The impact of decision aid use on the dilution effect when assessing fraud

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ABSTRACT

This study provides evidence that in a fraud risk assessment task, decision aid use increases auditor susceptibility to dilution, an information processing bias where non-predictive cues "water down" or dilute the predictive value of diagnostic cues. The results of a between-subjects experiment, in which senior auditors assessed fraud risk, indicate that in response to irrelevant information, decision-aided auditors lowered their fraud assessments more than did their unaided counterparts. Even in a high fraud risk context, where auditors should be particularly thoughtful as they review data in preparation for assessing fraud risk, the decision aid still impaired judgment.

Keywords: decision aid, dilution, fraud risk assessment

INTRODUCTION

This study provides evidence on how decision aids affect audit judgment in fraud risk assessment.[1] Specifically, the research examines whether decision aid use exacerbates auditors' susceptibility to dilution, an information processing bias where non-predictive cues "water down" or dilute the predictive value of diagnostic cues. Such a bias has the potential to compromise the audit process. Prior research provides evidence that senior auditors making unaided judgments lower their estimation of fraud risk when exposed to irrelevant information (Hackenbrack 1992; Hoffman and Patton 1997).

Audit firms are concerned with factors that affect fraud risk assessment and detection. High-profile cases involving companies such as Enron, Cendant and Sunbeam provide evidence that auditors indeed have experienced unprecedented financial and reputation losses when unqualified opinions were issued on financial statements later discovered to be fraudulent (Hirsch 2002). Regulators, prosecutors and standard setters responded to the magnitude of the discovered frauds. Laws have been enacted and standards revised.

While there are potential costs to any mis-estimation, the potential consequences for underestimating fraud risk are particularly high since this could ultimately contribute to audit firms issuing unqualified opinions on fraudulent financial statements. This, in turn, could expose auditors to greater legal liability and potentially significant financial consequences. As such, accounting research that provides insights into auditor judgment in fraud risk assessment could be beneficial to auditors seeking to improve processes to maintain their audit firm's viability.

The accounting literature provides evidence that, contrary to normative expectations, the addition of irrelevant information lowers the assessment of fraud risk (Hackenbrack 1992; Hoffman and Patton 1997). This finding, termed the dilution bias, is believed to result from auditors adopting a strategy in which the probability of fraud is determined by the degree of similarity between a firm and the auditor's prototype of a typical fraudulent firm. In this strategy, encountered characteristics (e.g., client reducing the number of company holidays) are compared to the auditor's mental prototype of firms with fraudulent reporting. Cues similar to the fraud prototype increase the perceived likelihood of fraud, and cues not similar to the prototype reduce the perceived likelihood of fraud. The relevance of dissimilar cues is ignored, suggesting that irrelevant information dissimilar to the prototype is erroneously incorporated into judgments, which leads the auditor to reduce the estimation of the likelihood of fraud.

A potential mechanism to reduce dilution is the decision aid (Hackenbrack 1992; Hoffman and Patton 1997). Typically, a fraud risk decision aid consists of an extensive list of fraud-related factors similar to those presented in *SAS 99* (AICPA 2002). While such aids are intended to improve auditor fraud decisions by ensuring no relevant factor is overlooked, they may have unintended consequences. The aid provides features of the prototypical fraud firm and, therefore, may encourage auditors susceptible to the dilution bias to think along the lines of the similarity-based inference process described earlier. As a result, decision aid use may exacerbate dilution and harm, rather than improve, auditor fraud judgments.

These predictions are investigated in an experiment where 140 supervising senior auditors made a fraud risk judgment after reviewing a case describing a hypothetical client (a publisher of college textbooks). The participants were assigned to one of eight experimental

[1] In this paper, the term fraud refers to an intentional material misstatement of the financial statements.

conditions created by crossing two levels of evidence type (relevant, mixed), two levels of decision aid (decision aid, no decision aid) and two levels of fraud environment (high, low).[2]

The results of this study indicate that auditors using a decision aid exhibited more dilution than their counterparts making unaided judgments. Even in a high fraud risk context, when auditors should be particularly thoughtful as they review data in preparation for assessing fraud risk, the decision aid still impaired judgment.

The implications to audit practice are significant. Firms unwittingly may be exposing themselves to greater levels of legal liability as a result of using a decision aid that encourages a bias which results in systematic underestimation of fraud risk. To compensate for this potential compromise to audit effectiveness, audit firms may want to explore alternatives to the current process.

BACKGROUND AND RELATED RESEARCH

Dilution is a cognitive processing bias in which non-predictive cues are incorporated into judgments and, as a result, "water down" or dilute the predictive value of diagnostic cues. Normatively, only information possessing predictive value with respect to a hypothesis should be incorporated into the decision-making process. Yet, psychology studies report that the introduction of non-diagnostic or irrelevant information often results in judgments that systematically differ from those based solely on predictive information (Nisbett et al. 1981; Zukier 1982; Edgell et al. 1996).

Accounting research provides evidence that auditors are influenced by irrelevant information even when making judgments for which they have been professionally trained (Hackenbrack 1992; Glover 1997; Hoffman and Patton 1997; Shelton 1999). Hackenbrack (1992) provided the initial evidence that information devoid of predictive value influences audit judgments. Subsequent studies have investigated factors that may either exacerbate of mitigate dilution in audit judgment. For example, Glover (1997) found that time pressure mitigated, but did not eliminate, the diluting power of non-diagnostic information. Hoffman and Patton (1997) and Glover (1997) suggested that the accountability inherent in hierarchical audit settings may increase dilution, but found no relation between the two. Later, Favere-Marchesi and Pincus (2006) found that accountability has an impact on both the frequency and magnitude of the dilution effect. Shelton (1999) investigated whether experience reduces dilution by comparing the judgments of seniors to those of managers and partners. She found that senior judgments were diluted by irrelevant information, but that partners and experienced managers did not exhibit dilution.

Taken as a whole, these accounting studies suggest that the accounting profession is not immune to dilution and that only high levels of experience eliminate dilution. Given that auditors at levels lower than manager and partner (e.g., senior) participate in making fraud judgments (Abdolmohammadi 1999), this research suggests that audit firms need to look for alternative dilution-reducing mechanisms.[3] One attribute of the audit environment posited as such a mechanism is the decision aid (Hackenbrack 1992; Hoffman and Patton 1997).

While each of the accounting studies on dilution previously mentioned had auditors generate unaided judgments, audit firms routinely use decision aids to improve judgment

[2] The mixed evidence condition includes relevant and irrelevant cues.

[3] Partners at several Big 4 firms indicated that it is within the scope of supervising seniors' duties to prepare the fraud risk questionnaire and provide an initial conclusion about fraud risk.

consistency and ultimately efficiency and effectiveness, especially at lower levels of the hierarchy, which is where dilution appears to be the biggest problem (Hansen and Messier 1986; Ashton and Willingham 1989; Brown and Murphy 1990; Graham, et al. 1991; Messier 1995; Shelton et al. 2001). In a fraud risk assessment task, audit firms use decision aids to direct auditor attention to risk factors such as those enumerated in *Statement on Auditing Standards No. 99: Consideration of Fraud in a Financial Statement Audit* (AICPA 2002) (Shelton et al. 2001).[4]

While fraud decision aids are intended to improve auditor judgment, past research suggests that this may not be the case. Pincus (1989) documents deterioration in judgment when there is reliance on a decision aid in a fraud assessment task. She provided subjects a decision aid which directed auditor attention to potential indicators of fraud. She found that for a no-fraud case, use of the questionnaire had no significant impact on fraud risk assessment. However, for a fraud case, questionnaire use had a dysfunctional effect on auditor judgment: auditors using the questionnaire had lower fraud risk assessments than non-users.

It is not clear from the findings why the questionnaire impaired judgment. Pincus conjectured that the decision aided auditors may not have considered as many relevant cues as auditors making unaided judgments. She also posited that unaided auditors may have focused more on negative cues, while their decision-aided counterparts focused on a more balanced set of positive, neutral and negative indicators. This study proposes that the negative effects of decision aids with respect to fraud judgments are due, at least in part, to decision aids exacerbating the effects of dilution.

THEORY AND HYPOTHESES

In the course of an audit, auditors routinely evaluate and classify information they encounter. For example, an auditor involved in fraud risk assessment must determine whether client-related conditions and events indicate the potential for fraud. Hoffman and Patton (1997) note that auditors commonly use a single source to gather information relating to several audit tasks. As multiple issues are considered simultaneously, evidence diagnostic to another judgment but irrelevant to fraud risk assessment may unintentionally be incorporated into the fraud risk judgment. Should this result in an underassessment of fraud risk, audit firms face potentially serious consequences (Pincus 1989).

Ideally an auditor classifies information by relevant and irrelevant cues and uses the cues in a Bayesian approach to update beliefs about the existence of fraud.[5] Relevant cues have predictive value in assessing whether a client is fraudulent. These cues can be divided into two groups: those more likely to be observed in the presence of fraud and those more likely to be observed in the absence of fraud. An example of a relevant cue more likely to be observed in the presence of fraud is the existence of a weak board of directors. In contrast, a relevant cue more likely to be observed in the absence of fraud is the existence of effective management oversight by a strong board of directors.

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4 SAS 82 (AICPA 1997), the predecessor to SAS 99, also required documentation of fraud risk. This auditing standard specifies that auditors are to document their assessment of fraud risk during the planning phase of the audit and to update the initial assessment as necessary throughout the course of the engagement.

5 A fraud risk assessment task was selected for this study because professional standards provide a basis for defining relevant information for fraud assessment. *Statement on Auditing Standards No. 99: Consideration of Fraud in a Financial Statement Audit* (AICPA 2002) discusses relevant fraud risk factors that might signal the existence of an intentional material misstatement (i.e., fraud).

Irrelevant characteristics neither increase nor reduce the likelihood of fraud. As such, these characteristics should have no effect on fraud risk assessment. The gender of the client's chief financial officer, for example, is a factor that should be unrelated to the probability of fraud.

The psychology literature suggests that people do not use the relevant vs. irrelevant approach just described to make likelihood judgments. According to Kahneman and Tversky (1972), people do not form likelihood judgments using a Bayesian approach, but rather judge the probability of an event by the degree of similarity between the object under consideration and the parent population.

In the context of an audit, auditors develop a mental model of a prototypical fraud firm based on a variety of sources including past experience, firm training, audit manuals, and professional auditing literature. In fraud risk assessment, auditors compare features of the client firm with features of this mental model. As the number of features common to both the client firm and the fraud prototype increases, so does the perceived similarity. Features of the client firm that do not match the prototype are classified as dissimilar. The judgment of fraud is positively related to the features that match (similar characteristics) and negatively related to features that do not match (dissimilar characteristics).

If similar characteristics map perfectly with relevant characteristics predictive of fraud and dissimilar characteristics map perfectly with relevant characteristics that are predictive of no-fraud, the similar vs. dissimilar approach just described is consistent with the normative approach. However, there is not perfect mapping between these groups because of the existence of irrelevant characteristics, cues lacking predictive value. Prior research suggests that when using similarity-based inference, decision makers incorporate all available evidence, whether it is relevant or not (Alba and Hutchinson 1987). Consequently, in the similarity model just described, the probability of fraud is determined solely on the basis of similarity or dissimilarity of features, and there is no distinguishing based on the relevance or irrelevance of dissimilar characteristics.

Consistent with prior literature (Hackenback 1982; Glover 1997), this paper asserts that similar features have predictive value, and therefore, are relevant. As Figure 1 (Appendix) illustrates, dissimilar characteristics can be divided into two subsets: 2(a) characteristics that are *relevant* but are more likely to be observed under the absence of fraud and 2(b) characteristics that are *irrelevant* to assessing whether a client is fraudulent yet are inconsistent with the model of a fraudulent client.

The framework previously described allows an auditor to classify a condition or event in one of three categories. Category 1(a), similar/relevant and more likely to be observed under the presence of fraud, contains characteristics diagnostic of the presence of fraud (e.g., unusually high dependence on debt). Category 1(b)/2(a), dissimilar/relevant and more likely to be observed under the absence of fraud, contains characteristics that are diagnostic of the absence of fraud (e.g., strong internal controls). Category 2(b), dissimilar/irrelevant to fraud, contains characteristics that in reality are not associated with the presence or absence of fraud (e.g., which days the client offers as paid holidays), but don't match the features of fraud in the auditor's prototype.

The psychology literature suggests that dilution is caused when a decision maker adopts a dichotomous classification strategy that only distinguishes between similar characteristics—those falling *within* Category 1(a)—and dissimilar characteristics—those falling *outsid*e of Category 1(a) (Kahneman and Tversky 1972, 1973; Tversky 1977; Nisbett et al. 1981). An

auditor using this strategy neglects to distinguish between Category 2(b) and Category 1(b)/2(a), dissimilar characteristics that are predictive of no-fraud and irrelevant dissimilar characteristics. When irrelevant evidence is compared to the auditor's mental model of prototypical fraud firms and dissimilarity is observed, the auditor could mistakenly treat the irrelevant dissimilar characteristic falling in Category 2(b) as possessing predictive value, Category 2(a). Because Category 2(a) represents relevant characteristics inconsistent with fraud, it follows that such a misclassification would cause the auditor to underestimate the probability of fraud.

Auditors receive extensive professional training to develop their judgment in evaluating evidence relevant to an audit. Therefore, it is likely that their decision making is influenced, to some degree, by the skills developed on the job. Consequently, audit decision making may involve some combination of the non-normative "feature matching" approach and the normative "paying attention only to relevant items" approach. The feature matching process, a relatively straightforward cookbook approach, may be more heavily utilized by novices because of their interest in following the rules. Experts with more developed knowledge structures have a better understanding of encountered situations and may be more inclined to incorporate a more complex, richer approach, focusing more heavily on relevant cues and discounting irrelevant cues (Shelton 1999). Though all auditors, to some degree, probably use both strategies, the relative importance of each approach may be a function of experience. Shelton's research suggests that more experienced auditors—managers and partners—minimize the feature-matching, similarity-based approach and rely more heavily on the relevant-irrelevant, normative approach. Less experienced auditors—audit seniors—on the other hand, are more inclined to rely on feature-matching.

Prior research (Abdolmohammadi 1999) and discussions with partners at several Big 4 accounting firms reveal that in practice it is common for supervising seniors to initially document fraud risk—subject to manager and partner review. Audit firms typically provide a decision aid to assist the auditor in assessing fraud risk. The decision aid is intended to guide the auditor through a series of fraud risk factors. Though designed to enhance performance by directing the auditor's attention to relevant information about a specific condition—1(a)/1(b) in Figure 1—use of a decision aid may actually contribute to a decline in performance for an auditor with moderate experience (e.g., an audit senior).

To such an auditor who uses a decision aid consisting of an extensive list of fraud-related factors similar to those presented in *SAS 99*, the red flags list essentially constitutes a list of features of the fraud prototype. Introducing the decision aid, therefore, may encourage auditors to rely more heavily on the feature-matching strategy previously described. Consequently, the auditor may classify as dissimilar any evidence not matching the red flags in the decision aid, and ignore whether this evidence is relevant or irrelevant. Thus, dissimilar irrelevant cues may be incorporated into judgment, resulting in a lower assessment of fraud.

Without the decision aid's promptings towards feature-matching, an unaided auditor with moderate experience may be less inclined to rely as heavily on the similar vs. dissimilar approach. As such, the unaided auditor is likely to exhibit less dilution than the auditor using a decision aid.

Based on this discussion, the prediction is made that, consistent with prior research, senior auditors making unaided judgments in a fraud risk assessment task will exhibit dilution.

H1: In a fraud risk assessment task, senior auditors making unaided judgments will exhibit dilution.

Further, it is predicted that in a fraud risk assessment task, the likelihood of a senior auditor's conclusion being influenced by irrelevant evidence increases when a red flags decision aid is used.

H2: In a fraud risk assessment task, senior auditors using a red flags decision aid will exhibit more dilution than senior auditors making unaided judgments.

Pincus (1989) found that fraud risk environment affected the fraud risk assessments of senior auditors using a decision aid. In a high fraud risk environment, decision-aided auditors' estimation of fraud was significantly lower than the estimation of fraud made by their unaided counterparts. In a high fraud setting, the focus on features and reliance on the red flags decision aid is likely to be quite strong. Auditors with moderate experience, therefore, would be very careful to make sure that all key features are thoroughly examined. Should use of the red flags decision aid exacerbate dilution because it causes the user to rely more heavily on the feature-matching strategy, then increased reliance on such an aid will lead to a larger negative effect. Therefore, it is predicted that for decision-aided auditors, a high fraud setting will have a greater level of dilution than a low fraud setting.

H3: In a high fraud risk environment, senior auditors using a red flags decision aid will exhibit more dilution than senior auditors using a red flags decision aid in a low fraud risk environment.

METHOD

Participants

The study was conducted with 140 audit seniors who agreed to participate in response to an invitation extended by their firm. The auditors were from four Big 4 firms and had an average of 38 months of experience, ranging from 22-84 months in public accounting.

Design

Manipulated Variables

The experiment employed a 2 x 2 x 2 between-subjects design in which evidence type (relevant, mixed), decision aid (decision aid, no decision aid) and fraud environment (high, low) were manipulated. The first manipulation was needed to measure dilution. The amount of irrelevant evidence presented to the auditor was varied. Auditors were assigned to one of two conditions, "relevant" or "mixed." In the "relevant" condition, the client-specific information included in the case had predictive value for fraud risk assessment. In the "mixed" condition, information considered to be irrelevant to fraud risk assessment appeared throughout the case. In this condition, the irrelevant cues were interspersed with diagnostic evidence throughout the case. A pre-testing process discussed in detail later in the paper determined the irrelevant cues. For a list of the irrelevant cues, see Table 1 (all tables are in the Appendix).

Dilution is measured as the difference between the average response to the fraud risk assessment in the "relevant" treatment and the corresponding average response in the "mixed"

treatment for each of the four conditions that result from crossing decision aid (decision aid, no decision aid) and fraud environment (high, low).

For the second manipulation, participants in the decision aid condition were asked to complete the decision aid which required them to check-off whether specified fraud risk factors were present or absent (see Table 2). The auditors in the no decision aid condition were not provided a decision aid. All auditors were asked to make an overall quantitative assessment of the likelihood that the financial statements were materially misstated due to fraud.

The third manipulation involved varying the types of signals provided in the case. In the high fraud condition, the case states that a significant portion of management's compensation package relates to fairly aggressive sales goals. Also in this condition, each of the four corporate executives serving on the seven-member Board of Directors is a member of the CEO/president/chairman of the board's family. In the low-fraud condition, the case states that top management is salaried and that no portion of management compensation relates to sales goals. In this condition, the CEO/president/chairman of the board serves on the seven-member Board of Directors along with six outside directors.

Dependent Variable

Fraud risk assessment is the dependent variable. On a 10-point Likert scale ranging from 0 (much lower than normal) to 9 (much higher than normal), participants indicated their responses to the question, "What is the likelihood that Wordsworth Press, Inc.'s financial statements are materially misstated due to *fraud*?" They were told to define "normal" as the typical privately-held client of a size similar to Wordsworth.

Instrument Development

Cue Selection

In order to confirm that selected cues presented in the case were, in fact, irrelevant to fraud risk assessment, four partners and five managers were asked to rate the impact that 16 items would have on their fraud risk judgments, using an 11-point Likert scale anchored at –5 (lower fraud risk) and +5 (increase fraud risk), with 0 indicating no impact on fraud risk.[6] The list evaluated by the auditors included potentially irrelevant cues along with relevant conditions identified in audit standards, firm practice guidelines and prior research (AICPA 1997; Heiman-Hoffman et al. 1996). Table 1 presents the results. Six items received a mean rating of zero (rounded) for the fraud risk assessment task. Since they had little or no value for predicting fraud, they were selected as the irrelevant items included in this study. On average, each irrelevant cue appearing in the case was given a zero rating by 80% of the partners and managers, with a mean rating of –0.03.

[6] Several of the irrelevant cues were included in Hoffman and Patton's (1997) dilution study.

Task and Procedure

The case materials began with an introductory letter, followed by general instructions. The instructions told the auditor to assume the role of a supervising senior in the planning phase of the audit. Instructions varied across treatments in only one respect. Participants in the decision aid condition were told, "Section 1 provides a fraud risk practice aid which you should complete as you consider the company background, financial information and work paper excerpt that follow." The instructions for participants in the no decision aid condition stated, "Section 1 provides company background, financial information and a work paper excerpt."

Essentially, the experimental materials consisted of two sections. In the decision aid condition, the decision aid was presented at the beginning of Section 1 so that the auditor could utilize it in evaluating the subsequent evidence. The decision aid presented a subset of red flags excerpted from *SAS 99* (AICPA 2002).[7]

Section 1 continued or, in the case of no decision aid, began with a case describing Wordsworth, Inc., a small manufacturing company that publishes college textbooks. Based primarily on a case presented in an auditing textbook (Konrath 1999), the narrative provided to participants briefly described the company's background, management, and operations.[8] At the end of this section, all participants were asked to indicate, on a 10-point scale (discussed earlier), the risk of fraud for the hypothetical client described in the case. Then they were asked to place all materials already viewed and responded to in an envelope provided, labeled "Completed."

Section 2 included a manipulation check, to verify that the auditors viewed the irrelevant cues as irrelevant. This section also gathered demographic data and included debriefing questions relating to the experimental task and the auditor's fraud background. Once Section 2 was completed, the participants were to place Section 2 materials in the "Completed" envelope. This concluded their participation in the study.

While no time limit was explicitly imposed for the activity, auditor responses indicated that the task averaged 26 minutes for each participant using a decision aid and 23 minutes for each participant making unassisted judgments. The difference was significant (t = -3.430; p = .001, one-tailed).

RESULTS

Manipulation Checks

To determine if the fraud environment and evidence type experimental manipulations were successful, several measures were analyzed. The effectiveness of the fraud environment manipulation was confirmed by comparing the fraud assessment mean for the low fraud environment conditions (5.36) to the fraud assessment mean for the high fraud environment conditions (6.55). The difference was significant (t = -5.422; p = .000, one-tailed). Overall, participants across conditions assessed fraud risk lower in the low fraud environment than in the high fraud environment.

To confirm that irrelevant cues were, in fact, deemed to be irrelevant by participants, each auditor was asked to evaluate the effect on fraud risk assessment of a mixture of relevant

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[7] To simulate a realistic audit, not all red flags included on the decision aids were relevant to the audit client.

[8] Some features of the case materials also were adapted from Hoffman and Patton (1997), Shelton (1999), Hackenbrack (1992), and Glover (1997).

and irrelevant cues.[9] Tables 3 and 4 summarize results for the responses of interest—those involving irrelevant cues.

Table 3 presents the average auditor rating of the impact that the six "irrelevant" cues embedded in the "mixed" conditions would have on their fraud risk judgments. As a whole, the irrelevant cue ratings rounded to 0, consistent with the ratings in the pretest. The cue, "in an attempt to improve the efficiency of company operations, the client engaged a consulting firm," rounded to -1 in some conditions. However, this should not affect the predicted *difference in dilution* between decision-aided auditors and unaided auditors since the cue was included in all "mixed" conditions.

Table 4 displays correlations between the auditor ratings of irrelevant cues and the dependent variable—fraud risk assessment. This analysis was conducted only for mixed conditions since the irrelevant cues were omitted from the relevant conditions. Overall, there was no correlation between the cues and fraud risk assessment—for both the low fraud and the high fraud conditions.

Hypotheses Tests

Table 5 presents descriptive statistics on the participants' fraud risk assessments as well as the resulting level of dilution.

Hypothesis 1 predicts that dilution would occur in the unaided conditions. The results, however, don't support this prediction. Table 6, Panel A, presents the results of a planned comparison between the mean fraud risk assessment in the unaided relevant conditions and the mean fraud risk assessment in the unaided mixed conditions. Based on the data, introducing irrelevant cues did not affect the fraud risk assessment of auditors who did not use decision aids (t = -0.451; p = .326, one-tailed).

Hypothesis 2 predicts that using a decision aid would increase dilution. Table 6, Panel B, presents the results of a planned comparison between the mean level of dilution in the decision aid conditions and the mean level of dilution in the no decision aid conditions. As expected, the mean level of dilution exhibited by auditors using a decision aid (0.63) was significantly more than the mean level of dilution of auditors making unassisted fraud risk assessments (-0.15) (t = 1.767; p = .040, one-tailed). Irrelevant information *decreased* fraud risk assessments of auditors using decision aids and had virtually no effect on the fraud risk assessments of auditors making unassisted fraud risk assessments. Panel C of Table 5 indicates that in the low fraud environment taken alone, a statistical difference was not observed between the level of dilution exhibited by decision-aided auditors (0.76) and their counterparts who used no decision aid (0.24) (t = 0.736; p = .233, one-tailed). However, Panel D of Table 5 demonstrates that in the high fraud environment, a significant difference was observed in the dilution level of decision-aided auditors (0.50) compared to unaided auditors (-0.53) (t = 1.954; p = .028, one-tailed).

Hypothesis 3 predicts that decision-aided auditors would display more dilution in a high fraud risk environment than in a low fraud risk environment. Table 6, Panel E, presents the results of a planned comparison between the mean dilution level for the low fraud risk decision-aided auditors (0.76) and the mean dilution level for the high fraud risk decision-aided auditors (0.50). No significant relation was observed (t = 0.428; p = .336, one-tailed).

[9] These cues appear in the "mixed" evidence conditions. A mixture of relevant and irrelevant cues was used to reduce the likelihood of having a transparent manipulation.

Additional testing was conducted to ascertain if the increase in dilution associated with decision aid use was statistically different across risk conditions. Table 5, Panel F presents the results. No difference was found (t = 0.595; p = .277, one-tailed).

DISCUSSION, IMPLICATIONS, FUTURE RESEARCH

Prior accounting research documents that auditor judgment is subject to dilution, a bias where irrelevant information waters down the predictive value of diagnostic cues (Hackenbrack 1992; Glover 1997; Hoffman and Patton 1997; Shelton 1999). The current study extends the extant literature, addressing the unanswered question: Do decision aids reduce dilution?

The results indicate that instead of reducing dilution as proposed in prior research (Hackenbrack 1992; Hoffman and Patton 1997), decision aid use actually exacerbates the bias. Audit seniors using a decision aid lowered their fraud risk assessments when exposed to irrelevant information.

Given the widespread use of decision aids in assessing fraud, audit firms may want to explore avenues to refine the fraud risk documentation process to reduce the likelihood of irrelevant information lowering the assessed level of fraud risk. While it is common for senior auditors to provide an initial assessment of fraud, which is reviewed by managers and partners, their decision-aided assessments are influenced by non-predictive information. Therefore, to improve effectiveness, firms may want to consider segregating the data gathering and initial fraud risk assessment tasks. It may be advantageous to have the senior auditor complete the fraud risk checklist and submit it to a manager whose judgment is less likely, based on additional experience, to exhibit dilution (Shelton 1999). Another viable alternative is to have the decision aid mechanically compute the output (initial fraud risk assessment) based on the input (red flags ratings) provided by the senior auditor.

In addition, audit firms may want to evaluate the extent of the benefits derived from use of a fraud risk decision aid. The findings of this study suggest that while decision aid use in the fraud risk assessment task may provide evidentiary and documentary support, there are notable limitations in the tool's ability to influence auditor fraud risk assessment.

This study experimentally examined a question that could not be answered with archival data. However, as with any study conducted in a laboratory setting, there are limitations relating to realism. First, it is possible that the simplified experimental task used in this study may have omitted audit environmental factors that may interact with the variables of interest. To this extent, the results should be interpreted with caution.

Second, the amount of information participants received was controlled in order to limit the time of the experimental task to about 30 minutes. In an actual audit setting, the data available would have been significantly greater and the task probably would have taken a number of hours over a period of several days. It cannot be known with certainty whether and to what extent the information and time limitation affected the findings.

A third limitation of the study is that in the experimental task, auditors were provided a decision aid that was not firm specific. Though there was a great deal of similarity between the decision aid used in this study and that used by the firm, the possibility exists that a minor difference could have altered the users' cognitive processing.

Finally, this study examined only one audit task—fraud risk assessment. Therefore, caution should be exercised in extrapolating the observed decision-aid induced dilution to other settings.

The findings of this study provide a unique opportunity for academics to undertake research that could benefit the audit profession. Future research could explore whether decision aids could be designed in a way that would minimize or counteract the dilution bias.

Recall that time pressure diminished, but did not eliminate, dilution (Glover 1997). Given the increased dilution of decision aid users documented by the current study, it may be informative for future research to examine what happens to dilution if auditors using decision aids also are under time pressure.

Finally, since this study concentrated solely on a fraud risk assessment task, follow-up studies are warranted to determine whether the observed dilution induced by decision aids extrapolates to other settings.

APPENDIX

Figure 1
Auditor Classification Sets

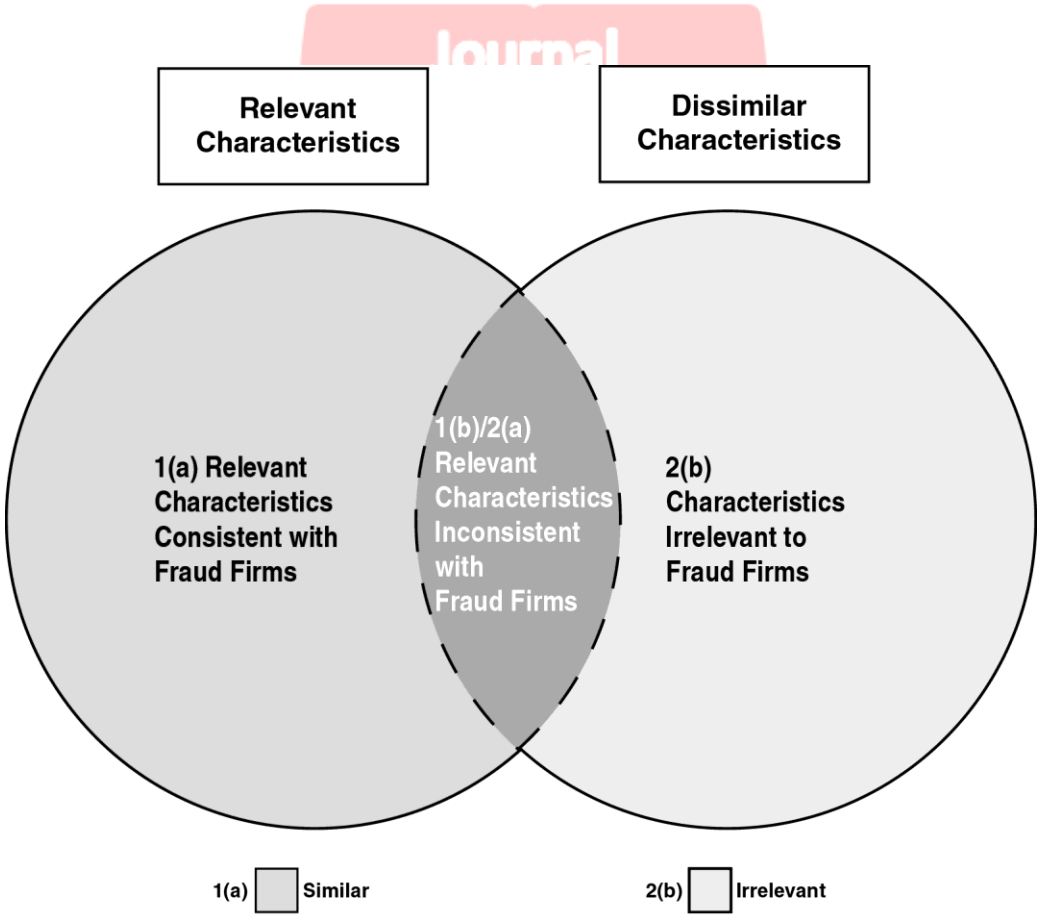

Table 1
Auditor Pretest Rating of Cue Relevance

	Auditor Rating[a]	Standard Deviation
Irrelevant Cues		
The client instituted a job rotation program at the lower management level.	-2.0	1.2
The client has devoted resources to developing methods of recycling by-products of its production process.	0.1+	0.8
A change in the local tax rate structure caused a decrease in the client's property taxes.	-0.1+	0.3
Last year the auditors were able to complete the engagement slightly under budget.	0.0+	0.0
Fringe benefit plans made available to employees are more generous than the industry average.	0.6	1.0
In an attempt to improve the efficiency of company's operations, the client engaged a consulting firm.	-0.2+	1.2
Historically, 75% of a client's (a publishing company's) publications are considered successful and are revised for future editions.	-0.2+	0.4
The client eliminated one of its 11 holidays.	0.2+	0.8
Relevant Cues		
Few adjustments have been necessary in prior engagements.	-2.7	1.4
Significant portion of management compensation relates to aggressive sales goals.	3.4	1.0
Significant increase in debt that is accompanied by an inability to generate cash flows from operations.	3.6	0.9
Adverse conditions exist in the client's industry.	2.3	1.4
Client management is experienced.	-0.4	1.6
The client has been audited for several years by your firm.	-1.4	1.4
A material portion of assets are based on estimates requiring significant judgment.	2.3	1.3
The board of directors and management are controlled by a single person or small group.	3.3	1.5

[a]Ratings are on a scale from –5 (lower fraud risk) to +5 (increase fraud risk); 0 = no impact.
+Indicates that the item rounds to 0 and is therefore included in the study as irrelevant evidence.

Table 2
Decision Aid

FRAUD RISK QUESTIONNAIRE

The following questionnaire contains risk factors that are relevant to the risk of material misstatement due to fraud. For each item, please check the appropriate box—based on the information presented in the case that starts on page [5].

Risk Factors Relating to Management Characteristics
Are the following risk factors present?
Yes No
- ☐ ☐ Management controlled by a single person or small group
- ☐ ☐ Inadequate monitoring of significant controls
- ☐ ☐ Management failure to correct known reportable conditions on a timely basis
- ☐ ☐ Management setting unduly aggressive financial targets and expectations for operating personnel
- ☐ ☐ Ineffective accounting staff
- ☐ ☐ Significant compensation tied to aggressive accounting practices
- ☐ ☐ High turnover of senior management, counsel, or board members

Risk Factors Relating to Industry Conditions
Are the following risk factors present?
Yes No
- ☐ ☐ New accounting, statutory, or regulatory requirements that could impair the financial stability or profitability of the entity
- ☐ ☐ High degree of competition or market saturation, accompanied by declining margins
- ☐ ☐ Rapid changes in the industry, such as significant declines in customer demand, high vulnerability to changing technology

Risk Factors Relating to Operating Characteristics and Financial Stability
Are the following risk factors present?
Yes No
- ☐ ☐ Significant pressure to obtain additional capital necessary to stay competitive
- ☐ ☐ Significant related-party transactions
- ☐ ☐ Difficulty in determining organizational control
- ☐ ☐ Unusually rapid growth in revenue or profitability
- ☐ ☐ High vulnerability to changes in interest rates
- ☐ ☐ High dependence on debt
- ☐ ☐ Unrealistically aggressive goals for sales or profitability incentive programs
- ☐ ☐ Threat of imminent bankruptcy or foreclosure
- ☐ ☐ Adverse consequences on significant pending transactions, such as a business combination or contract award, if poor financial results are reported

Table 3
Mean Auditor Ratings of Irrelevant Cues[1]
(standard deviations in parentheses)

	Low Fraud		High Fraud	
Irrelevant Cue	**Relevant**	**Mixed**	**Relevant**	**Mixed**
1. The client has devoted resources to developing methods of recycling by-products of its production process.	*0.03 (0.91)*	*0.14 (0.94)*	*0.09 (0.47)*	*0.23 (0.73)*
2. A change in the local tax rate structure caused a decrease in the client's property taxes.	*-0.00 (0.24)*	*0.03 (0.92)*	*-0.13 (1.01)*	*0.03 (0.62)*
3. Last year the auditors were able to complete the engagement slightly under budget.	*-0.03 (0.37)*	*-0.17 (0.66)*	*0.03 (0.31)*	*-0.11 (0.32)*
4. In an attempt to improve the efficiency of company operations, the client engaged a consulting firm.	*-0.54 (1.10)*	-0.74 (1.41)	-0.50 (0.92)	*-0.26 (1.09)*
5. Historically, 75% of a publisher's publications are considered successful and are revised for future editions.	*-0.19 (0.88)*	*0.09 (1.27)*	*-0.13 (0.79)*	*-0.11 (1.05)*
6. The client eliminated one of its 11 holidays.	*0.19 (0.52)*	*0.29 (0.57)*	*0.31 (0.78)*	*0.14 (0.43)*

[1]Ratings are on a scale from –5 (lower fraud risk) to +5 (increase fraud risk); 0 = no impact.
Italicized ratings round to 0.

Table 4
Correlation Between Irrelevant Cue Ratings and Fraud Risk Assessment

Panel A: Low Fraud Mixed Conditions

		Pearson Correlation	
	n	r	p-value (two-tailed)
Cue 1	35	-.038	.827
Cue 2	35	.293	.087
Cue 3	35	-.227	.190
Cue 4	35	.041	.816
Cue 5	35	.207	.234
Cue 6	35	.279	.105

Panel B: High Fraud Mixed Conditions

		Pearson Correlation	
	n	r	p-value (two-tailed)
Cue 1	35	.027	.878
Cue 2	35	.168	.335
Cue 3	35	-.263	.127
Cue 4	35	.216	.212
Cue 5	35	.033	.849
Cue 6	35	.159	.360

Table 5
Mean Fraud Risk Assessments[1] and Resulting Dilution Levels
(standard deviations in parentheses)

LOW FRAUD ENVIRONMENT

Decision Aid	*Type of Evidence*		*Dilution*	*t-statistic*	*p-value*[2]
	Relevant	Mixed			
	1	2			
	5.58	4.82			
	(1.87)	(1.07)			
Aid	n = 19	n = 17	0.76	1.508[3]	0.071
	3	4			
	5.61	5.37			
	(1.34)	(1.61)			
No Aid	n = 18	n = 19	0.24	0.498	0.311

HIGH FRAUD ENVIRONMENT

Decision Aid	*Type of Evidence*		*Dilution*	*t-statistic*	*p-value*[2]
	Relevant	Mixed			
	5	6			
	7.00	6.50			
	(1.06)	(0.89)			
Aid	n = 17	n = 20	0.50	1.561	0.064
	7	8			
	6.07	6.60			
	(1.16)	(1.12)			
No Aid	n = 15	n = 15	-0.53	-1.279	0.106

[1]Fraud risk assessments are on a scale ranging from 0 (much lower than normal) to 9 (much higher than normal).
[2]One-tailed test
[3]Levene's test for equality of variances shows a significant difference in variances, therefore the *t*-test for equality of means was computed assuming unequal variances.
Average dilution for the two decision aid conditions is 0.63.
Average dilution for the two conditions without a decision aid is -0.15.

Table 6
Statistical Analyses of the Planned Comparisons

	t-statistic[2]	*p-value*[1]
Panel A: Non-aided Conditions		
H1: 3+7 > 4+8	-0.451	.327
Panel B: Aided vs. Non-aided Conditions		
H2: (1+5)-(2+6) > (3+7)-(4+8)	1.767	.040
Panel C: Low Fraud: Aided vs. Non-aided Conditions		
H2: 1-2 > 3-4	0.736	.233
Panel D: High Fraud: Aided vs. Non-aided Conditions		
H2: 5-6 > 7-8	1.954	.028
Panel E: Risk Environment		
H3: (1-2) < (5-6)	0.428	0.336
Panel F: Risk Environment		
(1-2)-(3-4) < (5-6)-(7-8)	0.595	0.277

[1]One-tailed test
[2]Levene's test for equality of variances shows a significant difference in variances, therefore the *t*-test for equality of means was computed assuming unequal variances.

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