Training Auditors to Think Skeptically

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ABSTRACT

Auditors have been criticized for failing to effectively exercise professional skepticism despite the mandate to do so. One explanation for this failure is that current guidance does not adequately link the mandate with specific ways of cognitively processing audit evidence. We believe the standards imply that professional skepticism can be viewed as a diagnostic reasoning process, and have identified two cognitive skills comprising that diagnostic process: divergent and convergent thinking. Divergent thinking leads auditors to generate explanations for unusual evidence; convergent thinking guides an evaluation leading to eliminating infeasible explanations. We developed materials to train these skills, and assessed their effectiveness using auditors from three of the Big Four firms. We found that divergent-thinking training increases both the number and quality of explanations generated, and receiving both divergent- and convergent-thinking training leads to the likelihood of choosing the correct explanation more than four times that of divergent-thinking training alone.

Keywords: Professional skepticism, diagnostic reasoning, training
I. INTRODUCTION

Though auditors are required to exercise professional skepticism (AICPA 1997), 60 percent of Securities and Exchange Commission (SEC) enforcement actions against auditors between 1987 and 1997 involved their insufficient use of professional skepticism (Beasley et al. 2001). The Public Companies Accounting Oversight Board (PCAOB) reports that this shortcoming continued between 2004 and 2007 with the eight largest auditing firms having audit deficiencies caused, at least in part, by the failure to apply an appropriate level of professional skepticism (PCAOB 2008). Messier et al. (2010) examined 28 disciplinary proceeding cases related to engagement quality reviewers and found a lack of professional skepticism in 22 of 23 cases involving deficiencies in due professional care.

One possible explanation for auditors’ failure to exercise professional skepticism is that the guidance provided to auditors by the standards and by auditing audit firms fails to adequately link the professional skepticism mandate to be professionally skeptical with specific ways of cognitively processing audit evidence. In other words, auditors are not instructed in a thought process that would lead them to exhibit “a questioning mind” so that they are not “satisfied with less-than-persuasive evidence” (PCAOB 2006a). In this study, we evaluated whether providing auditors with the ability to reason diagnostically improves their ability to think in a manner consistent with the professional skepticism standards.

Prior research shows that auditors are able to perform in a skeptical manner (Hurtt et al. 2011), but that they do not always do so (e.g., McMillan and White 1993; Turner 2001). Examining why these inconsistencies occur, Hurtt et al. (2011) found that when auditors with higher levels of skepticism are reviewing workpapers, they are more likely to detect contradictions and that their detection rate increases in response to higher audit risk. In contrast, it seems that prompts to be professionally skeptical do not cause those auditors who are not
naturally inclined toward professional skepticism to behave like those who are (Brown et al. 1999; Gramling 1999; Peecher 1996). Nelson (2009) proposes that, among other factors, knowledge and training should positively impact auditors’ professional skepticism. In the current study, we increased auditors’ knowledge by training them to use specific cognitive skills to improve the level of professional skepticism in their judgments.

To translate the guidance provided to auditors by the professional standards into specific cognitive skills, our view is that professional skepticism can be understood as a sequence of cognitive skills that constitute a diagnostic-reasoning process. The type of diagnostic reasoning we ascribe to professional skepticism is found in the problem identification and structuring phases of creative problem solving. Specifically, we examine whether instructing auditors how to sequentially use divergent thinking followed by convergent thinking improves their ability to be professionally skeptical.

As part of professional skepticism, divergent thinking requires auditors to mentally generate explanations for evidence or circumstances they identify as unusual and convergent thinking requires them to assess the plausibility of the explanations they generate. These skills should allow auditors to behave skeptically in unstructured and ambiguous settings. Translating the features of professional skepticism from the standards into these trainable cognitive skills potentially creates a way for auditors to conduct their professional duties with the appropriate degree of professional skepticism.

For this study, we created an online training program designed to increase auditors’ understanding of professional skepticism by providing explicit training guidance on how to think in a more skeptical manner. The training program includes an in-depth explanation of the expectations for professional skepticism set forth in the auditing standards and training in
techniques that increase divergent and convergent thinking. Assessments that measure both the objective aspects of participants’ learning, such as knowledge and comprehension of the content and skills, as well as their ability to apply the skills are incorporated into the program. Thus, we can determine whether auditors trained in professional skepticism represented as a diagnostic-reasoning process increase the number of potential explanations generated in response to unusual situations, eliminate illogical explanations from further consideration, and improve their ability to generate and select the actual explanation or cause for a given unusual situation.

The professional skepticism training and assessment included 108 auditors who were randomly assigned to one of three training conditions: full training (divergent and convergent), partial training (only divergent), or a control (neither divergent nor convergent). The tasks in this study require participants to complete four separate on-line, self-paced sessions during assigned intervals over two weeks. At the end of each session, assessment data were collected to measure whether the training was comprehended and whether it resulted in the ability to apply the specific cognitive skills addressed in that session. The final training session synthesizes the concepts from the previous sessions and presents professional skepticism as a coherent, diagnostic-reasoning process. It also includes a comprehensive analytical review case to measure whether the cumulative effect of the training resulted in better performance in an ill-structured analytic review test.

We found that the training significantly increased participants’ knowledge and comprehension of divergent- and convergent-thinking skills. We also found that divergent-thinking training increases both the number and quality of explanations generated for an unusual situation. Our results support the importance of training auditors in both divergent and convergent thinking. In the final assessment case, participants who received both types of
training (full training condition) were more likely to generate and ultimately choose the correct explanation compared to those who were in the partial or control conditions.

The remainder of the paper is organized as follows. Section II describes professional skepticism as a diagnostic-reasoning process featuring cognitive skills that can be trained. Section III develops the hypotheses regarding the impact of divergent and convergent thinking on professional skepticism. Section IV discusses the training procedures and reviews the way in which the professional skepticism process is assessed. Section VI presents the data analysis and discussion of the results, and Section VII provides discussion and conclusions.

II. DIAGNOSTIC REASONING: PROFESSIONAL SKEPTICISM AS A FORM OF CREATIVE PROBLEM SOLVING

This study conceptualizes professional skepticism as problem identification and structuring within the broader field of creative problem solving, which itself is a form of diagnostic reasoning. In this section, we review the diagnostic-reasoning literature in auditing and the creative-problem-solving literature to examine whether training in divergent and convergent thinking might provide a structure for auditors that will help them be professionally skeptical.

While professional skepticism is crucial to audit practice, it is not precisely defined by the audit standards as a diagnostic reasoning process, but instead is discussed in terms of general states of mind or behaviors (e.g., PCAOB 2006b). AU Section 230.07 states that professional skepticism involves “a questioning mind and a critical assessment of audit evidence”\(^1\). The

\(^1\) Academic audit research provides a wide spectrum of professional skepticism definitions: the opposite of trust (e.g., Choo and Tan 2000; Shaub 1996; Shaub and Lawrence 1996, 1999), “presumptive doubt” (Bell et al. 2005; Nelson 2009), and “the propensity of an individual to defer concluding” (Hurtt 2010). In its definition, the Center for Audit Quality (2010) combines the guidance from the standards with Hurtt’s definition and also advocates “a thorough knowledge” of the client’s business and its economic environment.
notion of a “questioning mind” translates into a diagnostic-reasoning framework because skepticism involves identifying, investigating, and resolving evidence that is unexpected. Put differently, if no unusual or unexpected evidence is encountered, then professional skepticism is not stimulated.

The audit environment is ill-structured, complex, and nonroutine (Abdolmohammadi and Wright 1987), which is an appropriate setting for creative problem solving. That is, creative problem solving is well suited for ill-structured, ambiguous decision settings with multiple or unclear goals and unstated constraints (Mumford et al. 1994). Both the creative problem solving and the auditing environment often involve “discovered problems;” that is, problems are drawn from information or evidence rather than being overtly presented as problems to be solved (Abdolmohammadi and Wright 1987; Bedard and Biggs 1991; Mumford et al. 1994). In addition, the correct solution might never be found if the actual problem remains unidentified or incorrectly defined (Earley 2002). Based on the similarities between these environments, we anticipate that training methods used to successfully change cognitive skills in creative problem solving can be successfully modified to work for professional skepticism in the auditing environment.

The creative problem-solving process begins with problem identification and ends with a solution. The early part of the process is called problem construction and identification, which is where the problem is recognized and parameters of the problem are defined (Mumford et al. 1994; Reiter-Palmon and Robinson 2009). In the case of ill-structured problems, problem solvers must impose a structure and direct the problem-solving activities with their own resources (Mumford et al. 1994). This is the portion of the creative problem-solving process that we believe is analogous to professional skepticism. During an engagement, auditors must recognize
items or situations that should be considered unusual, a step that we see as analogous to problem identification. Then, they must conclude whether the unusual items or situations warrant additional consideration or if additional evidence of some sort needs to be obtained, a step that we see as analogous to problem construction. Professional skepticism can be viewed as a diagnostic-reasoning process that involves identifying unusual items or situations and imposing enough structure to determine potential causes. The actions the auditor might take once an unusual or unexpected item is identified, such as obtaining additional evidence, are important to the efficient, effective conduct of an audit. Therefore, the professional-skepticism process is iterative.

Bedard and Biggs (1991) provide insight into which cognitive skills auditors need to improve in order to act in a more skeptical manner. In their experiment, senior- and manager-level auditors evaluated an analytical review case and generated a hypothesis that they believed best explains the unusual relationships found within the case. The case contained four crucial facts embedded that, if properly combined, pointed to a singular solution. Verbal protocols captured why each participant generated a particular hypothesis and provided insight into the reasons that participants failed to identify the correct solution. The analysis shows that acquisition errors (failure to identify the necessary pieces of information) were uncommon since most participants were able to identify all four crucial facts. However, errors were likely to arise after the acquisition stage through either pattern-recognition errors (i.e., failure to combine all of the four crucial facts) or hypothesis-generation errors (i.e., failure to generate the correct hypothesis).
Divergent and Convergent Thinking

We alluded earlier to two cognitive skills associated with training creative problem solving that would be directly applicable to professional skepticism: divergent thinking and convergent thinking. Specifically, we believe that divergent and convergent thinking will help auditors avoid the hypothesis-generation errors that were found by Bedard and Biggs (1991).

In a creative problem-solving context, once a problem is encountered, divergent thinking involves generating potential solutions to the problem encountered by recognizing cues and links between available information in order to find explanations that might otherwise go undiscovered (Cropley 2006; Santanen et al. 2004; Scott et al. 2004). We consider divergent thinking to be the part of the professional-skepticism process in which the auditor thinks of multiple plausible explanations for the unusual items encountered, without an explicit, stringent effort to ensure that each explanation is logically valid in light of other knowledge and evidence. One concern during audits is that an auditor might accept an incorrect but plausible explanation for an unusual event or transaction (Kinney 1987; Koonce 1992). Divergent thinking helps prevent this by enabling auditors to make additional combinations of information, recognize links among remotely associated facts, and avoid accepting the first plausible explanation generated. Divergent thinking is similar to brainstorming, which is required as part of the auditors’ effort to detect fraud and has been shown to improve auditors’ ability to generate ideas about the occurrence and concealment of fraud (e.g., Carpenter 2007). The important difference is that brainstorming is a group activity whereas divergent thinking occurs at the individual level.

In contrast to divergent thinking, the aim of convergent thinking is to focus the search for a solution (Cropley 2006). In problem solving, convergent thinking facilitates recognition of weaknesses and limitations in the generated explanations in order to eliminate explanations that
should not be pursued (Cropley 2006). Convergent thinking enables decision makers to recognize potential areas in which to concentrate effort and to arrive at a final solution. In an audit setting, auditors should use convergent thinking to mentally test the plausible explanations they generated during divergent thinking.

With convergent thinking being almost the polar opposite of divergent thinking, it might seem counterintuitive to include both in the professional-skepticism process. However, Osburn and Mumford (2006) contend that the interplay of divergent and convergent processes leads to idea development through anticipating potential failures as well as successes. Using either divergent or convergent thinking alone leads to the production of different ideas or solutions (Cropley 1999). When only divergent thinking is used, the ideas or solutions generated have greater variability, but they lack focus, which can create inefficiencies. On the other hand, the use of only convergent thinking results in ideas that are more focused but lack variability, which decreases the chances that a set of potential solutions will contain the correct solution. It is the sequential effect of using divergent thinking followed by convergent thinking that facilitates the identification of parallel links and patterns among dissimilar ideas (Brophy 2001).

**Hypothesis Generation Process**

Gettys and his colleagues (Gettys and Fisher 1979, Fisher et al. 1983 Gettys et al.1986) detail a “hypothesis generation” process analogous to the diagnostic reasoning performed by medical professionals, computer programmers and auto mechanics. In it a decision maker responds to a situation requiring diagnosis by retrieving potential hypotheses from memory based on part of the available information, mentally checks these hypotheses against other available data for logical consistency, and then the hypothesis set generated as well as candidates for subsequent inclusion are evaluated for plausibility. A series of studies (Fisher et al. 1983)
focuses specifically on the functioning of the initial consistency checking. Consistency checking is a high-speed semantic verification process where hypotheses are checked for logical consistency against other available data and hypotheses found to be logically inconsistent are discarded. Hypotheses that survive the consistency checking process are considered sufficient in that they are at least logically possible candidates, though not necessarily being the best candidate in light of all the evidence.

It is useful to contrast our diagnostic reasoning process with the hypothesis generation process described above. As in hypothesis generation, divergent thinking requires retrieval of explanations for unusual evidence from memory. However, training auditors in divergent thinking moves it from an implicit process to an explicit, conscious process where auditors retrieve potential explanations from memory deliberately combining previous solutions and ideas in novel ways. It is also important to remember that divergent thinking is aimed at creating a large set of potential explanations without consideration of their logical consistency. The benefit of making the process explicit and to create a large set of potential explanations is to help overcome some potential biases in decision making. Consider that unexpected events elicit causal reasoning (Hastie 1984). If decision makers process sequentially they might engage in superficial rather than complete processing (Earley 2002). Similarly, they might be predisposed to assimilation effects (i.e., biased by prior expectations) (Tan 1995) or subject to some form of confirmation bias (Kida 1984; Trotman and Sng 1989). Thus, explicit instructions to think divergently are likely to overcome biases that would limit the ability to think skeptically.

Training in convergent thinking is intended to make explicit a process that implicitly occurs in hypothesis generation. In hypothesis generation, the processes of consistency checking and plausibility assessment serve to reduce the set of explanations by applying cognitive tests of
logical consistency and sufficiency to the hypotheses generated. During the hypothesis
generation process, these two processes occur automatically. Convergent thinking requires a
conscious evaluation of hypotheses where, in our case, they are subjected to specific rules of
logic. So, while there are parallels in terms of cognitive processing between our diagnostic
process and hypothesis generation, they differ in the critical aspect that our diagnostic process is
undertaken consciously with purposeful deliberation.

Koonce (1993) provides a framework for diagnostic-reasoning during auditors’ analytical
review built around four components: mental representation, hypothesis generation, information
search, and hypothesis evaluation. In her framework, explanations for unexpected fluctuations
are assumed to be retrieved from memory and subjected to a preliminary, unconscious
plausibility assessment. Several studies have empirically examined auditors’ hypothesis
generation. The findings show that the likelihood of an explanation being retrieved from memory
is a function of the perceived frequency of the underlying error (Libby 1985; Libby and
Frederick 1990) and whether hypotheses provided to the auditor are seen as more plausible
(Heiman 1990). These studies also find that analogies can be used as a mechanism for retrieving
explanations from memory (Marchant 1989) and initially generated hypotheses can interfere
with an auditor’s ability to subsequently consider another hypothesis (Heiman-Hoffman et al.
1995). This research provides support for the role of diagnostic reasoning and hypothesis
generation by auditors but it does not address the question of whether auditors can be trained to
more effectively execute these processes.

Training Cognitive Skills

Scott et al. (2004, 362) conducted a meta-analysis of 70 studies that focused on the
“production of original, potentially workable solutions to the novel and ill-defined problems of
relatively high complexity.” Of particular relevance is their conclusion that the training was likely to provide a set of heuristics or strategies for working with available knowledge rather than to develop new domain expertise. They also conclude that the use of approaches that stress cognitive-processing activities are positively related to success. In the case of skills such as convergent thinking, success tended to result from training that showed participants how to work with information in a systematic fashion. In terms of the more effective training approaches, Scott et al. point to four characteristics of the training that consistently contributed to success: (1) a sound, valid conceptualization of the underlying cognitive activities; (2) lengthy and challenging materials with discrete cognitive skills; (3) articulation of principles followed by illustrations of applications using real-world materials; and (4) presentation material followed by exercises appropriate to the domain at hand.

Previous audit research shows the importance of training on auditors’ judgments in other contexts (e.g., Bonner and Walker 1994; Earley 2001). Bonner and Walker (1994) examined whether practice alone, practice with outcome feedback, or practice with explanatory feedback most effectively trained auditors to perform correct ratio analysis in audit planning, and found that practice with explanatory feedback is the best method for improving auditor performance. Later research shows that performance improves even when feedback is provided after the task is complete (Earley 2001). The success of previous audit-related training supports the notion that auditors can be trained to perform divergent and convergent thinking.

**III. HYPOTHESIS DEVELOPMENT: PROFESSIONAL SKEPTICISM AS A PROCESS**

We base our expectations on two fundamental presumptions. First, professional skepticism as envisioned in the auditing standards can be represented by a diagnostic-reasoning process that incorporates divergent and convergent thinking. Consistent with the view of
professional skepticism found in the standards, this process can be applied across any situation an auditor might encounter in the course of an audit, and, upon encountering unusual audit circumstances or evidence, the auditor can perform it relatively quickly. Second, the diagnostic-reasoning process we propose translates into a trainable set of cognitive skills that auditors can use to perform in a professionally skeptical manner.

Research into creative problem-solving describes it as a thought process that can be deliberately applied to resolve open-ended problems, and approaches to training creative problem solving generally involve both divergent and convergent thinking (Puccio et al. 2006). Training the creative problem-solving tends to produce ideas that are more original (Rose and Lin 1994), and those trained in the creativity process are more willing “to defer judgment and to not exclude apparently strange, but original and potentially valuable ideas” (Kabanoff and Botter 1991 243). In their meta-analysis, Scott et al. (2004) found that problem solvers who receive training in divergent thinking generate more solutions that cover a broader range of possibilities within a given category, and the possibilities within each category are more sophisticated. That is, the explanations within each category are more refined, well thought out, and of higher quality.

Adapting divergent-thinking training to the audit environment should lead to similar outcomes. Thus, we expect that auditors trained to use divergent thinking while examining audit evidence will improve their ability to generate explanations. In addition, the explanations generated will be of higher quality and better thought out. These ideas are formally stated in the following hypothesis (H1a–c):
**H1**: In response to a situation identified as unusual or unexpected, compared with auditors who are not trained to use divergent thinking, auditors trained to use divergent thinking will generate:

(a) more unique explanations,

(b) a higher percentage of high-quality explanations, and

(c) a higher percentage of explanations that contain in-depth reasoning.

Whether the subject matter is technical knowledge, the procedural conduct of an audit or other professional skills, training auditors is expensive in terms of the direct time involved as well as the administrative overhead. Thus, an important question with regard to training our diagnostic process is whether training auditors in both divergent and convergent thinking is necessary, or whether divergent thinking alone is sufficient.

Generally, research has focused on training the entire creative problem-solving process (Scott et al. 2004), which includes both divergent and convergent thinking. Exceptions to training the entire creative problem-solving process include two studies involving professionals that explore divergent and convergent thinking as separate processes (Wantz and Morran 1994; Kilgour and Koslow 2009). Wantz and Morran (1994) explore the effectiveness of training graduate counseling students in either divergent or convergent hypothesis-formation strategies in making clinical assessments. Responding to videotaped client induction interviews, forms completed by participants who received divergent thinking training contained 1) more distinct, relevant information, 2) a broader spectrum of information and 3) more questions they would subsequent ask the client. Examining the advertising professionals, Kilgour and Koslow (2009) examine the trade-off between originality and the appropriateness of ideas by comparing the effects of divergent and convergent techniques among advertising “creatives,” account
executives and students. Convergent thinking alone results in more appropriate but less original ideas; divergent thinking training does not improve the originality of those predisposed to creativity but it did for those who are not. These studies support the view that divergent thinking training leads to consideration of a larger set of alternatives, while convergent thinking training leads to a more restricted perhaps relevant alternative set.

The combination of divergent and convergent thinking might lead to a synergistic improvement in outcomes over divergent thinking alone for several reasons. One reason is that when making a diagnostic evaluation decision makers employ a process similar to the hypothesis generation process described by Gettys and his associates. That is, absent training in both divergent and convergent thinking decision-makers naturally engage in consistency checking of hypotheses as they are generated and plausibility assessments for new candidates beyond the initial one (Fisher et al. 1983 Dougherty et al. 1997). On the other hand, those receiving training in both would consciously avoid eliminating hypotheses through consistency checking and plausibility assessment, focusing on establishing a more exhaustive list and deferring the evaluation of hypotheses generated until the subsequent convergent thinking phase. Thus, one result of training auditors in both divergent and convergent thinking will be a larger set of explanations than divergent thinking alone, due to a reduction or limitation of the simultaneous evaluation and removal of potential hypotheses that occurs in a hypothesis-generation process.² This expectation is expressed in the second hypothesis (H2) below:

**H2:** Auditors trained to use both divergent and convergent thinking will generate a larger list of potential explanations than auditors who are trained in divergent thinking alone.

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² One implication that by engaging in consistency checking, which by its nature is a high-speed, relatively cursory process, and plausibility assessments auditors trained in divergent thinking alone risk inadvertently eliminating an explanation that might ultimately prove to be correct.
Another potential advantage of auditors being trained in both divergent and convergent thinking is that the explanations generated during divergent thinking are subjected to deeper cognitive processing and explicit logical evaluation during the convergent-thinking stage. An example of the benefits that result from deeper processing is the addition of evaluative operations to the creative problem-solving process. Mumford et al. (2003) found that incorporating evaluative operations such as searching for key facts resulted in solutions of higher quality that were more original. In the area of advertising, applying evaluative operations to less original ad campaigns has been shown to result in better ideas and improved efficiency when they were applied to more original ideas (Lonergan et al. 2004). Similarly, Caughron and Mumford (2008) examine whether engaging in planning, which they view as mental simulation of future actions, impacts the creative process. They show that compared to other experimental conditions those who engaged in planning produced outcomes with higher levels of quality and originality because planning stimulates thought about future aspects such as implementation (Osburn and Mumford 2006).

Our approach explicitly trains to auditors to assess the logical validity of hypotheses generated during divergent thinking. In our convergent thinking training, auditors were taught to check for logical errors by imagining circumstances where their hypothesis 1) explain more than the event they consider unusual (a violation of necessity) and 2) explain only part or none of the unusual event (a violation of sufficiency). Previous research into explicit hypothesis testing has found that when trying to test the truth of a hypothesis participants tend to have a “confirmation bias” (Wason 1960 1968 Klayman and Ha 1987). The important implication of this commonly used approach to evaluating hypotheses is that in some tasks it can cause decision-makers to fail to consider that some aspects of their hypothesis are unnecessary, which would have been
detected through use of a disconfirmation strategy (Klayman and Ha 1987). For example, an
auditor might hypothesize that an unexplained increase in a client’s accounts receivable is due to
slow collections, when in fact collections have slowed substantially only for one major customer.
Without the logical tests included in convergent thinking, the auditor could accept the hypothesis
that “explains” more than is necessary and engage in inefficient additional procedures. In their
study of the benefits of planning on creativity, Caughron and Mumford (2008) conclude that the
key mechanism that planning provided was encouragement to consider future failures, which is
a less formal form of disconfirming strategies.

Directing auditors to assess the logical validity of the explanations they generated during
divergent thinking will cause them to more deeply process and logically test the implication of
each hypothesis. By eliminating illogical explanations the auditor reduces the set of plausible
explanations and can focus on the logically valid solutions, creating a more efficient and
effective audit. This, in conjunction with the deeper cognitive processing of hypotheses, will lead
to superior explanations for unusual audit situation. Therefore, our third hypothesis (H3)
encompasses this expectation:

**H3**: Auditors trained to use both divergent and convergent thinking will be more likely to
identify the correct solution from their generated list of explanations for a situation
identified as unusual than auditors who are trained to use divergent thinking alone.

**IV. TRAINING AND ASSESSMENT PROCEDURES**

Participants were randomly assigned to one of three assessment conditions: (1) “full
training” received training in both divergent thinking and convergent thinking, (2) “partial
training” received training in divergent thinking and an alternative task instead of convergent
thinking, and (3) “control” received neither divergent nor convergent thinking training. We
divided training and assessments into a preliminary or pre-training module and four separate training modules, and each condition received a unique combination of training activities (see Table 1). Regardless of condition, all participants received training in the creation of expectations, identification of unusual audit evidence, and the underlying concepts of professional skepticism within the auditing standards in module one and the same exercises, scenarios, or assessment case at the end of each module. The control condition received alternative tasks in both modules two and three, while partial training received an alternative task in only module three. In the second module, the alternative task consisted of training in ways of dealing with group interactions, and the alternative task in module three trained participants to deal with client relationships. Both alternative tasks were presented in a fashion similar to the professional-skepticism process training and were designed to be informative but have a neutral effect on professional skepticism.

[Insert Table 1 about here]

Training Modules

The design of the training modules incorporates the four key characteristics of successful problem-solving training programs (Scott et al. 2004). Each module (1) is based on a sound understanding of the required, underlying cognitive activities; (2) is relatively challenging and includes strategies that explain how to use the professional-skepticism process; (3) includes illustrations in both every day, real-world settings and auditing settings; and (4) requires participants to practice the strategies in a complex, realistic audit environment. The questions and practice scenarios within each training module provide the participants with explanatory feedback. The preliminary module introduced the participants to the study, but did not include any training. The participants practiced using the survey program and we collected demographic
data, a measure of general auditing knowledge (modified from Tan and Kao 1999), and participants’ trait level of professional skepticism using the Hurtt Scale (Hurtt 2010).

The content of the first training module is designed both to increase an auditor’s knowledge of professional skepticism and to introduce professional skepticism as a process. It provides an overview of the relevant auditing standards, and emphasizes the importance of creating expectations and identifying anomalies that are inconsistent with those expectations. It concludes with exercises that require participants to create expectations and identify anomalies by categorizing audit circumstances and evidence as either usual or unusual.

The second training module focuses on strategies for the effective use of divergent thinking. Participants in the full and partial training conditions are instructed on how to mentally develop a set of plausible explanations for the unusual events or transactions that are identified. To do this, they are taught to define a problem in a way that encourages generation of multiple possible explanations for the unusual events or transactions that have been discovered. After the divergent-thinking strategies are explained, participants are able to practice the newly learned strategy in an audit situation followed by feedback. At the end of the module, all participants regardless of condition are asked to generate plausible explanations for unusual audit situations presented as scenarios.

Strategies for convergent thinking are included in the third training module. Using logic-based tests found in formal hypothesis testing (Brown et al. 1999; Klayman and Ha 1987), participants in the full training condition are shown how to mentally test whether their explanations explain (1) only the evidence indicating the unusual event and nothing more (fully explain), (2) not only the unusual event but also other circumstances (over-explain), (3) only a part of the unusual event (partially explain), or (4) logically explain none of the unusual event
The results of convergent thinking should be that only explanations that fully explain an unusual event should be kept and the others discarded as not logically valid. They practice applying convergent thinking with explanatory feedback. At the end of the module, all participants regardless of condition are given three scenarios for unusual audit situations that include seven to nine explanations derived from pretests of the scenarios. Only some of the provided explanations are logically valid.

All of the concepts and strategies that a participant received in the previous three training modules are brought together in the fourth module. For the full training condition this involves synthesizing them into the complete professional skepticism process while the partial training and control receive only parts of the professional skepticism process. An audit analytical review case for a small manufacturing company is included in the fourth module and used as the final assessment of participants’ ability to apply the skepticism process. We modified the case (adapted from Bedard and Biggs 1991) so that the four crucial facts can be explained jointly by either a legitimate business reason or the original error/fraud reason.

Training Procedures

The modules were administered through an Internet-based survey program. The survey program captured all assessment measures, thought protocols, demographic measures, personality measures, and time spent on each individual screen. We sent participants a personalized invitation, including a Web link for each module. They were instructed not to discuss any of the assessment materials or to share their personalized Web links with other participants. The participants had two business days to complete each module. Participants could complete the module at any time during the two-business day interval; however, regardless of when they finished a module, participants had to wait until the end of the interval before they
received the link to the next module. Reminder emails were sent one day after the initial link was sent and at the end of the second business day if the module had not been completed. The link to the next module was never sent to a participant unless the previous module was completed.

Participants

In a joint effort by the Center for Audit Quality (CAQ) and three of the four Big Four firms, participants were selected from across the United States. A total of 122 participants started the training and 108 participants completed the training. Participants were senior auditors and had worked an average of 3.5 busy seasons (see Table 2 for various demographic assessments and statistical comparisons across conditions).

[Insert Table 2 about here]

V. RESULTS

Creating Expectations and Identifying Conflicting Evidence

Since participants were assigned randomly to conditions and all three conditions received training in creating expectations and identifying unusual situations as part of the first training module, there should be no differences in related measures across conditions. The module included five scenarios: (two usual and three unusual). The assessment measures for the first module are participants’ percentage of correctly identified unusual and usual scenarios. As expected, we found no differences across the three conditions for correctly identifying either unusual scenarios ($F = 0.69, p = 0.502$) or usual scenarios ($F = 0.34, p = 0.710$). Combining the three conditions, unusual scenarios were identified correctly 86.5% of the time and usual scenarios were identified correctly 71.8% of the time. Thus, we conclude that all conditions

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3 Participants completed the training and assessments during their normal working schedule; some dropped out for reasons such as heavy workloads, scheduled vacations, and unanticipated client demands. The attrition was balanced across treatment conditions.

4 The training materials stated that “Audit evidence, regardless of its source, that is not consistent with what you expect to find would be identified as ‘unusual’.”
show the same level of effectiveness and efficiency in creating expectations and identifying unusual evidence.

**Manipulation Checks: Knowledge and Comprehension**

To test whether participants acquired knowledge (ability to recall the training) and comprehension (ability to interpret the training) from the professional-skepticism process training, multiple-choice questions were given either in the preliminary module or in the training modules. When an assessment condition received the professional-skepticism process training in a module, the corresponding knowledge and comprehension questions were answered in that same module and included feedback. Otherwise, when a condition received an alternative task, the multiple-choice questions pertaining to the excluded process training were included in the preliminary module and did not include feedback.

We expected to find no differences in knowledge and comprehension for the first training module, since all conditions received the same training. As expected, there are no significant differences between any of the conditions (80.0% average across conditions; $F = 0.60, p = 0.552$). For the second training module, we expected and found that those in the full and partial training conditions to perform better. A statistical contrast shows that those who received training in divergent thinking correctly answered a higher percentage of questions relating to divergent thinking ($\mu = 70.7\%$) than those who did not receive the training ($\mu = 51.4\%; t = 5.97, p < 0.001$, one-tailed). For the third module, the contrast shows that, as expected, those who received training in convergent thinking (the full training condition only) answered more questions correctly relating to convergent thinking ($\mu = 76.8\%$) than those who received training (partial and the control) ($\mu = 49.1\%; t = 9.81, p < 0.001$, one-tailed). Taken as a whole, these results consistently demonstrate that participants receiving the specific type of professional-
skepticism process training acquired greater knowledge and comprehension of that particular skill.

Convergent thinking could not be measured in the final assessment case without leading participants through the diagnostic-reasoning process. We expected that those trained in convergent thinking (full-training condition) would test explanations for logical validity, and invalid, plausible explanations would be eliminated. To examine this point, we used participants’ responses to the unusual scenarios from the first module that were presented again at the end of the third training module that included a list of seven to nine explanations for each scenario. These explanations were systematically chosen to fit into three categories: (1) explanations that are plausible and logically valid (i.e., completely valid), (2) explanations that are plausible but should be eliminated because they either under- or over-explain the unusual situation (i.e., partially valid), and (3) explanations that are plausible but do not explain any of the unusual situation (i.e., completely invalid). When those who received training in convergent thinking were compared with those who did not, we found that those trained in convergent thinking (1) kept more valid explanations ($\mu = 79.9\%$ vs. $\mu = 71.5\%$; $t = 2.78, p < 0.001$, one-tailed), (2) correctly eliminated significantly more partially valid explanations ($\mu = 37.5\%$ vs. $\mu = 10.6\%$; $t = 6.48, p < 0.001$, one-tailed), and (3) correctly eliminated significantly more completely invalid explanations ($\mu = 58.8\%$ vs. $\mu = 27.6\%$; $t = 7.45, p < 0.001$, one-tailed).

**Dependent Variables: Coding of Responses**

The dependent variables used to test the effectiveness of the professional skepticism training are taken from the participants’ responses to the final assessment case. These responses were coded by two independent coders, each of whom had prior public accounting experience, and who were blind to the hypotheses and participant conditions. They coded the raw count of
explanations generated, quality of explanations, reasoning within explanations, number of crucial facts contained in the generated explanations, whether one of the two correct solutions was chosen, and the participants’ description of the process they used. The raw count is the number of unique explanations (i.e., not rewording an explanation) that are plausible (i.e., must relate to the information within the case). The quality of an explanation is measured by whether it contains at least one of the four crucial facts. The level of reasoning is determined by whether an explanation includes a description of why something is unusual and incorporates at least one of the crucial facts. When coding each explanation for quality and reasoning, the coders also identified which of the crucial facts, if any, were included. The coders received detailed directions regarding how to code each of these measures. They substantially agreed on the appropriate coding (initial agreement was 91.7%; \( K = 0.76, p < 0.001 \)), and all disagreements were settled by discussions between the two coders.

**H1: Impact of Divergent-Thinking Training**

Participants’ ability to use divergent thinking to generate explanations for unusual circumstances is measured in the final assessment case. To test H1a, H1b, and H1c, we used the raw count, quality, and level of reasoning found in participants’ generated explanations, respectively. Hypothesis 1a predicts that auditors trained to use divergent thinking (partial and full training) will generate more unique explanations than those who did not receive divergent-thinking training (control condition). The overall ANOVA is statistically significant (\( F = 3.40, p = 0.037 \)). Table 3, Panel A presents the contrasts between those who received training in divergent thinking and those who did not. As predicted, those who received divergent-thinking

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5 The overall ANOVA for time spent completing the final assessment case is not significant (39-minute average across conditions; \( F = 0.207, p = 0.813 \)).

6 Other variables, including the participant’s Hurtt Professional Skepticism score, motivation, and experience, were used as covariates in the statistical tests not reported here. None of these were significant nor did they affect the reported results.
training generated a statistically significant higher number of unique explanations ($\mu = 5.46$ vs. $\mu = 4.41$; $t = 1.84$, $p = 0.034$, one-tailed).

Hypothesis 1b predicts that auditors trained to use divergent thinking will have a higher percentage of quality explanations. The overall ANOVA is statistically significant ($F = 3.08$, $p = 0.049$). Table 3, Panel B presents the contrast for the percentage of explanations that contained at least one of the four crucial facts.\(^7\) As predicted, participants who received divergent-thinking training generated a significantly higher percentage of explanations that contained at least one of the four crucial facts ($\mu = 71.3\%$) compared with those who did not receive divergent-thinking training ($\mu = 56.0\%$; $t = 2.47$, $p = 0.008$, one-tailed).

Hypothesis 1c predicts that auditors trained to use divergent thinking will include reasoning that explains why something is unusual, and use at least one of the crucial facts in their explanations. The overall ANOVA is statistically significant ($F = 7.24$, $p = 0.001$). Table 3, Panel C presents the contrast of the percentage of explanations that contained reasoning between those who received training in divergent thinking and those who did not. Consistent with expectations, a statistically significant higher percentage of explanations that contained reasoning is found for those who received divergent-thinking training ($\mu = 50.6\%$ vs. $\mu = 23.5\%$; $t = 3.78$, $p < 0.001$, one-tailed).

Overall, H1a, b, and c were supported. Those who received training in divergent thinking generated a greater number of unique explanations than those who did not receive the training. Furthermore, the higher percentage of quality and better-reasoned explanations they generated

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\(^7\) We use percentages because if total numbers were used it would bias the results in favor of participants who generated more explanations compared to those who generated fewer. However, using raw numbers does not change the conclusions.
demonstrates that the increase in the number of explanations generated did not come at the cost of lower quality.

**H2 and H3: Joint Impact of Divergent- and Convergent-Thinking Training**

Hypothesis 2 predicts that auditors trained in both divergent and convergent thinking will generate more explanations than auditors who are trained in just divergent thinking. Table 4, Panel A presents the contrast between the full-training condition (which received training in both types of thinking,) and the partial-training condition (which received divergent-thinking training only) for the number of explanations generated. As expected, those who received training in both divergent and convergent thinking generated more explanations ($\mu = 6.1$) than those who received training in divergent thinking alone ($\mu = 4.9; t = 1.88, p = 0.032, \text{one-tailed}$). This supports the contention that auditors must be taught both types of thinking to achieve the maximum benefits of the professional-skepticism training.

Hypothesis 3 predicts that auditors trained to use both divergent and convergent thinking will be more likely to identify the explanation that correctly explains an unusual situation from the list of explanations they generated relative to divergent thinking alone.\(^8\) Specifically, it predicts that a synergistic improvement in the profession-skepticism process due to the interplay between divergent- and convergent-thinking processes will result in the full-training condition being better able to generate and choose one of the two correct solutions for the unusual evidence found within the final analytical review case. Table 4, Panel B presents the results for the participants’ choice of the most likely explanation. The Chi-square test among the three conditions is statistically significant ($\chi^2 = 13.50, p = 0.001$). As expected, the full-training

\(^{8}\) There is an implicit presumption that the control condition that received neither type of training will not perform as well as either group that received some training in the professional-skepticism process. And, results clearly support that presumption. None of the participants in the control condition identified one of the two possible solutions.
condition had a significantly higher success rate for generating and choosing one of the two actual solutions ($\mu = 25.0\%$) than the partial-training condition ($\mu = 5.3\%; \chi^2 = 5.69, p = 0.017$). Although two participants in the partial-training condition generated and selected the correct solution, this percentage does not significantly differ from zero. Therefore, training in both divergent and convergent thinking is needed in order to exhibit the diagnostic reasoning necessary for professional skepticism.

[Insert table 4 about here]

**Analysis of the Written Descriptions of the Process Used**

*Use of the Professional-Skepticism Process in the Final Assessment Case.* While participants in the full-training and partial-training conditions acquired knowledge and comprehension of the professional-skepticism process, it might be the case that they did not apply it in analyzing the final assessment case. It is also possible that participants naturally use the cognitive skills taught in the training, in which case the training offers no particular benefit. To assess these possibilities, we collected thought protocols in the final assessment case, which were also coded by the independent coders. Following the divergent-thinking stage, participants explained how their explanations were generated; and after the convergent-thinking stage, they explained how they chose the explanation they considered most likely to explain the evidence.

After generating explanations (divergent-thinking stage), we expected to find that, relative to those in the control condition, participants in both the partial-training and full-training conditions had created expectations and identified evidence that did not match their expectations, which led them to engage in divergent thinking. Table 5 presents the analysis of the participants’ reported descriptions, of their use of divergent-and convergent-thinking in the final assessment.

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9 At no point in the final assessment case were participants told to use the process in which they were trained.
case. As expected, there is a statistically significant difference between statements of those who received training in divergent thinking relating to their creation of expectations, identifying anomalies, and divergent thinking while generating explanations compared with those who did not receive the training ($\mu = 39.2\%$ vs. $\mu = 5.9\%$; $\chi^2 = 12.63, p < 0.001$).

[Insert table 5 about here]

After choosing the final explanation (convergent-thinking stage), we would expect participants in the full-training condition to discuss convergent thinking and testing explanations for logical validity more than those in the control and partial-training conditions. As expected, there is a significant difference in the reported use of convergent thinking while testing explanations for logical validity between those who received convergent-thinking training and those who did not ($\mu = 75.0\%$ vs. $\mu = 38.9\%$; $\chi^2 = 12.52, p < 0.001$). Also, there is a significant difference for testing explanations for over-explanation ($\chi^2 = 19.41, p < 0.001$) and for under-explanation ($\chi^2 = 11.58, p < 0.001$) between those who received convergent-thinking training and those who did not.

*Partially Incorrect vs. Completely Incorrect.* Further analysis of the written descriptions of the participants who did not choose one of the two correct solutions in the final assessment case examines whether the chosen explanation had at least one of the four crucial facts (partially correct) or none of the four crucial facts (completely incorrect). Table 6, Panel A shows that there is a significant difference in the level of correctness between all assessment conditions in terms of choosing partially correct explanations ($\chi^2 = 6.03, p = 0.049$). When the chosen explanation is incorrect, the full-training condition is better at being at least partially correct compared to the control ($\mu = 88.9\%$ vs. $\mu = 64.7\%; \chi^2 = 4.75, p = 0.029$), but not the partial-training condition ($\mu = 83.3\%; \chi^2 = 0.39, p = 0.533$).
Cue-Acquisition Errors vs. Hypothesis-Generation Errors. To understand where the training helped the most, we assessed cue-acquisition errors and hypothesis-generation errors separately. A cue-acquisition error is measured by whether or not all four crucial facts are discovered, and a hypothesis-generation error is measured by whether the correct solution is found when all the crucial facts are discovered. In the final assessment case, when a participant failed to select one of the two correct solutions, we assessed whether the mistake occurred due to a cue-acquisition error or a hypothesis-generation error.

In Table 6, Panel B, we show that there were no differences between conditions in cue-acquisition errors ($\chi^2 = 1.46, p = 0.483$). The full training had a 33.3% success rate, the partial training had a 26.3% success rate, and the control had a 20.6% success rate. There was a statistically significant difference between the conditions in making hypothesis-generation errors ($\chi^2 = 10.11, p = 0.006$). Of those who found all four crucial facts, the full-training condition ($\mu = 75.0\%$) had a significantly higher success rate than both the partial-training condition ($\mu = 20.0\%; \chi^2 = 4.79, p = 0.029$) and the control ($\mu = 0.0\%; \chi^2 = 8.06, p = 0.005$) conditions. The partial training ($\mu = 20.0\%$) was not significantly different from the control condition ($\mu = 0.0\%; \chi^2 = 1.59, p = 0.208$). Therefore, among those who were able to identify all four crucial facts, the professional-skepticism process training helped to avoid hypothesis-generation errors.

VI. DISCUSSION AND CONCLUSIONS

Professional skepticism has been found to be lacking in audit practice and has not been effectively induced in experimental settings. However, researchers have found that some auditors
are skeptical by nature and behave as the standards require (Hurtt 2010; Hurtt et al. 2011), while those who are not naturally skeptical do not behave so. One solution to this deficiency is to formally train auditors to be professionally skeptical. We adopt the view that professional skepticism is, in part, a diagnostic-thought process that can be effectively trained.

The audit standards state that professional skepticism involves “a questioning mind and a critical assessment of audit evidence” (PCAOB 2006, AU Section 230.07). We identified two cognitive skills that we believe capture the diagnostic process implied by the standards: divergent and convergent thinking. Divergent thinking is the creation of potential solutions for novel solutions in creative problem solving, which parallels the auditors’ challenge to generate explanations for unusual evidence they encounter. Convergent thinking counterbalances divergent thinking by evaluating the logical validity of explanations generated during divergent thinking and eliminating infeasible ones. Both skills have been shown to be trainable and useful in diagnostic reasoning. Two important aspects of these skills are that they are consistent with guidance found in the standards and that auditors can be trained to use them. Thus, we based our training of the professional-skepticism process on teaching auditors how to sequentially employ divergent thinking followed by convergent thinking.

To implement our training, we developed four on-line training modules to instruct auditors in how to apply these professional skepticism skills. Assessments indicated that this training was successful. Auditors who completed both divergent-and convergent-thinking training increased the number and quality of explanations in response to evidence not consistent with their expectations. Training auditors to use both divergent and convergent thinking resulted in a greater ability to generate and ultimately choose the correct explanation. Nine of the 36 participants trained to use both types of thinking correctly identified one of the two viable
explanations in the final assessment case, while only two of the 38 who received only divergent-thinking training and none of the 36 who received neither type of training identified one of two possible solutions. It follows that receiving both divergent-and convergent-thinking training led to auditors having a four-fold likelihood of identifying a logically viable explanation than that of divergent thinking alone, and infinitely better than having neither type. This result can be viewed from two perspectives. One-fourth of our participants who were fully trained were able to identify one of the solutions. On the other hand, three-fourths of the fully trained participants did not identify one of the solutions. Even though we were able to greatly improve the skeptical-thought process, we still have a long way to go.

The data show that this result is due to training in both divergent and convergent thinking, which allow auditors to generate alternatives more freely in the divergent-thinking phase because they know that explanations generated will be subsequently scrutinized for logical validity when performing convergent thinking. Our data are consistent with the idea that training in both results in auditors not trying to sort out which alternatives “make sense” when performing divergent thinking, and instead focusing on generating explanations. An important implication of this is that, if the auditor tries to do both of these at once, neither process receives its due effort and the best explanation might not be generated or might be prematurely discarded.

Our results point to convergent thinking causing auditors to process generated explanations more deeply. Not only did those trained to use convergent thinking identify correct solutions much more often, they were able to discard logically invalid explanations as well. Furthermore, when the chosen explanation was incorrect, those receiving both types of training were more likely to find all four of the critical facts and make fewer hypothesis-generation errors. Interestingly, Bedard and Biggs (1991) found a difference between senior and manager
auditors in their propensity to commit hypothesis-generation errors. In their study, 14 participants combined critical facts to generate a hypothesis. Six out of seven senior auditors failed to identify the correct hypothesis, but only two of seven manager auditors made this error. Our sample consisted entirely of senior-level auditors, and the occurrence of hypothesis-generation errors by our participants who received both divergent- and convergent-thinking training is similar to the rate found for audit managers by Bedard and Biggs.

From the firms’ perspective, one possible concern is that auditors’ use of the professional-skepticism process might create audit inefficiencies due to the time needed to generate and then eliminate explanations. That is, the time savings due to the higher-quality, reasoned-out explanations that are retained might not offset the time required to engage in the process. We measured the time to complete the final assessment case as well as the time to compete the scenarios in the first three modules, and no differences across conditions were found. Thus, those trained to use divergent- and convergent-thinking successfully chose one of the correct solutions more often, generated more quality and reasoned-out explanations, and eliminated more potentially time-consuming, invalid explanations in the scenarios in the same time as the other training conditions.

Training auditors to employ specific cognitive skills necessitates a unique approach to altering their behavior. It requires effective identification of the appropriate skills and the development of effective instructional methods. We believe that we have chosen two necessary and important skills—divergent and convergent thinking—and that training in both results in substantial improvements in judgment over divergent thinking alone. This suggests that the underlying cognitive process is complex and, as yet, not completely understood. We
acknowledge that there could be other skills that would also improve the professional skepticism of auditors that we have not tested.

Our training required a substantial time investment on the part of the participants. While we demonstrated that our training was very effective, we cannot address the issue of the efficiency of the training method. There could be other training methods for communicating the knowledge of the cognitive skills that are beneficial in the professional-skepticism process in more efficient ways. This remains an interesting and open question.

The proper exercise of professional skepticism is of critical importance to the audit profession. Future research could continue to focus on training auditors to think skeptically by examining different cognitive skills or alternate training methods. We recognize that training might not be the only course for inducing auditors to think skeptically; that approaches, such as workpaper design, could also be effective.
REFERENCES


Church, B. 1991. An examination of the effects that commitment to a hypothesis has on auditor's evaluations of confirming and disconfirming evidence. *Contemporary Accounting Research* (Spring): 513–534.


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<th>Full</th>
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<th>Control</th>
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TABLE 2
Demographic and Other Measures

Means of Various Demographic Variables, Motivation, Comprehension of the Materials and the Hurtt Professional Skepticism Scale across Assessment Conditions

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<th>Variables</th>
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<tr>
<td></td>
<td>Full Training (n = 36)</td>
<td>Partial Training (n = 38)</td>
<td>Control (n = 34)</td>
<td>SD</td>
<td>F</td>
<td>p</td>
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<tr>
<td>Audit Experience&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.10</td>
<td>3.60</td>
<td>3.70</td>
<td>0.90</td>
<td>3.600</td>
<td>0.031</td>
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<tr>
<td>Comprehension&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.30</td>
<td>2.34</td>
<td>2.26</td>
<td>0.40</td>
<td>0.305</td>
<td>ns</td>
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<tr>
<td>Gender&lt;sup&gt;c&lt;/sup&gt;</td>
<td>50.0%</td>
<td>65.8%</td>
<td>58.8%</td>
<td>na</td>
<td>0.387</td>
<td>ns</td>
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</tr>
<tr>
<td>Industry&lt;sup&gt;d&lt;/sup&gt;</td>
<td>19.4%</td>
<td>34.2%</td>
<td>26.5%</td>
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<td>6.30</td>
<td>6.20</td>
<td>6.20</td>
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<sup>a</sup>Audit Experience is how many busy seasons worked.  
<sup>b</sup>Comprehension is comprehension of the training material received throughout all four modules on a 4-point scale.  
<sup>c</sup>Gender is the proportion of female participants.  
<sup>d</sup>Industry is the proportion of participants that work mainly in the manufacturing industry.  
<sup>e</sup>Motivation is motivation to perform well throughout all four modules on a 9-point scale.  
<sup>f</sup>Skepticism Scale is the score received on the Hurtt skepticism scale where the possible score range is 30-180.
TABLE 3
Tests of Hypothesis One: Impact of Divergent Thinking Training

Contrast Tests between Those Who Received Training in Divergent Thinking Compared to Those Who Did Not Receive the Training [Contrast Coefficients: Control (-2), Partial Training (1), Full Training (1)]

Panel A: Number of unique explanations generated in the final assessment case

<table>
<thead>
<tr>
<th>Training Received</th>
<th>Mean</th>
<th>SD</th>
<th>Difference</th>
<th>t</th>
<th>p*</th>
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<tr>
<td>Divergent Thinking</td>
<td>5.46</td>
<td>2.9</td>
<td>1.1</td>
<td>1.84</td>
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<td>Alternate Task</td>
<td>4.41</td>
<td>2.7</td>
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</table>

Panel B: Percentage of Unique Explanations Generated that Contain At Least One of the Four Crucial Facts Embedded in the Final Assessment Case

<table>
<thead>
<tr>
<th>Training Received</th>
<th>Mean</th>
<th>SD</th>
<th>Difference</th>
<th>t</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Divergent Thinking</td>
<td>71.3%</td>
<td>28.7%</td>
<td>15.2%</td>
<td>2.47</td>
<td>0.008</td>
</tr>
<tr>
<td>Alternate Task</td>
<td>56.0%</td>
<td>31.7%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel C: Percentage of Unique Explanations Generated in Which the Explanation Provides Reasoning for Why a Crucial Fact Could Be Present Within the Final Assessment Case

<table>
<thead>
<tr>
<th>Training Received</th>
<th>Mean</th>
<th>SD</th>
<th>Difference</th>
<th>t</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Divergent Thinking</td>
<td>50.6%</td>
<td>37.0%</td>
<td>27.0%</td>
<td>3.78</td>
<td>0.001</td>
</tr>
<tr>
<td>Alternate Task</td>
<td>23.5%</td>
<td>28.2%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p-values are one-tailed
Table 4 – Tests of Hypothesis Two and Hypothesis Three:
Joint Impact of Divergent and Convergent Thinking Training

Panel A: Contrast Test between Those Who Received Training in Both Divergent and Convergent Thinking Compared to Those Who Received Training in Only Divergent Thinking [Contrast Coefficients: Control (0), Partial Training (-1), Full Training (1)]

<table>
<thead>
<tr>
<th>Training Received</th>
<th>Mean</th>
<th>SD</th>
<th>Difference</th>
<th>t</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both Divergent and Convergent Thinking</td>
<td>6.1</td>
<td>3.4</td>
<td>1.2</td>
<td>1.88</td>
<td>0.032</td>
</tr>
<tr>
<td>Only Divergent Thinking</td>
<td>4.9</td>
<td>2.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p-value is one-tailed

Panel B: Comparisons among the Assessment Conditions (Full Training, Partial Training and Control) of Generating and Ultimately Choosing the Correct Solution in the Final Assessment Case.

<table>
<thead>
<tr>
<th>Chosen Solution</th>
<th>Full Training</th>
<th>Partial Training</th>
<th>Control</th>
<th>Full vs. Control</th>
<th>Full vs. Partial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>n</td>
<td>n</td>
<td>χ²</td>
<td>p</td>
</tr>
<tr>
<td>Correct Solution Generated and Ultimately Chosen</td>
<td>36</td>
<td>25.0%</td>
<td>38</td>
<td>5.3%</td>
<td>34</td>
</tr>
<tr>
<td>Correct Solution Generated and Ultimately Chosen</td>
<td>9.75</td>
<td>0.002</td>
<td>5.69</td>
<td>0.017</td>
<td></td>
</tr>
</tbody>
</table>
Table 5
Use of the Professional Skepticism Process

Comparisons among the Participants in the Assessment Conditions (Full Training, Partial Training, and Control) WhoReported Use of Various Aspects of the Professional Skepticism Process in the Final Assessment Case\textsuperscript{a}

<table>
<thead>
<tr>
<th>Variables</th>
<th>Training Received</th>
<th>Mean</th>
<th>Difference</th>
<th>$\chi^2$</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of Creating Expectations, Identifying Anomalies, and Divergent Thinking While Generating Explanations</td>
<td>Divergent Thinking</td>
<td>39.2%</td>
<td>33.3%</td>
<td>12.63</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Alternate Task</td>
<td>5.9%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of Convergent Thinking While Testing Explanations for Logical Validity</td>
<td>Convergent Thinking</td>
<td>75.0%</td>
<td>36.1%</td>
<td>12.52</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Alternate Task</td>
<td>38.9%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypothesis Testing for Explanations That Explain More Than the Unusual Situation While Testing Explanations for Logical Validity</td>
<td>Convergent Thinking</td>
<td>36.1%</td>
<td>31.9%</td>
<td>19.41</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Alternate Task</td>
<td>4.2%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypothesis Testing for Explanations That Do Not Explain All of the Unusual Situation While Testing Explanations for Logical Validity</td>
<td>Convergent Thinking</td>
<td>72.2%</td>
<td>34.7%</td>
<td>11.58</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Alternate Task</td>
<td>37.5%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a}The conditions that received the related portion of the professional skepticism process are compared to those that did not receive the related part of the training.
Table 6

Comparisons among the Assessment Conditions (Full Training vs. Partial Training, and Full Training vs. Control) of Incorrect Chosen Solutions in the Final Assessment Case

Panel A: Classification of Incorrect Solutions (Partially Correct or Completely Incorrect)

<table>
<thead>
<tr>
<th>Chosen Solution</th>
<th>Condition</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full Training</td>
<td>Partial Training</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>n</td>
</tr>
<tr>
<td>Partially Correct(^a)</td>
<td>27(^c)</td>
<td>36(^c)</td>
</tr>
<tr>
<td>Completely Incorrect(^b)</td>
<td>11.1%</td>
<td>16.7%</td>
</tr>
</tbody>
</table>

\(^a\)Included one-three crucial facts within the chosen solution
\(^b\)Included no crucial facts within the chosen solution
\(^c\)Only participants that did not chose the correct solution are included

Panel B: Error Types (Cue-Acquisition Error or Hypothesis Generation Error)

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Successful Avoidance of Error</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Condition</td>
<td>Full vs. Control</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>Full Training</td>
</tr>
<tr>
<td>Cue-Acquisition Error(^d)</td>
<td>36</td>
<td>33.3%</td>
</tr>
<tr>
<td>Hypothesis-Generation Error(^e)</td>
<td>12(^f)</td>
<td>75.0%</td>
</tr>
</tbody>
</table>

\(^d\)Did not acquire all four crucial facts
\(^e\)Acquired all four crucial facts but did not choose the correct solution
\(^f\)Only participants that avoided a cue-acquisition error are included.