	Risk Scenario	
	Low	**High**
CEO of Corporation	Well-known in community for charitable contributions. Former member of Chamber of Commerce. Fifteen years experience in construction-related industries. Independently wealthy.	Known for marketing endeavors, some of questionable nature. Indicted (but acquitted) on mail fraud charges in the past. Limited experience in construction related industries. Lavish lifestyle funded primarily by compensation from company.
Profitability	Constant dividends due to stable performance.	Constant dividends in spite of volatile performance.
Compensation to Officers	No significant compensation options to officers.	Significant compensation options to officers.
Debt Covenants	No debt covenants in threat of violation.	Debt covenants in threat of violation.
Internal Control Assessments	Assessed as good to strong in the past. Management open to recommendations for improvements.	Assessed as weak to average in the past. Recommendations for improvements largely unheeded by management.
Accounting and Internal Auditing Staff	Highly qualified staff. Low turnover.	Unable to keep highly qualified staff. High turnover.

TABLE 4
Analysis of Covariance for the Dependent Measure *Reduced Set Size*

Panel A: ANCOVA with F*requency Using Ratio Analysis* as Covariate

Source of Variation	*df*	*Sum of Squares*	*F*	*p*
Goal Framing	1	425.500	23.00	<0.001
Client Risk	1	93.660	5.06	0.029
Goal Framing x Client Risk	1	7.630	0.41	0.523
Frequency Using Ratio Analysis	1	152.390	8.24	0.006
Error	54	998.910		
Total	58	1744.75		

Panel B: Adjusted Treatment Means

Source	*Mean*	*Standard Dev*	*N*
Goal Framing:			
Inclusion	8.00	0.763	32
Elimination	13.44	0.832	27
Client Risk:			
High Risk	11.78	0.803	29
Low Risk	9.25	0.788	30
Goal Framing x Client Risk			
Inclusion / High Risk	9.30	1.086	16
Inclusion / Low Risk	6.70	1.075	16
Elimination / High Risk	14.82	1.199	13
Elimination / Low Risk	12.16	1.150	14

Panel C: Distribution of *Frequency Using Ratio Analysis* in Treatment Cells

Source	*Mean*	*Standard Dev*
Inclusion / High Risk	5.79	3.052
Inclusion / Low Risk	5.00	2.989
Elimination / High Risk	4.46	2.817
Elimination / Low Risk	4.86	3.371

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APPENDIX:
Experimental Instrument

Inclusion Goal Framing / Low Risk Environment

This packet contains a brief *audit task* followed by a brief set of demographical questions.

The *audit task* has no right or wrong answer, as the questions deal with your own professional judgment.

Please complete all pages. Work individually without consulting others.

Thank you sincerely for your help.

Background Information

The next two pages provide general information about this audit case.

You have accepted the engagement to audit Housedress Incorporated (HI), a manufacturer and distributor of brick, vinyl, aluminum and wood siding for residential construction. HI is a medium-size, publicly-traded (NYSE) U.S.-based corporation which was founded in 1949. The company is subject to the normal reporting requirements of a publicly-owned manufacturing concern. The accounting functions are centralized and all transactions are processed in the main office.

Although this is the first audit of HI by your firm, correspondence with the prior auditor (a friendly parting), as well as some background checking on your own, has provided some additional information. The CEO of HI, Joseph Sloan III, joined HI three years ago. He is well known in the community for his charitable contributions and is a former member of the Chamber of Commerce. He has fifteen years experience in construction-related industries. Sloan is independently wealthy due to the inheritance of family money.

HI has paid constant dividends in recent years, attributable to stable economic performance. HI offers no significant compensation options to its officers and has no debt covenants in threat of violation.

Internal controls of HI have been assessed as good to strong in the past and the management has been open to recommendations for improvements. The accounting and internal auditing staff is highly qualified and apparently satisfied as evidenced by little turnover within the past five years.

Relevant summarized financial information for the current year (19x9) and the prior year (19x8) follows:

19x8 Audited	
Income Statement	
Sales	538,042,000
Cost of Sales	(445,000,000)
Selling & Admin	(28,575,000)
Other Expenses	(18,245,000)
Income Taxes	(21,500,000)
Net Income	24,722,000
Balance Sheet	
Cash & Equivalents	14,467,000
Net Receivables	54,353,000
Ending Inventory*	75,500,000
Other Current Assets	2,554,000
Long Term Assets	294,516,000
Total Assets	441,390,000
Accounts Payable	72,533,000
Other Current Liabilities	5,828,000
Long Term Liabilities	133,587,000
Stockholders' Equity	229,442,000
Total Liab & Equity	441,390,000

19x9 Unaudited	
Income Statement	
Sales	505,100,000
Cost of Sales	(410,000,000)
Selling & Admin	(29,312,000)
Other Expenses	(20,346,000)
Income Taxes	(19,242,000)
Net Income	26,200,000
Balance Sheet	
Cash & Equivalents	13,328,000
Net Receivables	49,377,000
Ending Inventory	79,000,000
Other Current Assets	2,032,000
Long Term Assets	295,131,000
Total Assets	438,868,000
Accounts Payable	73,254,000
Other Current Liabilities	5,795,000
Long Term Liabilities	133,537,000
Stockholders' Equity	226,282,000
Total Liab & Equity	438,868,000

**Beginning Inventory for 19x8 was $75,500,000.*

You are currently performing analytical procedures for preliminary audit planning. In performing analytical procedures for planning, typically, various ratios will be analyzed. One such ratio is inventory turnover (cost of sales ÷ average inventory). Presented below are inventory turnover ratios for HI. The inventory turnover ratio in the first column was computed from the *prior year audited* financial statements, while the ratio in the second column was computed from the *current year unaudited* financial statements.

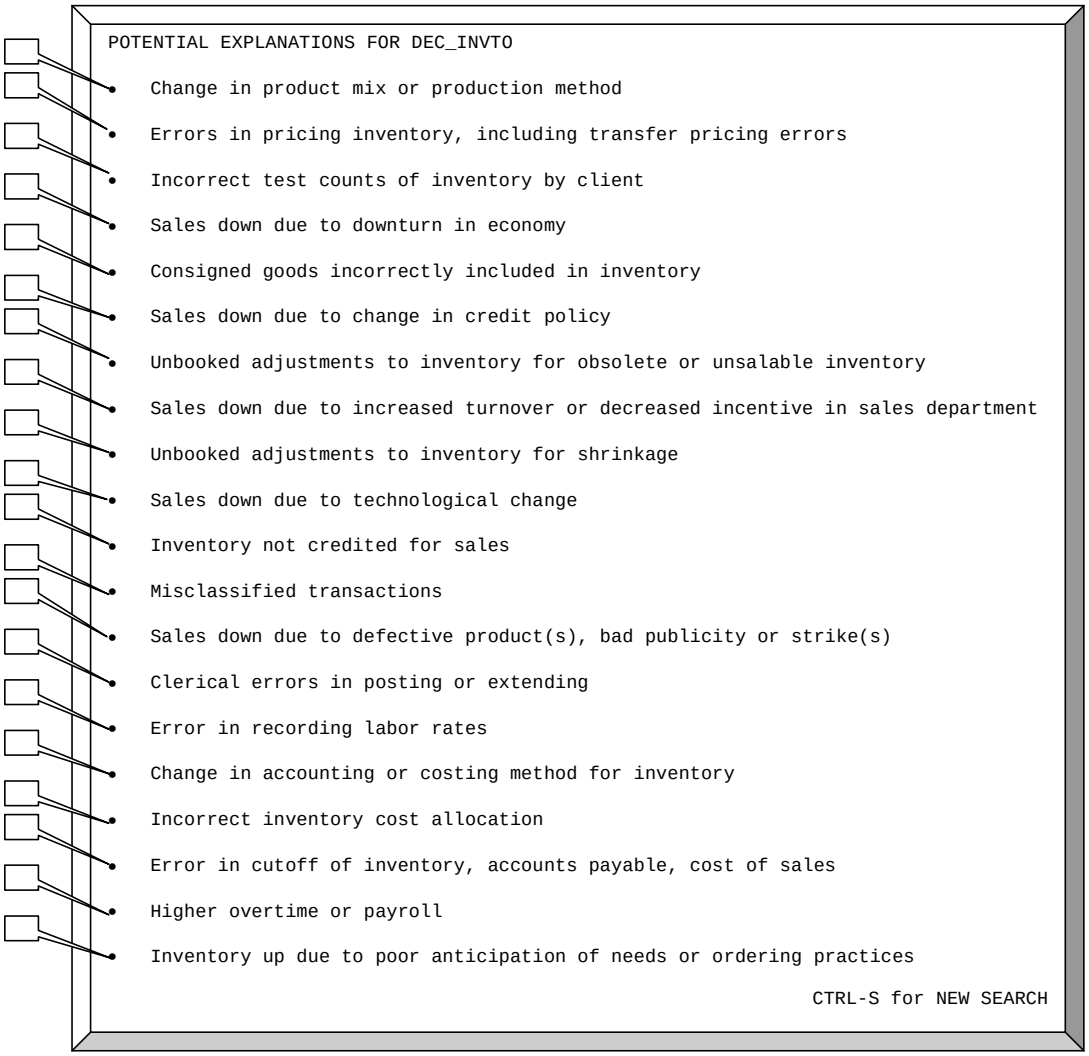
	Prior Year 19x8 Audited	Current Year 19x9 Unaudited	Change
Inventory Turnover Ratio (cost of sales ÷ avg inventory)	5.89	5.31	$\frac{(5.31 - 5.89)}{5.89} = -10\%$

The 10% decrease in the inventory turnover ratio may be viewed as material.

Audit Task

Your audit firm has developed analytical procedures software for field application that lists causal explanations for account/ratio changes. In developing the software, your firm has reviewed the workpapers of over 200 audits in HI's industry, which the firm performed over the past 8 years. In addition, the explanations provided by the software were reviewed extensively by a special committee made up of forty audit managers within your firm. During this review, the managers incorporated additional explanations for various account/ratio fluctuations. At the latter stages of development, the software was piloted on 20 audits, and after only slight modification, is now actively used in the field by the audit teams in your firm. You have attended a training session on the use of the software and are comfortable with its use.

The software has provided you with twenty potential explanations for the significant decrease in the inventory turnover ratio. Please mark the explanations that ***are likely*** to be the correct explanations with an "X".



Consider the likelihood of each explanation below. ***Circle the number*** *that best indicates* ***how likely*** *you believe each explanation to be as a cause of HI's decrease in the inventory turnover ratio.*

- Change in product mix or production method

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Errors in pricing inventory, including transfer pricing errors

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Incorrect test counts of inventory by client

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Sales down due to downturn in economy

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Consigned goods incorrectly included in inventory

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Sales down due to change in credit policy

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Unbooked adjustments to inventory for obsolete or unsalable inventory

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Sales down due to increased turnover or decreased incentive in sales department

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Unbooked adjustments to inventory for shrinkage

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Sales down due to technological change

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

Continued on the next page.

- Inventory not credited for sales

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Misclassified transactions

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Sales down due to defective product(s), bad publicity or strike(s)

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Clerical errors in posting or extending

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Error in recording labor rates

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- Error in cutoff of inventory, accounts payable, cost of sales

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- Higher overtime or payroll

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- Inventory up due to poor anticipation of needs or ordering practices

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

ADDITIONAL QUESTIONS

Without looking back, please answer the following questions.

1. Considering the information provided about Housedress Incorporated (HI), how would you assess *audit risk* for HI on the following scale? (Circle number)

Very Low Audit Risk	0	1	2	3	4	5	6	7	8	9	10	Very High Audit Risk

2. How *reliable* would you rate *the software* described in the audit case? (Circle number)

Not Very Reliable	0	1	2	3	4	5	6	7	8	9	10	Very Reliable

3. In the *audit task*, when considering the list of potential explanations provided by the software for HI's decrease in the inventory turnover ratio, which of the following best describes the manner in which you evaluated the list? (Check one.)
   ___ Marked "X" for explanations I believed were *likely* to be the correct explanations for the decrease.
   ___ Marked "X" for explanations I believed were *not likely* to be the correct explanations for the decrease.

DEMOGRAPHIC INFORMATION

Please answer the following questions as accurately as possible.
The information you report is anonymous and will be used for research purposes only.

1. How much auditing experience do you have? ____ years ____ months

   What is your rank?_____ (e.g. senior, supervising senior, etc.)

2. In your practice of public accounting, how frequently do you use *ratio analysis* in the preliminary audit planning stage?

Not Frequently	0	1	2	3	4	5	6	7	8	9	10	Very Frequently

3. In your practice of public accounting, how frequently do you analyze *the inventory turnover ratio* in the preliminary audit planning stage?

Not Frequently	0	1	2	3	4	5	6	7	8	9	10	Very Frequently

4. Approximately how long has it been since you worked on an audit with a material accounting error or irregularity *of any kind*?

   _____ years _____ months

5. Please estimate the total number of material accounting errors or irregularities *related to inventory* found on audits you have worked on *during the past two years*.

   _____ number of *inventory* errors or irregularities

6. Approximately how long has it been since you worked on an audit with a material accounting error or irregularity *relating to inventory*?

   _____ years _____ months

7. In your practice of public accounting, approximately what percentage of your engagements (engagements on which you have worked) have involved the *audit of inventories*?

   _____ % of engagements

Thank you for completing this survey!

Inclusion Goal Framing / High Risk Environment

This packet contains a brief *audit task* followed by a brief set of demographical questions.

The *audit task* has no right or wrong answer, as the questions deal with your own professional judgment.

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Although this is the first audit of HI by your firm, correspondence with the prior auditor (a friendly parting), as well as some background checking on your own, has provided some additional information. The CEO of HI, Joseph Sloan III, joined HI three years ago. He has limited experience in construction-related industries but was brought in for his marketing vision. Sloan is known for his marketing endeavors, some of which are of questionable character. In fact, Sloan has been indicted (but acquitted) on mail fraud charges in the past. The lavish lifestyle to which Sloan has become accustomed creates considerable financial demands, met primarily by his compensation from HI.

HI has paid constant dividends in recent years in spite of volatile economic performance. HI offers significant compensation options to its officers and has debt covenants in threat of violation.

Internal controls of HI have been assessed as weak to average in the past and recommendations for improvements have gone largely unheeded by management. The accounting and internal auditing departments have been unable to keep highly qualified personnel as evidenced by turnover within the past five years.

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Balance Sheet		**Balance Sheet**	
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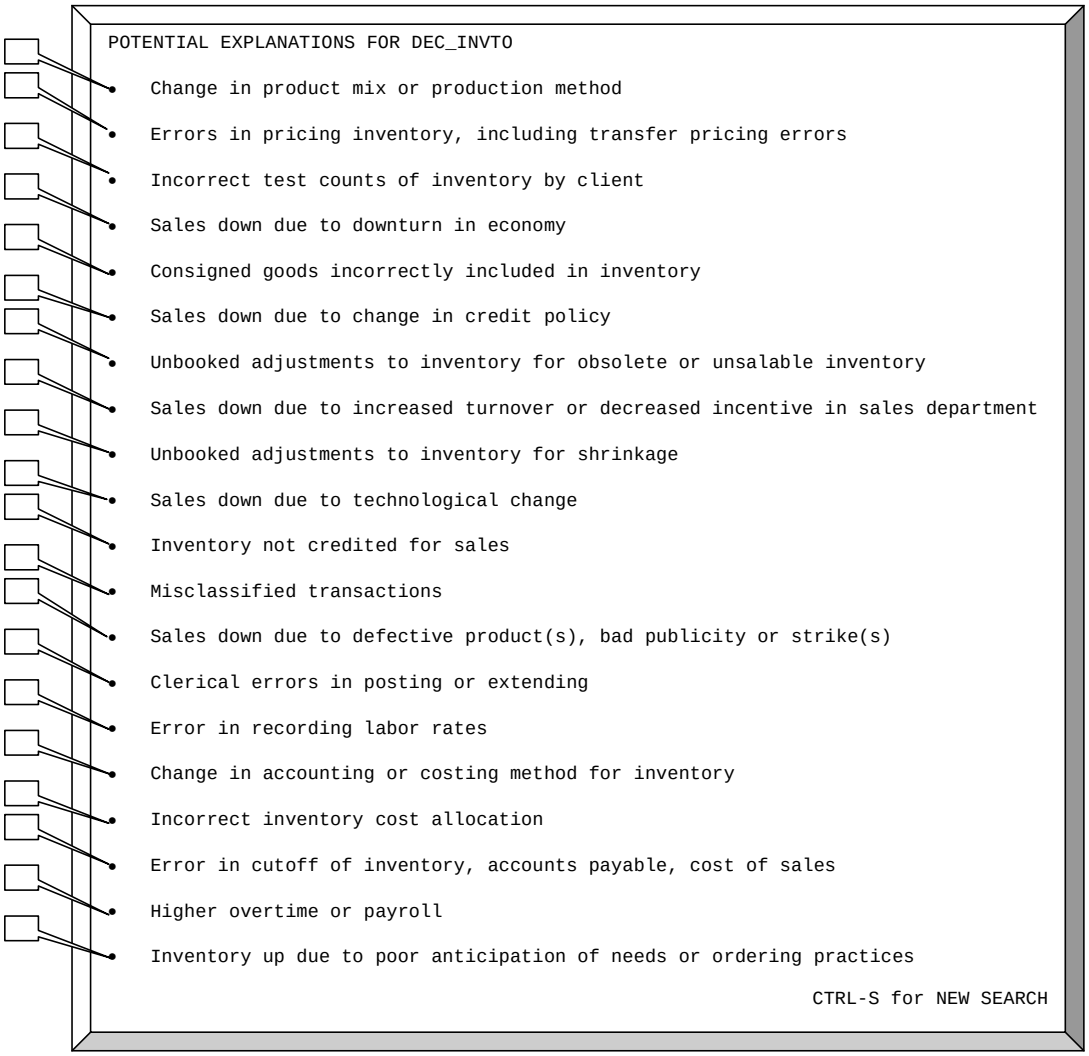

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3. In the *audit task*, when considering the list of potential explanations provided by the software for HI's decrease in the inventory turnover ratio, which of the following best describes the manner in which you evaluated the list? (Check one.)
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7. In your practice of public accounting, approximately what percentage of your engagements (engagements on which you have worked) have involved the *audit of inventories*?

   _____ % of engagements

Thank you for completing this survey!

Elimination Goal Framing / Low Risk Environment

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Although this is the first audit of HI by your firm, correspondence with the prior auditor (a friendly parting), as well as some background checking on your own, has provided some additional information. The CEO of HI, Joseph Sloan III, joined HI three years ago. He is well known in the community for his charitable contributions and is a former member of the Chamber of Commerce. He has fifteen years experience in construction-related industries. Sloan is independently wealthy due to the inheritance of family money.

HI has paid constant dividends in recent years, attributable to stable economic performance. HI offers no significant compensation options to its officers and has no debt covenants in threat of violation.

Internal controls of HI have been assessed as good to strong in the past and the management has been open to recommendations for improvements. The accounting and internal auditing staff is highly qualified and apparently satisfied as evidenced by little turnover within the past five years.

Relevant summarized financial information for the current year (19x9) and the prior year (19x8) follows:

19x8 Audited		**19x9 Unaudited**	
Income Statement		**Income Statement**	
Sales	538,042,000	Sales	505,100,000
Cost of Sales	(445,000,000)	Cost of Sales	(410,000,000)
Selling & Admin	(28,575,000)	Selling & Admin	(29,312,000)
Other Expenses	(18,245,000)	Other Expenses	(20,346,000)
Income Taxes	(21,500,000)	Income Taxes	(19,242,000)
Net Income	24,722,000	Net Income	26,200,000
Balance Sheet		**Balance Sheet**	
Cash & Equivalents	14,467,000	Cash & Equivalents	13,328,000
Net Receivables	54,353,000	Net Receivables	49,377,000
Ending Inventory*	75,500,000	Ending Inventory	79,000,000
Other Current Assets	2,554,000	Other Current Assets	2,032,000
Long Term Assets	294,516,000	Long Term Assets	295,131,000
Total Assets	441,390,000	Total Assets	438,868,000
Accounts Payable	72,533,000	Accounts Payable	73,254,000
Other Current Liabilities	5,828,000	Other Current Liabilities	5,795,000
Long Term Liabilities	133,587,000	Long Term Liabilities	133,537,000
Stockholders' Equity	229,442,000	Stockholders' Equity	226,282,000
Total Liab & Equity	441,390,000	Total Liab & Equity	438,868,000

**Beginning Inventory for 19x8 was $75,500,000.*

You are currently performing analytical procedures for preliminary audit planning. In performing analytical procedures for planning, typically, various ratios will be analyzed. One such ratio is inventory turnover (cost of sales ÷ average inventory). Presented below are inventory turnover ratios for HI. The inventory turnover ratio in the first column was computed from the *prior year audited* financial statements, while the ratio in the second column was computed from the *current year unaudited* financial statements.

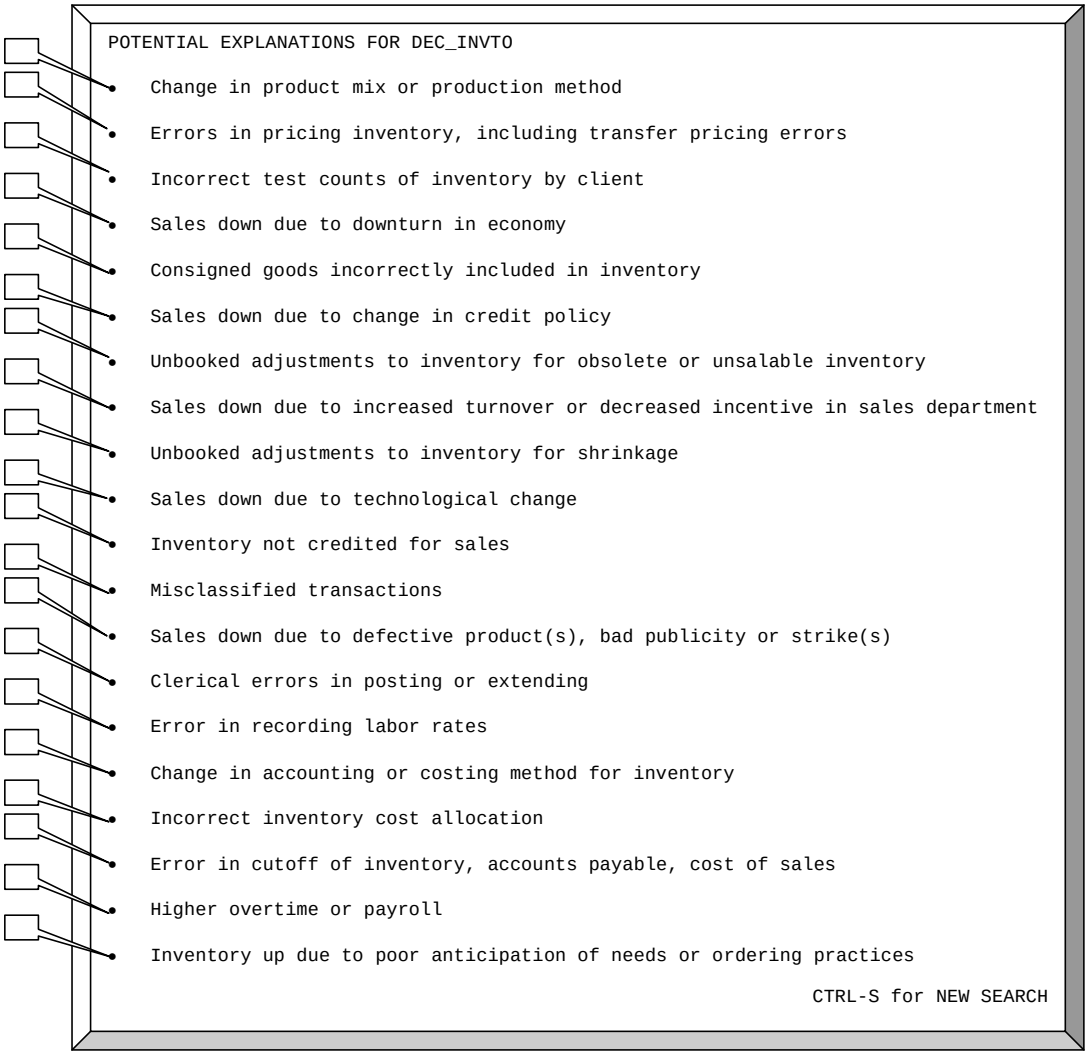
	Prior Year 19x8 Audited	Current Year 19x9 Unaudited	Change
Inventory Turnover Ratio (cost of sales ÷ avg inventory)	5.89	5.31	$\frac{(5.31 - 5.89)}{5.89} = -10\%$

The 10% decrease in the inventory turnover ratio may be viewed as material.

Audit Task

Your audit firm has developed analytical procedures software for field application that lists causal explanations for account/ratio changes. In developing the software, your firm has reviewed the workpapers of over 200 audits in HI's industry, which the firm performed over the past 8 years. In addition, the explanations provided by the software were reviewed extensively by a special committee made up of forty audit managers within your firm. During this review, the managers incorporated additional explanations for various account/ratio fluctuations. At the latter stages of development, the software was piloted on 20 audits, and after only slight modification, is now actively used in the field by the audit teams in your firm. You have attended a training session on the use of the software and are comfortable with its use.

The software has provided you with twenty potential explanations for the significant decrease in the inventory turnover ratio. Please mark the explanations that *are NOT likely* to be the correct explanations with an "X".



Consider the likelihood of each explanation below. ***Circle the number*** *that best indicates* ***how likely*** *you believe each explanation to be as a cause of HI's decrease in the inventory turnover ratio.*

- Change in product mix or production method

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Errors in pricing inventory, including transfer pricing errors

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Incorrect test counts of inventory by client

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Sales down due to downturn in economy

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Consigned goods incorrectly included in inventory

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- Sales down due to change in credit policy

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- Unbooked adjustments to inventory for obsolete or unsalable inventory

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- Sales down due to increased turnover or decreased incentive in sales department

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Unbooked adjustments to inventory for shrinkage

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Sales down due to technological change

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

Continued on the next page.

- Inventory not credited for sales

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Misclassified transactions

  Highly Unlikely 0 10 20 30 40 50 60 70 80 90 100 Highly Likely

- Sales down due to defective product(s), bad publicity or strike(s)

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- Inventory up due to poor anticipation of needs or ordering practices

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ADDITIONAL QUESTIONS

Without looking back, please answer the following questions.

1. Considering the information provided about Housedress Incorporated (HI), how would you assess *audit risk* for HI on the following scale? (Circle number)

Very Low Audit Risk	0	1	2	3	4	5	6	7	8	9	10	Very High Audit Risk

2. How *reliable* would you rate *the software* described in the audit case? (Circle number)

Not Very Reliable	0	1	2	3	4	5	6	7	8	9	10	Very Reliable

3. In the *audit task*, when considering the list of potential explanations provided by the software for HI's decrease in the inventory turnover ratio, which of the following best describes the manner in which you evaluated the list? (Check one.)
   ___ Marked "X" for explanations I believed were *likely* to be the correct explanations for the decrease.
   ___ Marked "X" for explanations I believed were *not likely* to be the correct explanations for the decrease.

DEMOGRAPHIC INFORMATION

Please answer the following questions as accurately as possible.
The information you report is anonymous and will be used for research purposes only.

1. How much auditing experience do you have? ____ years ____ months

   What is your rank?_____ (e.g. senior, supervising senior, etc.)

2. In your practice of public accounting, how frequently do you use *ratio analysis* in the preliminary audit planning stage?

Not Frequently	0	1	2	3	4	5	6	7	8	9	10	Very Frequently

3. In your practice of public accounting, how frequently do you analyze *the inventory turnover ratio* in the preliminary audit planning stage?

Not Frequently	0	1	2	3	4	5	6	7	8	9	10	Very Frequently

4. Approximately how long has it been since you worked on an audit with a material accounting error or irregularity *of any kind*?

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Although this is the first audit of HI by your firm, correspondence with the prior auditor (a friendly parting), as well as some background checking on your own, has provided some additional information. The CEO of HI, Joseph Sloan III, joined HI three years ago. He has limited experience in construction-related industries but was brought in for his marketing vision. Sloan is known for his marketing endeavors, some of which are of questionable character. In fact, Sloan has been indicted (but acquitted) on mail fraud charges in the past. The lavish lifestyle to which Sloan has become accustomed creates considerable financial demands, met primarily by his compensation from HI.

HI has paid constant dividends in recent years in spite of volatile economic performance. HI offers significant compensation options to its officers and has debt covenants in threat of violation.

Internal controls of HI have been assessed as weak to average in the past and recommendations for improvements have gone largely unheeded by management. The accounting and internal auditing departments have been unable to keep highly qualified personnel as evidenced by turnover within the past five years.

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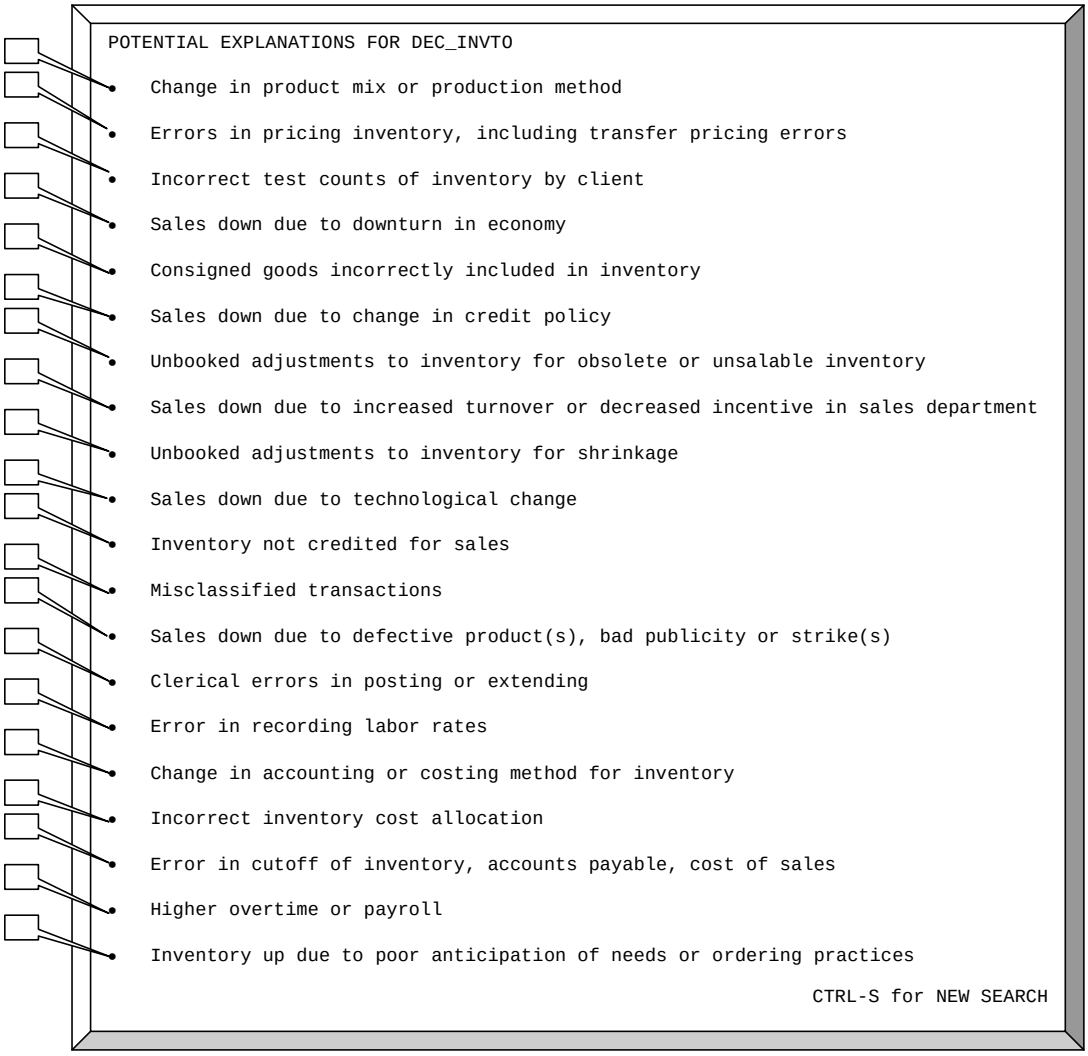

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VITA

JENNIFER M. MUELLER

Jennifer Mueller was born in Etowah County, Alabama, on June 12, 1972. She graduated from Hokes Bluff High School in Gadsden, Alabama, in 1990, and completed a Bachelor of Science in Business with a major in Accounting at Jacksonville State University in Jacksonville, Alabama, in May of 1994.

While pursuing her undergraduate degree, Jennifer worked as a corporate accountant for Anniston Health and Sickroom Supplies, a division of RoTech Medical Corporation of Orlando, Florida. Following receipt of her degree, she was promoted to management within Anniston Health and Sickroom Supplies, the position she held until returning to school.

Jennifer completed her Master of Accountancy at Virginia Tech in May of 1996 and subsequently entered the doctoral program at Virginia Tech.