

Pattern Identification and Industry-Specialist Auditors

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SUMMARY

Complex financial-statement misstatements that are difficult to diagnose are likely to be described by multiple cues that appear innocuous individually, but that form an ominous pattern. Because individual auditors are likely to obtain only some of the cues forming the pattern, it is important to understand how well auditors interpret incomplete cue patterns. In this paper, I experimentally examine whether industry-specialist auditors use their industry-specific knowledge to facilitate interpretation of incomplete patterns that are descriptive of misstatement. Overall, I find that matched specialists (i.e., those working in their industry) are able to interpret and fill in partial cue patterns, whereas mismatched specialists do not recognize the implications of even full patterns. Matched specialists respond to a partial cue pattern that potentially indicates misstatement by developing better mental models about the seeded misstatement, assessing higher risk of misstatement, and suggesting procedures that will be efficient and effective at discriminating the presence of the seeded misstatement. Despite higher assessments of general misstatement risk when receiving a partial cue pattern, mismatched specialists' mental models and suggested procedures do not indicate a focus on the seeded misstatement.

Keywords: Auditor Knowledge; Industry Specialization; Mental Models; Pattern Recognition.

Data Availability: Data used in this study are available upon request.

INTRODUCTION

Auditors' failure to identify and report complex financial statement misstatements has had severe consequences for financial statement users and for auditors themselves. Financial-statement misstatements that are complex or are being purposefully hidden are hard to diagnose because they are likely to be described by a pattern of apparently innocuous cues.¹ The problem of diagnosing such misstatements is further complicated when the pattern is incomplete. In this study, I examine whether industry-specialist auditors' unique knowledge allows them to diagnose such misstatements. Specifically, I investigate whether specialists use their industry knowledge to fill in the missing pieces of information in incomplete industry-specific patterns to identify the increased risk present.

It is important to understand the determinants of how well auditors interpret incomplete patterns suggestive of misstatement. Auditors must make judgments and decisions during the planning and evidence collection stages of the audit with incomplete information. Additionally, the division of labor among audit team members suggests the possibility that different auditors will collect the pieces of information that form a pattern. Individual auditors, who likely have seen only part of the pattern, would not have enough information, on their own, to identify the potential increased risk of misstatement. Consequently, unless at least one team member receives all of the information forming the pattern, the risk of misstatement may be assessed too low or identification of a misstatement may be delayed, negatively impacting both audit effectiveness and

efficiency. Moreover, because individual pieces of information are not, in themselves, very suggestive of misstatement, they are unlikely to be communicated.²

I experimentally examine whether industry specialists' knowledge differences lead to task-performance differences concerning a seeded misstatement. Industry-specialist auditors complete two cases, one matching and one not matching (as a benchmark) their industries of specialization. I manipulate whether they receive full, partial, or no patterns diagnostic of a misstatement embedded in case materials between participants. Auditors judge the likelihood of misstatement, explain what misstatement(s), if any, about which they are concerned, determine necessary additional audit procedures, and perform surprise recalls for each case.

Consistent with expectations, I find that matched specialists develop more complete mental models³ about the seeded misstatement when they receive partial or full cue patterns than when they receive no cue patterns. Additionally, matched specialists who receive full and partial cue patterns assess the likelihood of misstatement higher than matched specialists who receive no cue patterns. Critically, a mediation analysis confirms the role played by mental models for matched specialists. Specifically, mental model completeness significantly mediates the influence of the pattern manipulation on matched specialists' likelihood assessments. Matched specialists respond to a partial cue pattern that potentially indicates misstatement by developing more complete mental models about the seeded misstatement, assessing higher risk of misstatement and suggesting procedures that will be efficient and effective at discriminating the presence of the seeded misstatement.

In contrast, mismatched specialists generally do not develop more complete mental models about the seeded misstatement, even when they receive full cue patterns. Additionally, despite assessing higher general misstatement risk when receiving a partial cue pattern versus no cue pattern, mismatched specialists' mental models and suggested procedures do not indicate a focus on the seeded misstatement.

Collectively, these results suggest that matched specialists are able to interpret and fill in partial cue patterns, whereas mismatched specialists do not recognize the implications of even full patterns. To my knowledge, this is the first paper to investigate auditors' ability to identify partial patterns diagnostic of misstatement and the first to identify this ability as a comparative advantage of industry-specialist auditors. This research extends our understanding of industry specialists' knowledge of errors and provides additional evidence linking industry specialists' knowledge to performance.

The rest of this paper is organized as follows. The next section contains a review of the relevant literature and hypothesis development. In the third section, I describe the method that I use to test the hypotheses. In the fourth section, I describe the experimental results. In the fifth section, I present additional analysis. Finally, I discuss contributions and limitations.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Pattern Recognition

The ability to process patterns or configurations of stimuli that are important to subsequent judgments or decisions is known as configural information processing. Auditing researchers have reported that auditors configurally process information, provided that all cues are present and domain-specific knowledge implies such a

configuration is appropriate (Brown and Solomon 1990, 1991). Under these stylized conditions, auditors configurally process information about control-risk assessment, audit-procedure evidence evaluation, and financial-statement account comparison analysis. Auditors also process information configurally when making estimates of extent of audit testing (Kerr and Ward 1994) or planning judgments (Maletta and Kida 1993). In addition, auditors with recent manufacturing experience are more likely to identify a pattern diagnostic of an overhead application error than those with less recent manufacturing experience (Bedard and Biggs 1991).

When patterns of information reveal misstatement, auditors risk issuing incorrect audit opinions unless they recognize the components of such patterns. When a multi-cue pattern exists that is diagnostic of a material misstatement, auditors may receive none, some, or all of the cues. Previous research (e.g., Brown and Solomon 1990, 1991) that investigated auditors' ability to configurally process information manipulated the level of the cues received for a complete pattern (e.g., sales increased or sales decreased, a control was known to be present or absent). In contrast, I investigate how auditors respond to partial patterns of cues. If industry-specialist auditors possess superior knowledge about the industry in which they specialize, and can use this knowledge to imagine the conditions under which missing information would be diagnostic of misstatement, they should be likely to identify the misstatement from a partial pattern.

Since auditors likely receive incomplete patterns, it is important that they can assess the related potential misstatement implications. To date, the literature does not address whether auditors are able to process patterns when the presence or absence of cues is manipulated (e.g., there is or is not information available about whether a specific

control is in place to prevent a misstatement that could occur given the presence of another cue, and this information would be diagnostic about the risk of misstatement).

The question about this ability is especially important given the multi-person environment in which auditors work. This environment makes it likely that individual audit-team members receive partial cue patterns. While the team collectively may receive all of the cues, no single team member may possess the full pattern. The team member receiving each cue must recognize its potential importance or communicate it to other team members in order to detect the misstatement. Alternatively, a single auditor ultimately may collect all the cues forming a pattern; identification of the pattern will be delayed until all the cues are collected if the auditor does not recognize the incomplete pattern.

Even if recognized, cues that comprise the pattern may go uncommunicated. Several features of the audit environment suggest that auditors are unlikely to share unique information with other team members, consistent with findings in psychology (Stasser and Titus 1985). First, auditors work in very high information-load conditions and such conditions reduce information sharing (Stasser and Titus 1987). Second, larger auditees require larger audit teams and increases in group size reduce information sharing (Stasser, Taylor, and Hanna 1989). Finally, many audit tasks are “judgment” tasks where a demonstrably correct answer does not exist (Kennedy, Kleinmuntz, and Peecher 1997). Stasser and Stewart (1992) report that when participants believe that their task has a demonstrably correct answer they share more unique information than when they believe their task is a judgment task. Since conditions in the audit environment likely lead to low

levels of information sharing, identification of partial patterns suggestive of misstatement is very important.

Industry-Specialists' Knowledge

Some recent research has investigated performance by industry specialists. Industry specialists are those individuals so designated by their firms and whose training and experience is mainly in a particular industry. Examining industry specialists allows a strong test of knowledge and performance differences that arise due to experience. For example, Taylor (2000) reports that banking industry-specialist auditors' inherent risk assessments differ from those of non-specialists when evaluating loans receivable, but there are no differences between the groups when evaluating the more generic property, plant, and equipment account. Additionally, Wright and Wright (1997) report that auditors with retail-industry experience generate more plausible hypotheses of likely errors than do auditors without retail experience when faced with a retail-industry client.

Little previous research has investigated what knowledge industry-specialist auditors possess or how that knowledge is structured. However, Solomon, Shields, and Whittington (1999) report that industry-specialist auditors working in their industry of specialization have more knowledge of non-errors and non-error frequencies than do industry specialists working outside their industry of specialization. In fact, Solomon et al. (1999) report that 80% of the plausible explanations that industry specialists generate are for non-errors.

Interestingly, in the Solomon et al. (1999) study, matched industry specialists knew more about industry factors that may cause significant non-error fluctuations than mismatched industry specialists. However, matched industry specialists were only

weakly better at providing error explanations for significant fluctuations than were mismatched industry specialists. Therefore, while prior literature implies, but does not establish the role of mental models in identifying misstatements, it remains unclear whether the knowledge industry specialists possess will impact audit effectiveness when an error pattern is present.

I contend that auditors have rich knowledge representations of the complex environment in which they operate. Therefore, industry specialists' competitive advantage may derive from the amount and structure of their knowledge. Specialists' cognitive representations may allow them to draw inferences from partial patterns of cues that are diagnostic of misstatement in their area of expertise.

Mental models are cognitive representations of complex phenomena that people use to "run" thought experiments that allow inferences to be made (Greeno 1989). A mental model is an analogical memory model that people construct at the time of use based on what is in working memory; it is a function of external cues currently attended to and knowledge stored in memory (Brewer 1987). Mental models develop naturally with experience in a domain and contain the causal features of the domain that they represent (Norman 1983; Rumelhart and Norman 1988). For example, in physics, the behavior of a physical system can be analyzed, explained, and predicted by qualitatively simulating or envisioning the system's processes in a mental model (De Kleer and Brown 1983).

Domain knowledge plays an important role in the development of mental models (Fincher-Kiefer, Post, Greene, and Voss 1988; Spilich, Vesonder, Chiesi, and Voss 1979; Dutke 1986). Knowledge enables people to interpret text contents, allowing high

knowledge people to provide more extensive and accurate interpretations, and therefore better-developed mental models, than low knowledge people (Fincher-Kiefer et al. 1988). In auditing, I expect matched specialists to better interpret information about their industry than mismatched specialists, due to application of their superior knowledge about the industry. Therefore, they should create better-developed mental models of a case than do mismatched auditors.

Evidence about the existence and completeness of mental models can be found in explanations and surprise recalls. People base their explanations and judgments of events and recall of a target event or episode on their mental model. Mental models contain the substance of the facts as well as inferences people make and believe to be part of the original event or episode (Johnson-Laird 1983). Matched specialists, who have more knowledge about situations in their industry, are expected to create well-developed mental models that contain more explanations and inferences about the event or episode. Consequently, matched specialists likely will apply such explanations and inferences when assessing risk of misstatement.

Additionally, high knowledge individuals who are familiar with various game rules and moves (e.g., chess) better integrate game-related sequences and better recall game conditions than do individuals who are unfamiliar with these game rules and moves (Voss, Vesonder and Spilich 1980). More generally, higher knowledge individuals are better able to provide coherence to information. Similarly, matched specialist auditors with knowledge of industry practices and conditions likely will integrate information related to a possible misstatement and have good recall of items related to a seeded misstatement.

Therefore, I expect matched specialists who receive full and partial cue patterns to be able to understand the relationships among the cues. Recipients of partial cue patterns are expected to be able to provide coherence to the incomplete pattern. This should lead partial cue-pattern recipients to elaborate about the incomplete pattern and hypothesize about the missing information. They may even infer the existence of the missing piece of the cue pattern. Matched specialists who receive none of the cue pattern are not expected to elaborate about the unstated error pattern. As a result, matched specialists who receive partial cue patterns are expected to have better-developed mental models about the seeded misstatement than will matched specialists who receive no cue patterns.

Matched specialists who receive complete cue patterns are also expected to elaborate about the cue pattern and the error it suggests. As a result, matched specialists who receive complete cue patterns will have better developed mental models than those who receive no cue patterns, however the level of development relative to those in the partial cue pattern condition will depend on the relative diagnosticity of the partial and full cue patterns. When the full pattern is much more diagnostic of misstatement than is the partial pattern, those receiving full patterns will have better-developed mental models than those receiving partial patterns. However, when the full pattern is only marginally more diagnostic of misstatement than is the partial pattern, those receiving full patterns will have mental models that are at least as well developed as those receiving partial patterns. Figure 1 depicts my predictions about mental model development. More formally, I predict (all hypotheses are stated in alternative form):

H1a: Matched specialists receiving partial and full cue patterns will have better developed mental models about the seeded misstatement than will matched specialists receiving no cue patterns.

Mismatched specialists who receive partial cue patterns are expected neither to be able to understand nor add coherence to the incomplete information. They are not expected to elaborate on the incomplete pattern because they are not expected to recognize its significance. Their mental models are not expected to differ in level of development from mismatched specialists who receive no cue patterns. Mismatched specialists who receive full cue patterns may be able to interpret the patterns because they may have enough information, combined with their general accounting knowledge to deduce the misstatement. Consequently, if they recognize the significance of the pattern, they are expected to develop mental models that are better developed than mismatched specialists who receive the partial cue pattern. If they are unable to recognize the significance of the pattern because only industry-specific knowledge is sufficient to identify the pattern, their mental models will be as well developed as those of matched specialists who receive partial cue patterns. More formally, I predict:

H1b: Mismatched specialists receiving full cue patterns may have better-developed mental models about the seeded misstatement than mismatched specialists who receive no or partial cue patterns.

The above discussion suggests that the key difference between matched and mismatched specialists will occur when they receive partial cue patterns. Matched specialists who receive partial cue patterns are expected to understand the relationship among the cues and provide coherence to incomplete patterns resulting in well-developed mental models about the seeded misstatement. Mismatched specialists who receive partial cue patterns are not expected to understand these relationships, resulting in relatively impoverished mental models about the seeded misstatement. More formally, I predict:

H1c: Matched specialists receiving partial cue patterns will have better developed mental models about the seeded misstatement than will mismatched specialists receiving partial cue patterns.

Matched specialists likely possess knowledge of the patterns of business-operations information that would be diagnostic of misstatement, such as departures from expectations about “normal” conditions. Knowledge of these patterns may be acquired directly by experiencing the pattern on audits or indirectly from training sessions or discussions with colleagues. Auditors with this knowledge would have the cues that comprise the pattern accessibly stored in memory with connections developed between the cues that compose the pattern. Therefore, even if specialists receive only some of the cues comprising the pattern, it is likely that they would recognize the elevated potential for misstatement. Additionally, auditors with well-developed mental models likely will imagine the conditions under which the information heightens the risk of material misstatement, even if they have not previously encountered the misstatement.

Matched specialists who receive partial and full cue patterns suggestive of misstatement will assess the likelihood of misstatement conditioned on two factors: the perceived diagnosticity of the partial cue pattern about error and the conditional likelihood of the error(s) they are concerned about relative to other possible non-error conditions given the partial pattern. Matched specialists who receive no cue patterns suggestive of misstatement are not expected to perceive the unstated error risk. Therefore, I expect that matched specialists who receive partial cue patterns will assess the likelihood of misstatement higher than matched specialists who receive no cue patterns.

Matched specialists who receive full cue patterns will assess the likelihood of misstatement higher than those who receive no cue patterns, however, their likelihood

assessments relative to those in the partial cue-pattern condition will depend on the relative diagnosticity of the partial and full cue patterns. When the full pattern is much more diagnostic of misstatement than is the partial pattern, those receiving the full pattern will produce likelihood assessments that are higher than those receiving partial patterns. When the full pattern is only marginally more diagnostic of misstatement than is the partial pattern, those receiving full patterns will assess the likelihood of misstatement at least as high as those who receive partial cue patterns. Overall I expect auditors' likelihood assessments to be of the form depicted in Figure 2 and as stated more formally below.

H2a: Matched specialists receiving partial and full cue patterns will assess higher likelihoods of misstatements than will matched specialists receiving no cue patterns.

Mismatched specialists who receive partial cue patterns are also expected to assess the likelihood of misstatement conditioned on the perceived diagnosticity of the partial cue pattern about error and the conditional likelihood of the error(s) they are concerned about relative to other possible non-error conditions given the partial pattern. However, because they are expected to develop relatively impoverished mental models, mismatched specialists who receive partial cue patterns are not likely to perceive the diagnosticity of the partial cue pattern and thus are not expected to increase their assessment of risk of material misstatement. Their likelihood assessments are not expected to differ from those of mismatched specialists who receive no cue patterns. Mismatched specialists who receive full cue patterns may perceive the diagnosticity of the pattern for misstatement and if they do, they are expected to increase their assessed likelihood of misstatement accordingly. If they are not able to recognize the diagnosticity

of the pattern for misstatement, their likelihood assessments are not expected to differ from those of mismatched specialists who receive partial cue patterns.

The preceding discussion specifies predictions about likelihood assessments of mismatched specialists relative to other mismatched specialists. I make no predictions about likelihood assessments of matched versus mismatched specialists as this comparison is not clear *ex ante*. For example, one response to the uncertainty associated with being mismatched may be to assess the likelihood of misstatement higher overall. More formally, for mismatched specialists I predict:

H2b: Mismatched specialists receiving full cue patterns may assess the likelihood of misstatement higher than mismatched specialists receiving no or partial cue patterns.

The previous discussion examined the predicted impact of pattern completeness on likelihood assessments. The discussion hypothesized that pattern completeness will affect likelihood assessments in an indirect manner through the effect of pattern completeness on specialists' mental model development. I expect that mental model development will directly affect specialists' likelihood assessments. More formally, I predict:⁴

H3: Matched specialists' mental models about the seeded misstatement are expected to mediate the relationship between the pattern completeness manipulation and likelihood assessments.

As discussed earlier, the receipt of cues that are diagnostic of misstatement is expected to affect industry specialists' assessed likelihood of misstatement. Industry specialists who suspect a misstatement pattern likely seek information that can be used to determine whether the full pattern exists and the extent of any misstatement. Specialists who believe that there is a relatively higher risk of misstatement are expected to know

what industry-specific conditions would give rise to a misstatement, what tests should be performed, and what evidence should be gathered to determine the existence and extent of misstatement.

More experienced auditors perform more directed searches for information and choose procedures which yield evidence that better discriminates among possible causes of unexpected differences than do less experienced auditors (Biggs, Mock, and Watkins 1988). Similarly, I expect specialists who are more concerned about a particular misstatement, to propose a more directed search for evidence about that misstatement (i.e., to seek information with a greater ability to discriminate between the hypothesized error and a non-error). Greater audit time, therefore, should be allocated to evidence with higher discriminatory power.

Matched specialists who receive partial cue patterns will elaborate about the incomplete pattern, hypothesize about the missing information, and conduct more directed searches for evidence than matched specialists who receive no cue patterns. Consequently, I expect these specialists to allocate more time to procedures that will discriminate whether the seeded misstatement is present than will matched specialists who receive no cue patterns.

Matched specialists who receive complete cue patterns are also expected to elaborate about the cue pattern and the error it suggests. As a result, matched specialists who receive complete cue patterns will allocate more time to procedures that will discriminate whether the seeded misstatement is present than those who receive no cue patterns, however the amount of time allocated relative to those in the partial cue pattern condition will depend on the relative diagnosticity of the partial and full cue patterns.

When the full pattern is much more diagnostic of misstatement than is the partial pattern, those receiving full patterns will allocate more time to discriminatory procedures than those receiving partial patterns. However, when the full pattern is only marginally more diagnostic of misstatement than is the partial pattern, those receiving full patterns will allocate at least as much time to discriminatory procedures as those receiving partial patterns. Figure 2 depicts my predictions about time allocated to discriminatory procedures. More formally, I predict:

H4a: Matched specialists receiving full and partial cue patterns will allocate more time to procedures that will discriminate whether the seeded misstatement is present than will matched specialists receiving no cue patterns.

Mismatched specialists who receive partial cue patterns are not expected to be able to interpret the pattern, nor are they expected to understand the industry-specific conditions that would give rise to the misstatement. As such, they are not expected to have a particular misstatement in mind about which they will seek evidence. Therefore, mismatched specialists who receive partial cue patterns are not expected to differentially allocate time to procedures that will discriminate whether the target misstatement is present compared to mismatched specialists who receive no cue patterns. Mismatched specialists who receive full cue patterns may be able to identify the potential misstatement and may be able to conduct directed searches for evidence if their general knowledge of audit testing allows them to design tests that would discriminate the misstatement. If only industry-specific knowledge is sufficient to design tests that will discriminate the presence of the seeded misstatement, they will allocate as much time to discriminatory procedures as matched specialists who receive partial cue patterns. Stated more formally, these predictions are:

H4b: Mismatched specialists receiving full cue patterns may allocate more time to procedures that will discriminate whether the seeded misstatement is present than mismatched specialists receiving no or partial cue patterns.

Specialists who believe that there is a relatively low risk of misstatement are unlikely to have specific misstatements in mind. Consequently, they will be relatively unlikely to identify audit procedures that would provide evidence about the presence of a particular misstatement. Less experienced auditors generally perform ill-defined searches and choose audit procedures that poorly discriminate among possible causes of audit fluctuations (Biggs et al. 1988). Consequently, I expect mismatched auditors to allocate more time to audit procedures with relatively low ability to discriminate whether a misstatement is present than do matched specialists. Stated more formally, this prediction is:

H5: Mismatched specialists will allocate more time to procedures unlikely to discriminate the presence of misstatement than will matched specialists.

RESEARCH METHOD

Participants

Seventy-four industry-specialist auditors from four Big-Five firms participated in one of 19 sessions of the experiment; responses from 65 auditors are reported herein.⁵ Participants volunteered after being identified by their audit firms as having sufficient experience auditing banking clients or state and local government clients that they would be able to supervise an audit in one of these industries. As summarized in Table 1, participants' mean audit experience is 83.82 months. Participants are partners/principals (n= 10), senior managers (n= 11), managers (n= 14), and seniors (n= 30). Banking (government) specialists report having an average of 49.09 (4.87) months of experience

auditing banking clients and 0.57 (72.67) months of experience auditing government clients. Banking (government) specialists report spending an average of 63.46% (0.03%) of their time in the past year auditing banking clients and 0.43% (56.60%) of their time in the past year auditing government clients.

Task

The experimental instrument contains two cases, one bank and one city-government case. I chose these industries to minimize expected knowledge transfer thus providing a strong test of the effects of knowledge differences on performance. These industries have unique accounting issues and the industries are not included in the same industry category by any of the Big-Five accounting firms.

Each case provides background about the audit client and information about a revenue recognition problem. I developed the cases after consulting with audit partners who specialize in each of the target industries. Each case focuses on a revenue recognition problem that is unique to, but common within, the target industry. This ensures that industry knowledge, rather than general business or accounting knowledge, is necessary to identify the risk of misstatement.

I provided participants with unaudited revenue numbers and background information about two revenue items that comprise the area under audit. Each case contained a seeded material misstatement of one of the two revenue items discussed. For each case participants were asked to: read the case, assess the likelihood of material misstatement, report what (if any) misstatement they are concerned about, list procedures they would perform and audit hours necessary to determine whether their noted misstatements are present, and recall all important information from each case. After

completing the second case, participants answered a post-experimental questionnaire that contained manipulation checks and demographic questions.

Participants received the experimental materials in a set of six numbered envelopes. They were instructed to work at their own pace, to return each completed document to its envelope, and to close it before opening the next envelope. A proctor ensured participants complied with instructions during all sessions of the experiment. On average participants completed the materials in about 75 minutes.

Independent Variables

There are two independent variables: industry match and completeness of the misstatement-cue pattern.⁶ I create the two levels of industry match (i.e., matched and mismatched) by manipulating context and measuring participant industry specialization. I manipulate context within-participants at two levels. Each participant evaluates one banking case and one city-government case. I measure participants' industry of specialization; participants specialize in auditing banks or state and local governments. I manipulate completeness of the misstatement-cue pattern between-participants. The misstatement pattern for each case consists of three cues whose presence or absence in the case is manipulated at three levels (i.e., none: no cues present, partial: two cues present, and full: all three cues present).

Dependent Variables

Three classes of dependent variables are measured: mental representation measures, likelihood assessments, and total time allocated to procedures that will or will not discriminate the misstatement. I use four different mental representation measures to create the overall measure used to test H1: recall content, recall character, explanation

content, and explanation direction. I compute an overall measure of mental model by standardizing each of the above measures using Z-scores and summing. Higher scores are consistent with better-developed mental representations.

I collected the recall content and character measures when participants recalled all of the important information they could remember from the case. Participants were instructed not to look at the case materials while performing this task. I parse the recalls into idea units, and a doctoral student with auditing experience and I work independently to code the recalls and all other items for the project. The doctoral-student coder is blind to participant specialty and the hypotheses for all coding for this project.

We code recall idea units on two dimensions: content and character. Content of each recall idea unit is coded as relating to the misstatement area or not. Character of each idea unit is coded as expressing either case facts or as expressing relationships and inferences from the case. Participants who are better able to interpret the case scenario as indicating misstatement are expected to recall more items related to the misstatement area. These participants also are expected to make connections among facts presented and include more relationships and inferences related to the misstatement area in their recalls. Inter-rater agreement is 97.9% for content and 89.3% for character. Coding differences are mutually resolved.

I collected the explanation content and character measures when participants explained the misstatement(s) (if any) about which they were most concerned. We code these responses on two dimensions: content and direction. The content of each explanation idea unit is coded as relating to the misstatement area or not. The direction of each explanation idea unit is coded as supporting the seeded misstatement about the

target revenue area or not. Participants who are better able to interpret the case scenario and who focus on the seeded misstatement are expected to explain more items that relate to the target revenue area. The participants also are expected to include more items that explain the seeded misstatement. Inter-rater agreement is 90.6% for content and 79.3% for direction. Coding differences are mutually resolved.

After reading each case and before listing the recalls, participants rated the likelihood that a material misstatement was contained in the financial statements. The likelihood assessment is the dependent variable for H2. Participants were free to look back at the case materials while making this assessment. The likelihood assessment is elicited on a 101-point scale anchored by 0 (No chance of material misstatement) and 100 (Certain of material misstatement).

Finally, participants listed procedures and specified the audit time necessary to determine whether the potential misstatements they previously had identified were present. We coded these procedures on the ability to discriminate the target misstatement. The total time allocated to discriminatory procedures is the dependent measure for H4; total time allocated to non-discriminatory procedures is the dependent measure for H5. Procedures are coded as discriminatory if they would provide direct evidence about whether the target misstatement is present; procedures are coded as non-discriminatory if they would not provide such evidence or if they would provide evidence about the non-target revenue area. Inter-rater agreement is 79.5%. Coding differences are mutually resolved.

RESULTS

Hypothesis 1

In H1a, I predict that matched participants' mental models about the seeded misstatement will be better developed when they receive full and partial cue patterns than when they receive no cue patterns. In H1b, I predict that mismatched participants' mental models about the seeded misstatement may be better developed when they receive full cue patterns than when they receive no or partial cue patterns. Finally in H1c, I predict that matched specialists receiving partial cue patterns will have better developed mental models about the seeded misstatement than will mismatched specialists receiving partial cue patterns.

Note that the hypotheses and tests are in the form of specific interaction contrasts (Buckless and Ravenscroft 1990). For the matched specialists' predictions in H1a, H2a, and H4a, the contrasts are the no pattern-condition means compared to the mean of the partial and full pattern-condition means. For the mismatched specialists' predictions in H1b, H2b, and H4b, the contrasts are the full pattern-condition means compared to the mean of the no and partial pattern-condition means. H1c compares the matched specialists' mental model development in the partial-pattern condition to that of mismatched specialists in that condition.

I conduct a repeated-measures ANOVA with the overall mental model measures as dependent variables and industry match (within participant) and cue-pattern condition as independent variables. I present the means and the results of the planned contrasts in Table 2. Matched participants who receive full or partial-cue patterns have better

developed mental models for the seeded misstatement (mean 1.26) than do matched participants in the no-cue pattern condition (-0.51) and this difference is significant ($F_{1,62} = 7.545$, one-sided $p = 0.004$), supporting H1a. Mismatched participants who receive full-cue patterns do not have significantly better developed mental models for the seeded misstatement (-0.48) than do mismatched participants in the no- or partial-cue pattern condition (-1.10) ($F_{1,62} = 0.966$, one-sided $p = 0.165$). This is consistent with H1b. Finally, matched participants in the partial-pattern condition have better developed mental models for the seeded misstatement (0.89) than do mismatched participants in the partial-pattern condition (-0.80) ($F_{1,62} = 7.856$, one-sided $p = 0.004$), supporting H1c.

Hypothesis 2

In H2a, I predict that industry match and pattern completeness will interact such that matched participants will assess the likelihood of misstatement higher when they receive partial or full cue patterns than when they receive no cue patterns. In H2b, I predict that mismatched participants' likelihood assessments may be higher when they receive full cue patterns than when they receive no- or partial-cue patterns.

I conduct a repeated-measures ANOVA with matched and mismatched likelihood of misstatement as the dependent variables and industry match (within participant) and cue-pattern condition (between-participant) as independent variables. The means and planned contrast results are presented in Table 3 and are graphed in Figure 3. Matched participants' mean likelihood assessments in the partial- and full-cue pattern conditions (66.12) is greater than those in the no-cue pattern condition (43.90) and this difference is significant ($F_{1,62} = 6.720$, one-sided $p = 0.006$). The mean of the mismatched participants' likelihood assessments in the no- and partial-cue pattern condition (54.57) is smaller than

those in the full-cue pattern condition (54.67); however, this difference is not significant ($F_{1,62} = 0.000$, one-sided $p = 0.495$). Contrary to expectations, mismatched participants' likelihood assessments in the partial-cue condition (63.00) are marginally higher than those in the no-cue pattern condition (46.14) ($F_{1,62} = 3.832$, two-sided $p = 0.055$).

This evidence supports H2a for the matched participants; their likelihood assessments are higher in the full- and partial-pattern condition than in the no-cue condition. However, this evidence does not support H2b for the mismatched participants. Instead, it appears that mismatched participants may be aware that there is increased risk in the partial-pattern condition.

Hypothesis 3

In H3, I predict that matched specialists' mental model measures will mediate the relationship between likelihood assessments and the pattern-condition manipulation; this relationship is not predicted for mismatched specialists. I use mediation analysis to investigate this (Baron and Kenney 1986).⁷

Matched Specialists

I expect the mental model measure to mediate the relationship between the dependent variable, matched likelihood assessment, and the independent variable, pattern completeness. The matched likelihood assessment is correlated with the mental model measure ($r = 0.354$, Bonferroni adjusted $p = 0.038$).

An ANOVA (Panel A of Table 4) shows that the matched likelihood assessment is related to the independent variable pattern completeness ($F_{2, 62} = 3.417$, $p = 0.039$). An ANOVA (Panel B of Table 4) shows that the mental model measure is affected by pattern completeness ($F_{2, 62} = 4.226$, $p = 0.019$). Finally, an ANOVA (Panel C of Table 4) with

matched likelihood assessment as the dependent variable and pattern completeness and the mental model measure as independent variables shows that the relationship between the matched likelihood assessment and pattern completeness is mediated by the mental model measure; pattern completeness is not significant in this ANOVA ($F_{2, 59} = 1.666$, $p = 0.198$) and the mental model measure is significant ($F_{1, 59} = 5.634$, $p = 0.021$). This analysis demonstrates that pattern condition does not directly affect likelihood assessments for matched participants; instead, pattern condition affects matched likelihood assessments indirectly through its effect on mental model development. This evidence supports H3.

Mismatched Specialists

The relationship examined, but not expected to mediate, is between the dependent variable mismatched likelihood assessment and the independent variable pattern condition and the potential mediator, the mental model measure. The mismatched likelihood assessment is not correlated with the mental model measure ($r = 0.066$, Bonferroni adjusted $p = 1.000$).

An ANOVA (not tabulated) shows that the mismatched likelihood assessment is not related to the independent variable pattern completeness ($F_{2, 62} = 1.917$, $p = 0.156$). Therefore, for the mismatched participants, the relationship expected to be mediated between the dependent variable (likelihood assessments) and the independent variable (pattern completeness) is not significant and likelihood assessments are not correlated with the mental model measure, so there is no potential for mediation.⁸

Hypothesis 4

In H4a, I predict that matched participants who receive full and partial cue patterns will allocate more time to procedures that discriminate whether a misstatement is present than will matched participants who receive no cue patterns. In H4b, I predict that mismatched participants who receive full cue patterns may allocate more time to procedures that discriminate whether a misstatement is present than will mismatched participants who receive no or partial cue patterns.

I conduct a repeated-measures ANOVA with matched and mismatched time allocated to procedures that likely discriminate whether the target misstatement is present as the dependent variable and industry match (within participant), case order, and cue-pattern condition (between-participant) as independent variables, and matched and mismatched total time allocated to all procedures as covariates. I present the means and results of planned contrasts are presented in Panels A and B of Table 5 and means are graphed in Figure 4. Matched participants' mean time allocated to procedures that would likely discriminate the presence of the seeded misstatement in the partial- and full-cue pattern conditions (3.66) is greater than that in the no-cue pattern condition (1.69) and this difference is significant ($F_{1,57} = 3.389$, one-sided $p = 0.036$). Mismatched participants' mean time allocated to procedures that would likely discriminate the presence of the seeded misstatement in the no- and partial-cue pattern condition (1.35) is smaller than that in the full-cue pattern condition (2.24), however, this difference is not significant ($F_{1,57} = 0.916$, one-sided $p = 0.171$). These results support H4a and H4b.

Hypothesis 5

In H5, I predict that mismatched participants will allocate more time to procedures that likely will not discriminate whether a misstatement is present than will matched participants. I conduct a repeated measures ANOVA with matched and mismatched time allocated to procedures that likely will not discriminate the presence of the target misstatement as the dependent variables and industry match (within participant), case order, and cue-pattern condition (between-participant) as independent variables, and matched and mismatched total time allocated to all procedures as covariates. Means and results of planned contrasts are presented in Panels C and D of Table 5. Mismatched participants allocate more time to procedures that will not discriminate whether a misstatement is present (8.88) than did matched participants (7.51) and this difference is significant ($F_{1, 57} = 3.093$, one-sided $p = 0.042$). This evidence supports H5.

ADDITIONAL ANALYSIS

One concern is that participants performed better in their specialty industry not due to knowledge differences, but because they worked harder on the case that matched their specialization than on the case outside their specialization. I compare participants' self-reports of effort and the number of items that participants recall for each case to provide evidence on this possibility.

I collect self-ratings of effort and difficulty immediately after participants complete the recall task for each case; they respond on 11-point Likert scales anchored by 0 (Very easy) and 10 (Very hard) for the difficulty question and 0 (Not at all hard) and 10 (Very hard) for the effort question. Participants report that the cases mismatched on specialty are more difficult (6.01) than the cases matched on specialty (5.27); this

difference is significant ($F_{1, 60} = 10.501$, two-sided $p = 0.002$) and that they work harder on the mismatched cases (5.78) than on the matched cases (4.17); this difference is significant ($F_{1, 60} = 41.778$, two-sided $p = 0.000$).

Because participant self-reports of effort are noisy measures of effort (Bettman, Johnson, and Payne 1990), I also compare participant work output (i.e., the number of items recalled for each case) as a measure of effort. The number of items recalled does not differ depending on whether the participants are matched on industry specialty ($F_{1, 62} = 1.521$, two-sided $p = 0.222$). This analysis, in combination with the observed systematic differences in the recalls and explanations provide evidence that knowledge, not effort, explains the results.

CONCLUDING REMARKS

Limitations

I am aware of two boundary conditions in relation to the theory I test in this paper. First, the theory applies to situations in which industry specialists are expected to have a comparative advantage over non-specialists due to knowledge differences. This comparative advantage is expected to exist when patterns are composed of industry-specific cues or are focused on industry-specific transactions. Industry specialists are unlikely to have as large a comparative advantage in situations where there are opportunities for knowledge transfer by analogy or direct transfer. Knowledge transfer likely occurs when a situation in one industry is easily mapped into a target situation in another industry (Thibodeau 2003). Transfer is likely when auditing common “generic” accounts (e.g., property, plant, and equipment) as virtually all firms have such accounts and the audit procedures, accounting requirements, and sources of risk are similar across

industries. Transfer also is likely in similar industries or where sources of risk, methods of accounting, or types of transactions are similar. In my study, to ensure a powerful test of my theory I chose industries that have little in common and I designed the cases around issues that are unique to these industries so that opportunities for knowledge transfer were minimized.

Second, the theory specifies how industry specialists are expected to react when a misstatement is present. It is likely that there are implications for how industry specialists react when a misstatement is absent as well; however those predictions are not developed in this paper. This may be a fruitful area for future research.

Conclusions

Misstatements that are difficult to diagnose because they are complex or hidden from the auditor may be described by a pattern of cues. The division of labor on audits suggests the possibility that different auditors will collect the cues that form a pattern. Features of the audit ecology, such as the large amount of information to be processed, the types of tasks performed and the size of audit teams make it likely that little sharing of information about pattern cues will occur. Therefore, it is important to understand how well individual auditors interpret incomplete patterns suggestive of misstatement.

In this paper, I examine whether industry-specialist auditors use their knowledge to help them interpret incomplete patterns that are descriptive of misstatement. Consistent with expectations, matched specialists develop more complete mental models about a seeded misstatement when they receive partial or full cue patterns than when they receive no cue patterns. These mental models are related to differences in matched specialists' assessments of misstatement likelihood. Mismatched specialists do not develop more

complete mental models with more pattern cues and their mental models are not related to their assessments of misstatement likelihoods.

Overall, these results imply that matched specialists are able to interpret and fill in partial cue patterns. They respond to partial cue patterns by increasing the assessed risk of misstatement. Mismatched specialists do not suspect the seeded misstatement under these conditions. This suggests that identification of incomplete patterns of misstatement may be a comparative advantage for industry specialist auditors.

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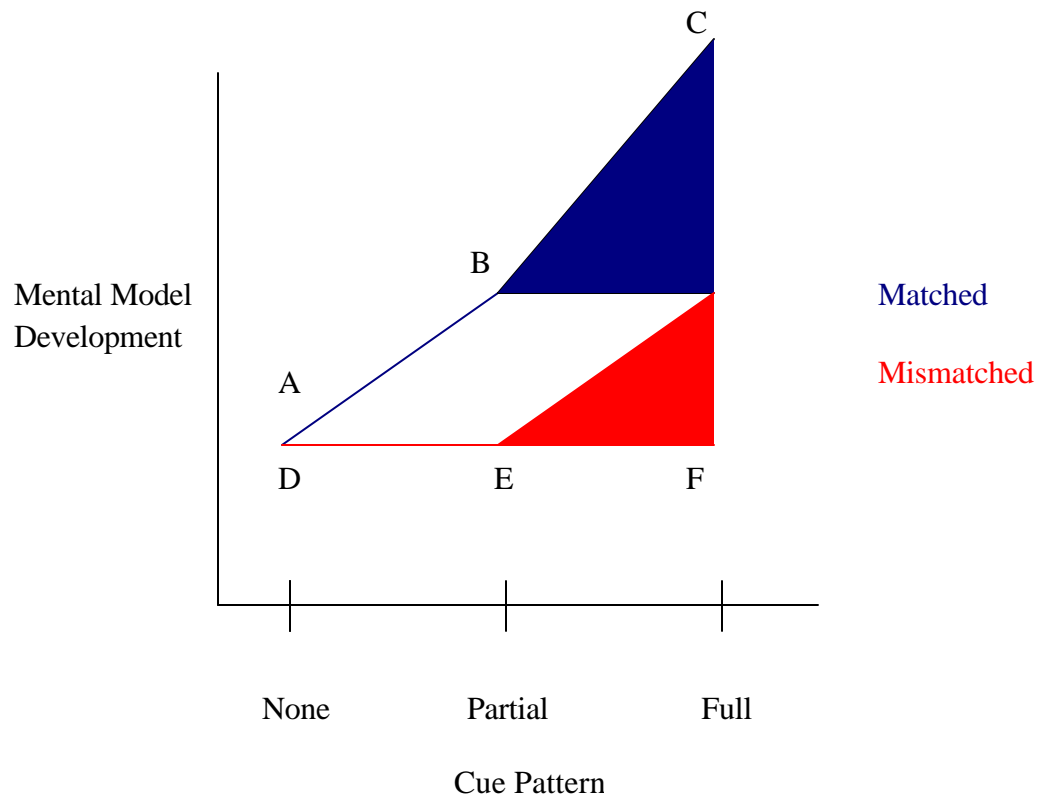
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Figure 1
Hypothesis 1

H1a contrasts: $A < (B + C)/2$

H1b contrasts: $(D + E)/2 = F$

H1c contrast: $B > E$



Industry match is operationalized at two levels within participants. Matched participants are those working in their industry of specialization; mismatched participants are those working outside their industry of specialization.

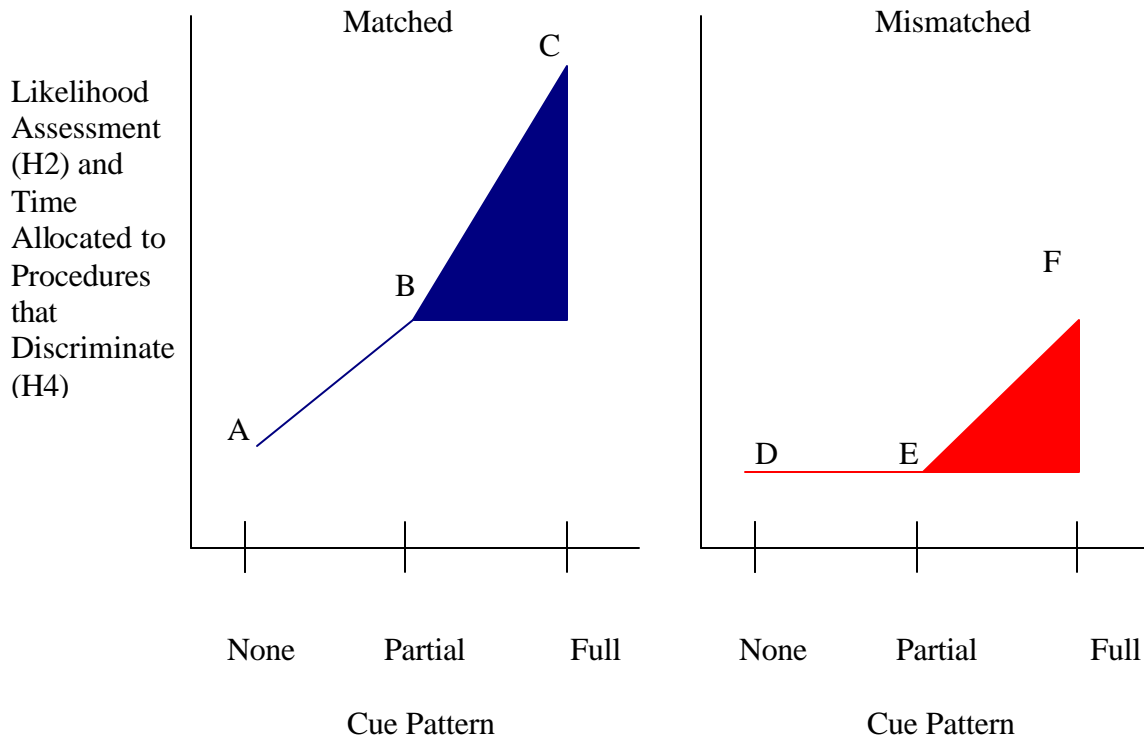
The **cue pattern** condition is operationalized at three levels between participants. Participants in the none condition received no cues from the seeded misstatement pattern. Participants in the partial (full) condition received two (all three) cues from the seeded misstatement pattern.

The **dependent variable** is the sum of four standardized measures of the completeness of the participants' mental models about the seeded misstatement. A higher number indicates better developed mental models.

Figure 2
Hypotheses 2 and 4

H2a and H4a contrasts: $A < (B + C)/2$

H2b and H4b contrasts: $(D + E)/2 = F$

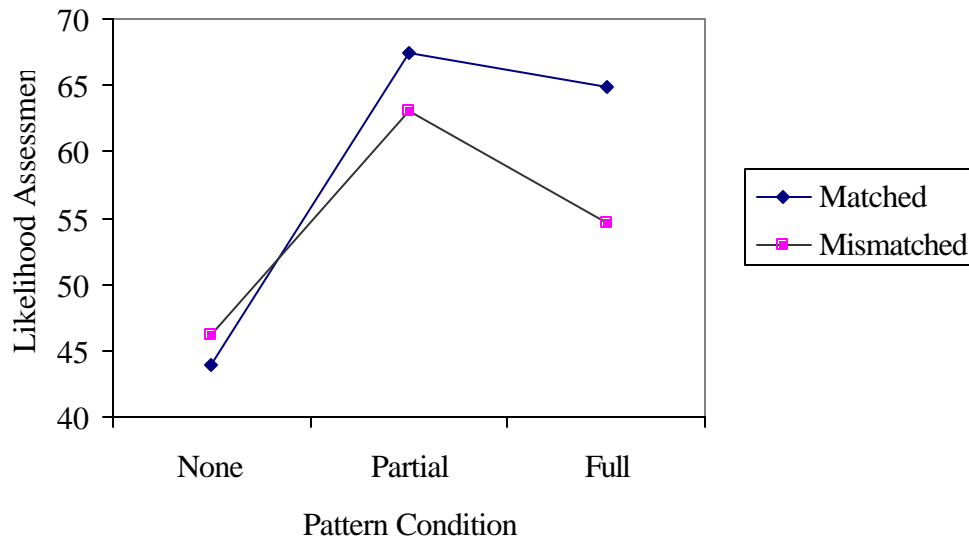


See Figure 1 for explanations of **industry match** and **cue pattern** variables.

The dependent variable for H2 is the likelihood that a material misstatement was contained in the financial statements. Participants rate this likelihood on a 101-point scale anchored by 0 (No chance of material misstatement) and 100 (Certain of material misstatement). I present two graphs as theory does not specify the relative positions of the lines for matched and mismatched participants for this dependent variable.

The dependent variable for H4 is the total time allocated to procedures coded as discriminatory. Participants listed procedures they believed were necessary to determine whether the potential misstatement(s) they had listed existed and time necessary to complete those procedures.

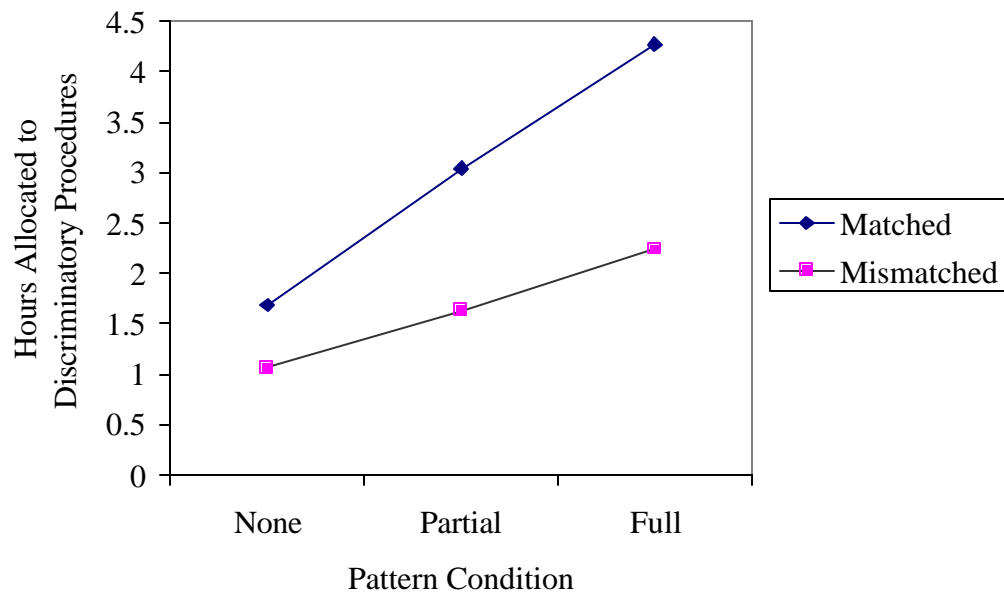
Figure 3
Likelihood Assessment Results



See Figure 1 for explanations of **industry match** and **cue pattern** variables.

The dependent variable is the likelihood that a material misstatement was contained in the financial statements. Participants rate this likelihood on a 101-point scale anchored by 0 (No chance of material misstatement) and 100 (Certain of material misstatement).

Figure 4
Discrimination of Procedures Results



See Figure 1 for explanations of **industry match and cue pattern** variables.

The dependent variable is the total time participants allocated to procedures that can discriminate whether the target misstatement was present.

Table 1
Participant Demographics

	All Participants (n= 65)	Banking Specialists (n= 35)	Government Specialists (n= 30)
Months of audit experience [Mean (Std. Dev.)]	83.82 (69.87)	71.46 (62.40)	98.23 (76.22)
Title:			
Seniors	30	19	11
Managers	14	9	5
Senior Managers	11	2	9
Partners/Principals	10	5	5
Months experience auditing:			
Banks		49.09 (52.75)	4.87 (15.62)
State and local governments		0.57 (2.16)	72.67 (78.94)
Percent of time in past year auditing:			
Banks		63.46% (29.79)	0.03% (0.18)
State and local governments		0.43% (2.54)	56.60% (29.63)

Table 2
Overall Mental Model Measures
 LS Mean (SE) [n] Cell

H1a contrasts: $A < (B + C)/2$

H1b contrasts: $(D + E)/2 = F$

H1c contrast: $B > E$

Panel A: Overall Mental Model Measure			
	Cue Pattern:		
	None	Partial	Full
Matched	-0.51 (0.53) [21] A	0.89 (0.51) [23] B	1.64 (0.53) [21] C
Mismatched	-1.39 (0.45) [21] D	-0.80 (0.43) [23] E	-0.48 (0.45) [21] F

Panel B: Tests of H1		
Planned Contrasts	F_{1, 62}	p > F (1-tailed)
Matched None < (Matched Partial + Full)/2	7.545	0.004
(Mismatched None + Partial)/2 = Mismatched Full	1.293	0.130
Matched Partial > Mismatched Partial	7.856	0.004

Industry match is operationalized at two levels within participants. Matched participants are those working in their industry of specialization; mismatched participants are those working outside their industry of specialization.

The **cue pattern** condition is operationalized at three levels between participants. Participants in the none condition received no cues from the seeded misstatement pattern. Participants in the partial (full) condition received two (all three) cues from the seeded misstatement pattern.

The **dependent variable** is computed by standardizing the four mental model measures (Recall content, Recall character, Explanation content, and Explanation direction) using Z-scores and summing to compute **overall mental model measures**.

Table 3
H2: Likelihood Assessments
 LS Mean (SE) [n] Cell

H2a contrasts: $A < (B + C)/2$

H2b contrasts: $(D + E)/2 = F$

Panel A: Likelihood Assessments			
	Cue Pattern:		
	None	Partial	Full
Matched	43.90 (7.05) [21] A	67.44 (6.74) [23] B	64.81 (7.05) [21] C
Mismatched	46.14 (6.23) [21] D	63.00 (5.95) [23] E	54.67 (6.23) [21] F

Panel B: Tests of H2		
Planned Contrasts	F_{1, 62}	p>F (1-tailed)
Matched None < (Matched Partial + Full)/2	6.720	0.006
(Mismatched None + Partial)/2 = Mismatched Full	0.000	0.495

See Table 2 for explanations of **industry match** and **cue pattern** variables.

The dependent variable is the likelihood that a material misstatement was contained in the financial statements. Participants rate this likelihood on a 101-point scale anchored by 0 (No chance of material misstatement) and 100 (Certain of material misstatement).

Table 4
Matched Participants' Mediation Analysis

Panel A: Effect of Cue Pattern on MatchLA				
Source	Sum of squares	df	F	p>F
Cue Pattern	7,130.28	2	3.417	0.039
Error	64,696.70	62		

Panel B: Effect of Cue Pattern on MatchMM				
Source	Sum of squares	df	F	p>F
Cue Pattern	50.10	2	4.226	0.019
Error	367.45	62		

Panel C: Effect of Cue Pattern and MatchMM on MatchLA				
Source	Sum of squares	df	F	p>F
Cue Pattern	3,264.97	2	1.666	0.198
MatchMM	5,520.90	1	5.634	0.021
Cue Pattern *				
MatchMM	1,517.32	2	0.774	0.466
Error	57,817.11	59		

Variable Definitions:

See Table 2 for explanation of the **Cue Pattern** variable.

MatchLA = matched specialists' likelihood assessments

MatchMM = matched specialists' overall mental model measures

Table 5
Procedure Discrimination
Adjusted LS Mean (SE) [n] Cell

H4a contrasts: $A < (B + C)/2$

H4b contrasts: $(D + E)/2 = F$

Panel A: Time Allocated to Discriminatory Procedures			
	Cue Pattern:		
	None	Partial	Full
Matched	1.69 (0.88) [21] A	3.04 (0.84) [23] B	4.28 (0.87) [21] C
Mismatched	1.06 (0.77) [21] D	1.63 (0.74) [23] E	2.24 (0.77) [21] F

Panel B: Tests of H4		
Planned Contrasts	F_{1, 57}	p>F (1-tailed)
Matched None < (Matched Partial + Full)/2	3.389	0.036
(Mismatched None + Partial)/2 = Mismatched Full	0.916	0.171

Panel C: Time Allocated to Non-discriminatory Procedures			
	Cue Pattern:		
	None	Partial	Full
Matched	8.77 (0.88) [21] A	7.42 (0.84) [23] B	6.19 (0.87) [21] C
Mismatched	9.43 (0.77) [21] D	8.86 (0.74) [23] E	8.25 (0.77) [21] F

Panel D: Test of H5		
Planned Contrasts	F_{1,57}	p>F (1-tailed)
Mismatched > Matched	3.093	0.042

See Table 2 for explanations of **industry match** and **cue pattern** variables.

The **dependent variable for H4a and H4b** is the total time, in hours, participants allocated to procedures that can discriminate whether the target misstatement was present. The **dependent variable for H5** is the total time, in hours, participants allocated to procedures that would not discriminate whether the target misstatement was present.

ENDNOTES

¹ A pattern is composed of multiple pieces of information that must be combined, like the individual pieces of a mosaic, for the misstatement to emerge. When a pattern exists, no single piece of information is informative enough, on its own, to identify the misstatement. Rather, all of the cues forming the pattern must be perceived and appropriately processed for the misstatement to be conclusively identified.

² The review process will result in some formalized information sharing; however, evidence from court documents suggests that the review process does not always result in complete information sharing (cf., Erickson, Mayhew, and Felix 1996).

³ Mental models are cognitive representations of complex phenomena that can be used to “run” thought experiments that allow inferences to be made (Greeno 1989).

⁴ I do not make a similar mediation prediction for mismatched specialists as I do not expect there will be sufficient variation in mismatched specialists’ mental model development or likelihood assessments to allow detection of such a relationship.

⁵ I exclude nine participants because they reported either significant experience in both industries ($n = 2$) or no significant experience in either industry ($n = 7$).

⁶ I also manipulate the order of the cases; half of the subjects receive the banking case first and half receive the government case first. Except as noted there are no predicted or observed order effects, so I combine all subsequent analysis across order conditions.

⁷ A mediation analysis requires a relationship to mediate. Generally, the following analysis is required: First, the dependent variable of interest (e.g., likelihood assessment) is shown to be related to the independent variable (e.g., pattern completeness). Second, the expected mediator variable (e.g., standardized mental model measure) is shown to be related to the independent variable. Third, the mediator variables are shown to be correlated with the dependent variable. Finally, the mediator and original independent variables are run against the dependent variable. If the mediator variable mediates the relationship between the dependent variable and the original independent variable, the significance of the original independent variable will be reduced over the first ANOVA and the mediator variable will be significant in this analysis.

⁸ For completeness, an ANOVA shows that the mental model measure is not affected by pattern completeness ($F_{2, 62} = 1.077, p = 0.347$). Finally, an ANOVA with mismatched likelihood assessment as the dependent variable and pattern completeness and the mental model measure as independent variables shows that the relationship between the mismatched likelihood assessment and pattern completeness is not mediated by the mental model measure; pattern completeness is not significant in this ANOVA ($F_{2, 59} = 1.395, p = 0.256$) and the mental model measure also is not significant ($F_{1, 59} = 0.166, p = 0.686$).