Training Auditors to Perform Analytical Procedures Using Metacognitive Skills

R. David Plumlee
The University of Utah

Brett A. Rixom
Florida International University

Andrew J. Rosman
Fairleigh Dickinson University

ABSTRACT: Although lower-level auditors increasingly carry out mandatory analytical procedures (APs) in audits, they do not perform as well as partners and managers. In order to improve performance in APs by lower-level auditors, we investigated tasks requiring creativity, where training in metacognition—consciously thinking about one's thought process—improves task performance. As a result, we train lower-level auditors to use a sequential thought process comprised of two metacognitive skills: divergent thinking, where they generate explanations for unusual evidence, followed by convergent thinking, where they evaluate explanations generated and eliminate those judged infeasible. To test the efficacy of our training, we conducted an experiment with three conditions: both divergent and convergent thinking, divergent thinking only, and a control. We found that training auditors in only divergent thinking increases both the number and quality of explanations generated for an unusual situation. However, the combination of divergent and convergent thinking training leads to improved explanation generation over divergent thinking alone and, more importantly, leads to a greater likelihood of generating and choosing the correct explanation.

Keywords: *metacognition; divergent thinking; convergent thinking; training; analytical procedures; ill-structured tasks.*

I. INTRODUCTION

Auditors are required to use analytical procedures (APs) in planning and reviewing engagements (American Institute of Certified Public Accountants [AICPA] 1988, SAS No. 56). Over the last ten years, APs account for up to 25 percent of budgeted audit hours and are increasingly performed by lower-level staff (Trompeter and Wright 2010). At the same time, the Public Company Accounting Oversight Board (PCAOB) finds that an intractable issue in eliminating deficiencies in audit firms' performance of APs is the failure to apply an appropriate level of professional skepticism, particularly in terms of setting and testing expectations (PCAOB 2008). This confluence of circumstances motivates us to ask whether training lower-level staff in cognitive problem-solving strategies can help them conduct APs more effectively. Specifically, we examine the efficacy of training auditors in metacognition—how they think about problems—as a way to improve their ability to perform APs.

Auditors increasingly rely on APs to assess risk and direct detailed substantive tests (Trompeter and Wright 2010), which makes APs critically important to detecting fraud and misstatements. As lower-level auditors perform APs more regularly, their ability to do so well becomes even more consequential. Bedard and Biggs (1991, 640) suggest training lower-level auditors to engage in "creative construction of explanations" as a way to enable them to provide better interpretations of unexpected evidence. However, client-specific circumstances and the ambiguous nature of APs (Abdolmohammadi and Wright 1987) make training auditors to perform APs across a variety of settings a challenge, which is why we choose to investigate metacognitive processes that are generalizable across settings to guide training.

We rely on the similarity between AP and creative problem-solving tasks to develop training centered on two metacognitive processes: divergent and convergent thinking. Divergent thinking entails mental generation of explanations for evidence or circumstances through recognition of cues and links within available information, and conceiving potential explanations that might otherwise go unnoticed (Cropley 2006; Santanen, Briggs, and DeVreede 2004; Scott, Leritz, and Mumford 2004). In contrast, convergent thinking focuses on the search for a solution where decision-makers identify weaknesses and limitations in their explanations to eliminate unlikely explanations and thereby focus on more likely explanations (Cropley 2006). We posit that training auditors to engage in divergent thinking before convergent thinking will enable them to better evaluate associated explanations, methodically winnow them, and propose viable solutions.

We created an online training environment and randomly assigned 108 senior auditors to one of three experimental conditions: full training (divergent and convergent thinking), partial training (only divergent thinking), or a control (neither divergent nor convergent thinking). The training included four self-paced online sessions. At the end of each session, we measured comprehension of the training and ability to apply the skills addressed in that session. The final session synthesized the concepts from prior sessions and included a comprehensive case to measure whether the training resulted in better performance in an AP task.

As expected, we found that divergent thinking training increased both the number and quality of explanations generated for an unusual situation. However, full training in both divergent and convergent thinking improved explanation generation beyond divergent thinking training alone. Furthermore, those in the full-training condition were more likely to generate and choose the correct explanation compared with those in the partial-training or control conditions. A follow-up study provided additional evidence that individuals without training in both skills tend to winnow explanations prematurely through "consistency checking" during the explanation-generation process. Consistency checking is a subconscious, high-speed verification process during which decision-makers discard explanations found to be inconsistent with parts of the available evidence. However, the discarded explanations may have been viable in light of all of the available evidence.

This research furthers the understanding of auditors' judgment performance in four important ways. First, prior audit research supports the importance of effective diagnostic reasoning by auditors (e.g., Bedard and Biggs 1991), but it does not examine whether training auditors to employ certain cognitive processes can improve their diagnostic reasoning or whether enhanced diagnostic reasoning, in turn, improves performance. We show that effective training in metacognitive skills increases auditors' diagnostic reasoning by enabling them to control and direct their thinking, which should be useful across a broad range of audit tasks.

This study also deepens our understanding of the hypothesis-generation process in APs. Rather than the reasonable presumption that learning to think divergently alone improves problem solving, we find that training in both divergent and convergent thinking provides significantly better results. This is because instructing auditors on how to generate hypotheses or explanations without explicit knowledge that the process includes subsequent convergent thinking means that they are likely to engage in consistency checking. That is, unless auditors consciously separate the process of generating explanations from assessing their viability, it is difficult for them to piece together all necessary facts or, more critically, it will lead them to eliminate the correct explanation. We also extend the research on creative problem solving by experimentally examining the joint effects of divergent and convergent thinking training on auditors, and demonstrate that a reduction in consistency checking is a mechanism by which training in both can improve performance.

Finally, we offer some insight into a potential source of difficulty auditors have in being sufficiently professionally skeptical (PCAOB 2008, 2013). According to Hurtt (2010, 151), professional skepticism is "the propensity of an individual to defer concluding until the evidence provides sufficient support for one alternative/explanation over others." It follows that if auditors are able to defer drawing premature conclusions by controlling and directing their thinking, then they will have an essential characteristic associated with professional skepticism. We show that auditors trained to use both divergent and convergent thinking tend to avoid premature elimination of explanations, instead subjecting explanations to subsequent, explicit evaluation. Thus, by training auditors in both these metacognitive processes, we show a potential route to increasing auditors' skeptical thinking.

Next, Section II presents the background literature relevant to the role of mental representations in APs, and research into divergent and convergent thinking. Section III develops the hypotheses. Section IV discusses the training procedures and the way we evaluated the use of the metacognitive skills in our AP task. Section V presents the data analysis and results; Section VI provides a discussion and conclusions.

II. BACKGROUND LITERATURE

Prior research establishes the important role of auditors' mental representations in analytical procedures. An auditor's mental representation of an analytic procedure situation contains his or her current beliefs about information relevance and links to potential explanations or solutions (Koonce 1993). A seminal paper on this point is by Bedard and Biggs (1991); they find that auditors who fail to generate the correct explanation in an analytical procedures task have incomplete mental representations (also see Brewster 2011).

We extend the prior research by arguing that divergent and convergent thinking are metacognitive processes that will improve auditors' AP performance. We posit that training in these two metacognitive processes will improve auditors' mental representations and, thus, their ability to generate quality hypotheses and solve AP tasks.

Our premise is based on a meta-analysis of creative problem-solving research by Scott et al. (2004, 362) that focused on the "production of original, potentially workable solutions to novel and ill-defined problems of relatively high complexity." Of particular relevance is their conclusion that

creative problem-solving training provides a set of strategies for working with available knowledge rather than developing new domain expertise. Problem solvers who receive training in divergent thinking generate more explanations that cover a broader range of options and produce more sophisticated possibilities and better solutions (Scott et al. 2004). They also generate more original ideas (Rose and Lin 1984), defer evaluative judgments, and retain original and unusual ideas (Kabanoff and Bottger 1991). Problem solvers who receive training in convergent thinking incorporate evaluative operations, such as searching for key facts, which results in better, more original solutions (Mumford, Connelly, and Gaddis 2003).

Wantz and Morran (1994) investigate the effectiveness of training graduate counseling students in either divergent or convergent hypothesis-formation strategies in making clinical assessments. They find that, compared to convergent hypothesis formation, training in divergent thinking resulted in (1) more relevant information, (2) a broader spectrum of information, and (3) more questions to pose to clinical clients. Examining advertising professionals, Kilgour and Koslow (2009) find that use of convergent thinking alone results in more appropriate, but less original, ideas, and divergent thinking alone improves the level of originality for those who are not predisposed to creativity.

Using either divergent or convergent thinking alone leads to the production of different kinds of ideas or solutions (Cropley 1999). When only divergent thinking is used, ideas have greater variability, but they often lack focus, which can create inefficiencies. Conversely, the use of only convergent thinking results in ideas that are more focused, but tend to be overly narrow, which decreases the probability that a set of potential solutions will contain the correct solution. In contrast, divergent thinking followed by convergent thinking potentially promotes identification of parallel links and patterns among dissimilar ideas (Brophy 2001).

This research shows that training in just divergent or convergent thinking improves problem solving, albeit in different manners. Auditors can potentially benefit from training in both of these metacognitive skills that individually have been proven successful in a creative problem-solving context. Knowing how to think divergently and convergently can help auditors find solutions in APs by allowing them to control and direct their thinking (Flavell 1979). One goal regarding APs is that auditors become more willing "to defer judgment and to not exclude apparently strange but original and potentially valuable ideas" (Kabanoff and Bottger 1991, 243).

III. HYPOTHESIS DEVELOPMENT

We develop three hypotheses about the impact of training auditors to use divergent and convergent thinking on their ability to solve ill-structured problems. Our first hypothesis focuses exclusively on the impact of divergent thinking training. The second and third predict benefits from the combination of training in both kinds of thinking.

Divergent thinking requires explicit, conscious generation of hypotheses or explanations from memory. Training auditors in divergent thinking should enable them to deliberately retrieve potential explanations from memory and combine previous solutions and ideas in new ways. Divergent thinking aims to create a richer set of potential explanations without considering their logical consistency. Making the process explicit forces auditors to be aware of the need to consider a broader set of possible explanations when they complete APs.

As an example, assume an auditor is conducting APs for preliminary planning and encounters a financial ratio that differs substantially from expectations. An auditor trained to engage in divergent thinking will consciously combine evidence included in the task with experiences from memory to generate a mental list of potential explanations for the unexpected deviation that potentially includes relationships that otherwise might have gone undetected. Furthermore, as part of divergent thinking, auditors are encouraged to generate novel explanations. Thus, auditors who receive divergent thinking training should generate a greater number of unique explanations.

In addition, divergent thinking should result in explanations that reflect deeper thought due to auditors' increased awareness of the process. We expect this deeper processing to result in explanations that refer to facts or circumstances critical to a viable solution and explanations that contain reasoning for inclusion in the set (Scott et al. 2004; Rose and Lin 1984; Kabanoff and Bottger 1991). Our first hypothesis states these ideas as parts (a) to (c) of H1:

H1: In response to an AP task, auditors trained to use divergent thinking, compared with auditors not trained to use it, will generate a richer set of possible explanations. More specifically, auditors will generate:
(a) more unique explanations;
(b) a higher percentage of explanations that refer to critical facts; and
(c) a higher percentage of explanations that contain reasoning for their inclusion.

Research into creative problem solving suggests that training in the combination of divergent and convergent thinking should lead to better outcomes than training in divergent thinking alone (Brophy 2001; Osburn and Mumford 2006). One benefit is that training in both allows auditors to avoid consistency checking, which allows them to focus on establishing a more exhaustive list of explanations.

The key to this expectation lies in the diagnostic process of a decision maker without formal diagnostic training. Research by Gettys and his colleagues (Gettys and Fisher 1979; Fisher, Gettys, Manning, Mehle, and Baca 1983; Gettys and Fisher 1986; Dougherty, Gettys, and Thomas 1997) shows that typical decision makers respond to a situation requiring diagnosis by retrieving explanations from memory, based on only part of the available information. During the explanation-generation process, they engage in consistency checking, which means they mentally compare these explanations with other available data for logical consistency and evaluate the set of explanations generated for plausibility.

Rather than engaging in consistency checking, auditors trained in both divergent and convergent thinking will be aware that they can defer any evaluation of explanations generated during divergent thinking until the convergent thinking stage. Thus, one result of training auditors in both kinds of thinking should be larger sets of potential explanations.

Continuing our example of an auditor conducting APs, without training in both divergent and convergent thinking, auditors will resort to consistency checking, resulting in a smaller set of explanations for the results found in the APs than auditors trained in both processes, who will avoid prematurely eliminating explanations because they are aware that a more complete assessment will follow during convergent thinking. Our second hypothesis (H2) expresses this expectation:

H2: In response to an AP task, auditors trained to use both divergent and convergent thinking will generate a larger list of potential explanations than auditors trained to use divergent thinking alone.

Convergent thinking in the creative problem-solving literature takes on several forms, such as planning (Caughron and Mumford 2008) and evaluative operations (Mumford et al. 2003). We extend the problem-solving literature on convergent thinking to auditing by conceptualizing the task facing auditors as one in which they logically analyze an explanation by determining whether it (1) explains more than the event the auditor considers unusual (a violation of necessity), or (2) explains only part or none of the unusual event (a violation of sufficiency) (Brown, Peecher, and Solomon 1999; Klayman and Ha 1987). For an explanation to be logically necessary, the unusual evidence would not occur unless the condition described in the explanation also was present. For example, an auditor encounters a situation where manufacturing labor as a percentage of direct manufacturing costs is much higher than last year. The auditor's initial explanation is that the higher labor cost is due to unauthorized overtime, but actually, there was a rise in product demand and

most of the overtime is authorized. In this case, the explanation of unauthorized overtime was not necessary to explain the higher labor costs; thus, it is a violation of necessity. A sufficient explanation is one where the unusual evidence would only occur when the condition described in the explanation was present. In the unexpectedly high labor cost situation, if the auditor had offered the explanation that overtime had occurred, then it would not be sufficient because some of the overtime was authorized, which is usual. The explanation violates sufficiency because it accounts for all of the unusual evidence, but it also accounts for usual events.

Directing auditors to utilize convergent thinking on the explanations they generate during divergent thinking will cause them to assess the logical validity of each more deeply. An additional benefit is that conscious elimination of explanations may help the auditor understand the interplay among multiple crucial facts. Eliminating illogical explanations also means the auditor reduces the set of plausible explanations and can focus further consideration on the logically valid alternatives. Thus, training in both divergent and convergent thinking will lead auditors to more deeply examine explanations, better understand crucial facts, and eliminate from consideration logically invalid explanations. In turn, auditors trained in both divergent and convergent thinking provide a superior explanation for unusual audit situations. Our third hypothesis (H3) expresses this expectation:

H3: In response to an AP task, auditors trained in both divergent and convergent thinking will be more likely to identify the correct solution from their generated list of explanations than auditors trained to use divergent thinking alone.

IV. EXPERIMENTAL METHODS

Participants

A joint effort by the Center for Audit Quality (CAQ) and three of the Big 4 firms yielded participants for the experiment from across the United States. One hundred twenty-two participants started the experimental training and assessments, and 108 completed it.[1] Participants were senior auditors who had worked as auditors for an average of 3.5 busy seasons. Table 1 reports various demographic and other measures by experimental condition. The only dimension on which the conditions differed was audit experience; the average ranged from 3.14 busy seasons to 3.68.[2]

Experimental Design and Procedures

Participants were assigned randomly to one of three experimental conditions: (1) those in "full training" received instruction in divergent and convergent thinking, (2) those in "partial training" received instruction in the use of divergent thinking, and (3) those in "control" received no instruction in either metacognitive skill. We do not include a convergent-only condition because we view the diagnostic process as a sequence of divergent thinking followed by convergent thinking. Therefore, convergent thinking not preceded by divergent thinking would lead to assessing the validity of explanations without first generating a set of explanations to assess.

We divided training and assessments into a preliminary module and four training modules. Table 2 shows the unique combination of training and assessments that participants in each

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[1] 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.

[2] Since audit experience differed across experimental conditions, we incorporated it as a covariate in statistical comparisons for the effects of experimental conditions. In none of these analyses was audit experience statistically significant, nor did it affect the statistical inferences. Therefore, we report our results without consideration of audit experience.

TABLE 1

Demographic and Other Measures
Means of Various Demographic Variables

Variables	Condition[a]			SD	Statistic	p-value
	Full Training (n = 36)	*Partial Training* (n = 38)	*Control* (n = 34)			
Audit Experience	3.14	3.61	3.68	0.90	F = 3.60	0.031
Comprehension	2.30	2.34	2.26	0.40	F = 0.31	0.738
Gender	50.0%	65.8%	58.8%	NA	χ^2 = 1.90	0.387
Industry	19.4%	34.2%	26.5%	NA	χ^2 = 2.06	0.358
Motivation	6.30	6.20	6.20	1.50	F = 0.36	0.700
Skepticism Scale	140.60	141.80	140.50	11.60	F = 0.37	0.695

[a] *Full Training*: Auditors were trained in the use of the metacognitive skills of divergent thinking and convergent thinking; *Partial Training*: Auditors were trained in the use of the metacognitive skill of divergent thinking; *Control*: Auditors were not trained in either of the metacognitive skills. All auditors, regardless of condition, were trained in the use of procedural knowledge to develop expectations and identify conflicting evidence.

Variable Definitions:
Audit Experience = number of busy seasons worked;
Comprehension = comprehension of the training material received on a four-point scale;
Gender = proportion of female auditors;
Industry = proportion of auditors who work mainly in the manufacturing industry;
Motivation = motivation to perform well in the training on a nine-point scale; and
Skepticism Scale = score received on the Hurtt Professional Skepticism Scale with a possible score range of 30–180.

condition received. The control condition received alternate training in the second and third training modules instead of the divergent and convergent thinking training, while partial training received alternate training in module three instead of the convergent thinking training. The alternate training in the second module consisted of ways of dealing with group interactions, and the alternate training in the third module consisted of ways to deal with client relationships. The alternate training was presented in a fashion similar to the metacognitive skill training.

All modules were administered through web-based survey software. The software captured all assessment measures, retrospective thought protocols, demographic measures, personality measures, and time spent on each individual screen. Each participant received a personalized invitation that included a web link for each module, and was instructed not to discuss any of the experimental materials or to share their personalized web link with other participants. They had two business days to complete each module and could complete them at any time during that period. Regardless of when they finished a module, they had to wait until the end of the two business days before they received 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.

We used multiple-choice questions to examine whether participants acquired knowledge, as measured by ability to recall the training, and comprehension, as measured by ability to interpret the training. As Table 2 shows, when an experimental condition received the diagnostic-process training, the corresponding knowledge and comprehension questions were answered in that module. When participants received alternate training in module two or three, the knowledge and comprehension questions pertaining to the excluded training were included in the preliminary module.

TABLE 2

Training Activities and Assessments

Module	Training Activities	Condition		
		Full Training	Partial Training	Control
Preliminary	Preliminary assessment of auditing knowledge	X	X	X
	Module two multiple-choice training questions			X
	Module three multiple-choice training questions		X	X
One	Training in developing expectations and identifying evidence that conflicts with those expectations	X	X	X
	Multiple-choice training questions with feedback	X	X	X
	Assessment of developing expectations and identifying conflicting evidence	X	X	X
Two	Training and practice in the use of divergent thinking	X	X	
	Multiple-choice training questions with feedback	X	X	
	Alternate training with related multiple-choice questions			X
	Assessment of the use of divergent thinking	X	X	X
Three	Training and practice in the use of convergent thinking	X		
	Multiple-choice training questions with feedback	X		
	Alternate training with related multiple-choice questions		X	X
	Assessment of the use of convergent thinking	X	X	X
Four	Review and synthesis of training that the participant received in the previous three modules	X	X	X
	Final assessment of using the synthesized training to correctly identify the cause of an unusual audit situation	X	X	X
	Obtain retrospective thought protocols of the process used to complete the final assessment	X	X	X

Manipulation Checks: Knowledge and Comprehension

Participants' ability to recall (knowledge) and interpret (comprehension) the training constitutes a starting point for the effectiveness of the training. Therefore, we compared the accuracy rates for the knowledge and comprehension multiple-choice questions across conditions and modules. We expected to find no differences in knowledge and comprehension for the first training module because all conditions received the same training. In untabulated results, the average percent correct across the conditions was 80.0 percent, and there are no statistically significant differences across conditions ($F = 0.60$, $p = 0.552$). For the second training module, we expected those in the full- and partial-training conditions to perform better because they received the divergent thinking training. An untabulated statistical contrast shows that those who received the training correctly answered a higher percentage of divergent thinking questions than those who did not receive the training (70.7 percent versus 51.4 percent; $t = 5.97$, $p < 0.001$, one-tailed).[3] For the third module, we conducted an untabulated statistical contrast between those who received full convergent thinking training versus those who received either partial training or control. For the

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[3] Before estimating the contrasts, we conducted two untabulated one-way ANOVAs with Condition as the three-level independent variable. The model for the divergent thinking questions was statistically significant ($F = 23.74$, $p < 0.001$), as was the model for the convergent thinking questions ($F = 47.89$, $p < 0.001$).

percentage of convergent thinking questions correctly answered, those who received the full training correctly answered a higher percentage (76.8 percent versus 49.1 percent; t = 9.81, p < 0.001, one-tailed). These results demonstrate that participants trained in a specific metacognitive skill acquired greater knowledge and comprehended more of the particular skill, which demonstrates the effectiveness of intended manipulations.

Training Modules

Every participant received one preliminary module and four training modules. To motivate the training and make it professionally meaningful, we told participants that the training "focuses on ways that you can improve your ability to effectively and efficiently exercise professional skepticism throughout an audit." Their professional skepticism scores using the Hurtt Professional Skepticism Scale (Hurtt 2010) were collected, which allowed testing for any effects due to the reason put forth for the training. The preliminary module introduced the study to participants, but did not include any training. It allowed them to practice using the survey software and included demographic and general auditing knowledge questions (modified from Tan and Kao [1999]).

Participants in all three experimental conditions received the same material in the first training module, which introduced the basic concepts of professional skepticism found in the auditing standards and explained the importance of creating expectations and identifying evidence inconsistent with those expectations. The notion of identifying unexpected evidence is consistent with ill-structured tasks where problems lack precise definition. To provide participants with the same procedural knowledge, all participants were told that their expectations should account for what is usual for the client, industry, and the evidence normally found in the audit. The module's instruction was followed by a set of multiple-choice questions designed to assess participants' knowledge and comprehension of the module's content and to reinforce learning by providing explanatory feedback. For example, knowledge and comprehension were assessed by questions such as "According to AU Section 329 (Analytical Procedures), which of the following is NOT true about creating expectations?" The module ended with an assessment that presented two usual and three unusual scenarios,[4] requiring participants to create expectations and identify conflicting evidence by categorizing the evidence as either usual or unusual.

The substantive metacognitive skill training occurred in the second and third training modules. In the second training module, the participants in the full- and partial-training conditions received instructions and illustrations on the effective use of divergent thinking to develop a set of plausible explanations for unusual events or transactions. The instructions directed them to view the generation of multiple possible explanations for the unusual events or transactions that had been discovered as a "creative challenge." Multiple-choice questions with explanatory feedback were included. Finally, participants completed an assessment where they applied divergent thinking to generate plausible explanations for audit scenarios determined by pretests to be unusual.

In the third training module, the participants in the full-training condition received instructions and illustrations on the effective use of convergent thinking. The instructions directed them to test explanations using logic-based tests found in formal hypothesis testing (Brown et al. 1999; Klayman and Ha 1987). They were shown how to test whether their explanations (1) met the criteria of being necessary and sufficient, (2) violated the necessity criterion, (3) violated the sufficiency criterion, or (4) met neither of the criteria. Multiple-choice questions and practice applying convergent thinking in an audit situation with explanatory feedback were included.

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[4] The training materials said: "Audit evidence, regardless of its source, that is not consistent with what you expect to find would be identified as 'unusual.'"

Finally, participants completed an assessment where they applied convergent thinking to eliminate plausible, yet illogical, explanations for unusual audit situations.

The fourth module did not introduce any new concepts. Instead, participants reviewed all of the concepts and strategies they received in the previous three training modules. For the full-training condition, the fourth module synthesized information on the relationship between expectations and unusual evidence and combined divergent and convergent thinking into a complete diagnostic process. In the partial-training condition, it synthesized information up through the divergent thinking stage of the diagnostic process. The control condition participants did not receive information about the diagnostic process. The fourth module also included the overall assessment case, which was an AP task where they could apply their training to identify correctly the cause of an unusual ratio fluctuation. The case addressed the audit of a small manufacturing company, as adapted from Bedard and Biggs (1991), and contained four crucial facts that could be explained jointly as either a specific business decision or an error. Finally, participants completed retrospective protocols in which they described the process they used to create their list of possible explanations and the process by which they chose the explanation they considered the most likely actual cause.

Convergent thinking could not be measured in the final assessment case without leading participants through the diagnostic process. However, we expected that those exposed to convergent thinking in the full-training condition would test explanations for logical validity and eliminate invalid plausible explanations. 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, along with a list of seven to nine explanations for each. We chose these explanations to fit into three categories: (1) *completely valid:* explanations that are plausible and logically valid; (2) *partially valid:* explanations that are plausible, but should be eliminated because they either under-explain (i.e., violation of sufficiency) or over-explain (i.e., violation of necessity) the unusual situation; and (3) *completely invalid:* explanations that are plausible, but do not explain any of the unusual situation (i.e., violation of sufficiency). We compared those who received full training in convergent thinking to those who received only partial training or control.[5] In untabulated results, those trained in convergent thinking (1) kept more valid explanations (79.9 percent versus 71.5 percent; t = 2.78, p < 0.001, one-tailed), (2) correctly eliminated more partially valid explanations (37.5 percent versus 10.6 percent; t = 6.48, p < 0.001, one-tailed), and (3) correctly eliminated more completely invalid explanations (58.8 percent versus 27.6 percent; t = 7.45, p < 0.001, one-tailed). These provide support for the effectiveness of our convergent thinking training.

Dependent Variables: Coding Responses

We obtain the dependent variables used to test for the hypothesized effects from the participants' responses to the overall assessment case in module four. Two independent coders, each of whom had prior public accounting experience and were blind to the hypotheses and participant conditions, coded these responses. They coded the raw count of explanations generated, whether any of the four crucial facts were included in an explanation, whether an explanation contained reasoning for why a crucial fact is included, whether a correct solution was chosen, and the participants' description of the process they used. The coders received detailed directions regarding how to code each of these measures. For example, they were told that the raw count is the

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[5] Before estimating the contrasts, we conducted three untabulated one-way ANOVAs with Condition as the three-level independent variable. All models were statistically significant, kept more valid explanations (F = 3.94, p = 0.022), eliminated more partially valid explanations (F = 21.66, p < 0.001), and eliminated more completely invalid explanations (F = 28.27, p < 0.001).

number of unique explanations, not including rewording a previous explanation that is plausible based on the information within the case. They substantially agreed on the appropriate coding (initial agreement was 91.7 percent; K = 0.76, p < 0.001), and the two coders settled all disagreements via discussions between the two of them.

V. RESULTS

H1: Impact of Divergent Thinking Training

Participants' ability to use divergent thinking to generate explanations for unusual circumstances is measured in the overall assessment case.[6] We used the number of unique explanations (H1a), the percentage of explanations that refer to crucial facts (H1b), and the percentage of explanations that include reasoning for why a crucial fact was included (H1c) as the dependent variables. We conducted three untabulated one-way ANOVAs with *Condition* (*Full, Partial, Control*) as the three-level independent variable, and each of the models was statistically significant: unique explanations (F = 3.40, p = 0.037), crucial facts (F = 3.08, p = 0.049), and reasoning (F = 7.24, p < 0.001).[7]

Table 3, Panel A shows the means, medians, and standard deviations for these measures across conditions, and Table 3, Panel B presents the planned contrasts between participants who received training in divergent thinking and the control group who did not receive any training in divergent thinking for all three dependent variables. As predicted, we find that auditors trained to use divergent thinking generated a higher number of unique explanations (5.46 versus 4.41; t = 1.84, p = 0.034, one-tailed) and a higher percentage of explanations that contained at least one of the four crucial facts compared with those who did not receive divergent thinking training (71.2 percent versus 56.0 percent; t = 2.47, p = 0.008, one-tailed). They also generated a higher percentage of explanations that contained in-depth reasoning (50.5 percent versus 23.5 percent; t = 3.78, p < 0.001, one-tailed). Each of these results is consistent with the predictions in the first hypothesis.

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

H2 predicts that auditors trained in both divergent and convergent thinking will generate more explanations than auditors trained in just divergent thinking. Table 3, Panel C presents the planned contrast between the full- and partial-training conditions for the number of explanations generated. As expected, those who received training in both divergent and convergent thinking (full training) generated more explanations (6.08) than those who received training in divergent thinking alone (4.87) (t = 1.88, p = 0.032, one-tailed). This supports the contention that auditors taught both metacognitive skills produce a larger set of potential explanations than those trained in divergent thinking alone.

H3 predicts an improvement in the diagnostic process due to the synergy between divergent and convergent thinking. Specifically, it predicts that auditors trained to use both divergent and

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[6] An untabulated overall ANOVA for time spent completing the final assessment case is not statistically significant (39-minute average across conditions; F = 0.207, p = 0.813).

[7] We conducted three separate ANCOVAs with these dependent variables. For each model, *Condition* was the independent variable, *Audit Experience* was a covariate, and their interaction was included. We find an overall statistically significant difference across the three conditions for unique explanations (F = 3.11, p = 0.049), crucial facts (F = 4.47, p = 0.014), and reasoning (F = 6.16, p = 0.003). Neither *Audit Experience* nor its interaction with *Condition* was statistically significant in any of these ANCOVAs, and the statistical interpretation for *Condition* did not differ from that found in the ANOVAs. Therefore, we report only the one-way ANOVA results with *Condition* as the three-level independent variable for each of these tests.

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TABLE 3

Tests of H1 and H2

Panel A: Descriptive Statistics

Condition[a]	Unique Explanations Mean [Median] (Std. Dev.)	Inclusion of Crucial Facts Mean [Median] (Std. Dev.)	Inclusion of Reasoning Mean [Median] (Std. Dev.)
Full Training (n = 36)	6.08 [6.00] (3.35) A[b]	72.1% [78.9%] (28.2%) B	52.6% [64.1%] (36.0%) C
Partial Training (n = 38)	4.87 [4.00] (2.26) D	70.4% [77.5%] (29.4%) E	48.6% [50.0%] (38.2%) F
Control (n = 34)	4.41 [3.50] (2.67) G	56.0% [61.3%] (31.7%) H	23.5% [14.3%] (28.2%) I

Panel B: Planned Contrasts for Divergent Thinking (H1): Full Training and Partial Training versus Control

H1a: Unique Explanations: (A + D)/2 > G	t = 1.84	p = 0.034*
H1b: Explanations that Include Crucial Facts: (B + E)/2 > H	t = 2.47	p = 0.008*
H1c: Explanations that Include Reasoning: (C + F)/2 > I	t = 3.78	p = 0.001*

Panel C: Planned Contrast for the Combination of Divergent and Convergent Thinking (H2): Full Training versus Partial Training

H2: Unique Explanations: A > D	t = 1.88	p = 0.032*

* p-value is one-tailed due to a directional prediction.

[a] *Full Training*: Auditors were trained in the use of the metacognitive skills of divergent thinking and convergent thinking; *Partial Training*: Auditors were trained in the use of the metacognitive skill of divergent thinking; *Control*: Auditors were not trained in either of the metacognitive skills. All auditors, regardless of condition, were trained in the use of procedural knowledge to develop expectations and identify conflicting evidence.

[b] Cell Reference: Letter used to refer to which cells are being used in the planned contrasts in Panel B and Panel C.

Panel A reports the descriptive statistics for the number of unique explanations generated, the percentage of those explanations that include at least one of the four crucial facts, and the percentage that contain reasoning for why a crucial fact is present in the final assessment.

Panel B reports the results of the planned contrasts between auditors who received training in the metacognitive skill of divergent thinking (full training and partial training) and those who did not (control). Before running the contrasts, we conducted three untabulated one-way ANOVAs with Condition as the three-level independent variable, and each of the models was statistically significant: unique explanations (F = 3.40, p = 0.037), crucial facts (F = 3.08, p = 0.049), and reasoning (F = 7.24, p < 0.001).

Panel C reports the results of the planned contrast between auditors who trained in the metacognitive skills of divergent thinking and convergent thinking (full training) and those who trained only in the metacognitive skill of divergent thinking (partial training). Before running the contrast, we conducted an untabulated one-way ANOVA with Condition as the three-level independent variable, and the model was statistically significant (F = 3.40, p = 0.037).

convergent thinking (full training) are more likely to identify an explanation that correctly explains an unusual situation from the list of explanations they generated relative to divergent thinking alone. An untabulated omnibus Chi-square test shows an overall statistically significant difference between the three conditions ($\chi^2 = 13.50$, p < 0.001). As expected, an untabulated contrast shows that those in the full-training condition had a significantly higher success rate for generating and choosing one of the two actual solutions than the partial-training condition (25.0 percent versus 5.3 percent; $\chi^2 = 5.69$, p = 0.017). None of the participants in the control condition generated and selected the correct solution. These results strongly suggest that training in both divergent and convergent thinking is more likely to lead auditors to exhibit significant levels of diagnostic reasoning.

Use of Metacognitive Skills in the Final Assessment

We used retrospective written protocols to understand the specific ways in which different types of training affected the diagnostic process used to complete the final assessment. We collected thought protocols in the final assessment,[8] which the independent coders also coded. The instructions to the participants stated, "Please describe the process that you used in choosing what you believe to be the actual cause of the results in the analytical review." Our interest was in whether the process they described included specific comments about the metacognitive skills they had been trained to use.

Table 4, Panel A shows the percentages of participants who report using different metacognitive skills, based on the self-descriptions of the process each participant used. Table 4, Panel A shows that 80.6 percent of the participants in the full-training condition and 81.6 percent in the partial-training condition reported using divergent thinking. In contrast, only 55.9 percent of the participants in the control condition, who did not receive divergent thinking training, reported using it. Table 4, Panel B shows a significantly higher percentage of participants who received divergent thinking training reported using it than participants who did not receive this training (81.1 percent versus 55.9 percent; $\chi^2 = 7.53$, p = 0.006).

We also examined participants' self-reported process descriptions to determine their use of convergent thinking as an overall process. Table 4, Panel A shows that 75.0 percent of those who received convergent thinking training reported using it in their diagnostic process. Half of those in the partial-training condition (50.0 percent) reported its use even though they did not receive convergent thinking training, and only 26.5 percent of those who received neither type of training reported use of convergent thinking. Table 4, Panel C shows a statistically significant difference in the reported use of convergent thinking between those who received convergent thinking training and those who did not (75.0 percent versus 37.9 percent; $\chi^2 = 12.52$, p < 0.001).

As part of convergent thinking in the full-training condition, we trained participants to test their generated explanations for violations of necessity and sufficiency. When we examine participants' reports for testing sufficiency, a pattern similar to overall use of convergent thinking was reported (full, 72.2 percent; partial, 50.0 percent; control, 23.5 percent), which resulted in statistically significant differences between those who received convergent thinking training and those who did not ($\chi^2 = 11.58$, p < 0.001). The percentages of those reporting testing for violation of necessity is particularly interesting. While 36.1 percent of participants trained in convergent thinking reported testing for violation of necessity, only two participants in the partial-training condition and one in the control reported using it. A statistical comparison between the percentages of those trained to use convergent thinking and those who were not shows a significant difference in testing explanations for necessity ($\chi^2 = 19.41$, p < 0.001).

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[8] At no point in the final assessment were participants told to use the process in which they were trained.

TABLE 4

Auditors' Reported Use of Metacognitive Skills

Panel A: Descriptive Statistics

Condition[a]	Divergent Thinking	Convergent Thinking	Testing for Violation of Necessity	Testing for Violation of Sufficiency
Full Training (n = 36)	80.6%	75.0%	36.1%	72.2%
	A[b]	B	C	D
Partial Training (n = 38)	81.6%	50.0%	5.3%	50.0%
	E	F	G	H
Control (n = 34)	55.9%	26.5%	2.9%	23.5%
	I	J	K	L

Panel B: Planned Contrasts Full Training and Partial Training versus Control

Divergent Thinking: (A + E)/2 > I	$\chi^2 = 7.53$	p = 0.006

Panel C: Planned Contrasts Full Training versus Partial Training and Control

Convergent Thinking: B > (F + J)/2	$\chi^2 = 12.52$	p < 0.001
Testing for Violation of Necessity: C > (G + K)/2	$\chi^2 = 19.41$	p < 0.001
Testing for Violation of Sufficiency: D > (H + L)/2	$\chi^2 = 11.58$	p < 0.001

[a] *Full Training*: Auditors were trained in the use of the metacognitive skills of divergent thinking and convergent thinking; *Partial Training*: Auditors were trained in the use of the metacognitive skill of divergent thinking; *Control*: Auditors were not trained in either of the metacognitive skills. All auditors, regardless of condition, were trained in the use of procedural knowledge to develop expectations and identify conflicting evidence.
[b] Cell Reference: Letter used to refer to which cells are being used in the planned contrasts in Panel B and Panel C.
Panel A reports the descriptive statistics for auditors' reported use of divergent thinking, convergent thinking, hypothesis testing for violation of necessity, and hypothesis testing for violation of sufficiency. The use of "divergent thinking" column reports the percentage of auditors who discussed divergent thinking in their written description of the process used during the generation of explanations in the final assessment. The use of "convergent thinking" column reports the percentage of auditors who discussed convergent thinking in their written description of the process used while choosing a specific explanation from their generated explanations in the final assessment. The use of hypothesis "testing for violation of necessity" column reports the percentage of auditors who discussed testing explanations to see whether their generated explanations explain more than the unusual situation while choosing a specific explanation in the final assessment. The use of hypothesis "testing for violation of sufficiency" column reports the percentage of auditors who discussed testing explanations to see whether the explanations do not explain all of the unusual situation while choosing a specific explanation in the final assessment.
Panel B reports the results of the planned contrast between auditors who trained in the metacognitive skill of divergent thinking (full training and partial training) and those who did not (control). Before running the contrast, an untabulated omnibus Chi-square test was conducted and shows an overall statistically significant difference between the three conditions ($\chi^2 = 7.54$, p = 0.023).
Panel C reports the results of the planned contrasts between auditors who trained in the metacognitive skills of divergent thinking and convergent thinking (full training) and those who did not receive training in both metacognitive skills (partial training and control). Before running each contrast, three separate untabulated omnibus Chi-square tests were conducted and show an overall statistically significant difference between the three conditions for convergent thinking ($\chi^2 = 16.50$, p < 0.001); testing for violation of necessity ($\chi^2 = 19.48$, p < 0.001); and testing for violation of sufficiency ($\chi^2 = 16.61$, p < 0.001).

Our analysis of thought protocols in the final assessment suggests that auditors are less likely to engage in these metacognitive skills without being trained to do so. This is particularly true for testing necessity when convergent thinking.

Supplementary Experiment

In formulating H2, we maintain that auditors trained to employ divergent thinking followed by convergent thinking (i.e., full training) will generate a larger list of potential explanations than those trained in divergent thinking alone (i.e., partial training), because they would defer elimination of alternatives they generate until a subsequent deliberate evaluation.

To investigate whether those trained in both metacognitive skills are aware that they defer elimination of explanations, we conduct a smaller supplementary experiment to gather data on the process individuals employ in generating explanations. The supplementary experiment incorporates two training conditions: full training and convergent thinking only.[9] The full-training condition began with divergent thinking training, while the convergent-only condition received training in an alternative task. Then, both conditions received convergent thinking training. The participants were 46 Master's of Accounting students from a large public university enrolled in a fraud and forensic accounting class. They were randomly assigned to either condition.[10] We used the same web-based survey software and similar experimental procedures from the first experiment.

We used several statements to examine whether full training led to a deferral of evaluation for explanations generated by asking participants whether the statement was indicative of the process that they used when generating explanations in the final case. These statements were included in the materials following participants' generation of explanations and selection of their most likely explanation. The statements, along with the participants' average responses on a seven-point Likert scale where 1 = completely disagree (i.e., indicates not deferring judgment of explanations until after the generation phase) and 7 = completely agree (i.e., indicates deferring judgment), are shown in Table 5. The average responses to three of the four questions were significantly different, while the difference for a fourth statement was marginally significant. The differences indicate that individuals trained in both metacognitive skills defer elimination of explanations when generating explanations for unusual situations compared to those who only received convergent thinking training. In addition, we combined these four questions into a scale of "deferring explanation elimination" (Cronbach's alpha = 0.738) and find that the two conditions differed significantly in the expected direction (full, 5.64, versus convergent, 3.99; $t = 4.79$, $p < 0.001$, one-tailed).

These results support our contention that training in both metacognitive skills leads individuals consciously to keep explanations they generate for later evaluation during the convergent thinking phase. With training in convergent thinking alone, decision makers eliminate explanations while they are being generated, possibly eliminating a correct explanation or eliminating an incorrect explanation that might provide a better understanding of the problem and aid in choosing the correct solution.

VI. DISCUSSION AND CONCLUSIONS

Partners and managers perform APs better than do lower-level auditors, in part because the former have greater technical knowledge and a more diverse set of previous solutions that they can retrieve from memory as needed. Since lower-level auditors do not have these experiences to draw

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[9] The combination of training in an alternative task followed by convergent thinking training was not included in the primary experiment.

[10] One participant indicated he or she was in the tax track of the Master's of Accounting program with limited auditing knowledge and was excluded from all analyses. This exclusion had no effect on the inferences drawn from the results.

TABLE 5

Use of Consistency Checking
Means for the Responses to the Consistency Checking Items

| Consistency Checking Items[b] | Condition[a] | | t-stat. | p-value |
	Full Training (n = 22)	Convergent Training (n = 23)		
My list includes all of the explanations that I could think of, including explanations that I thought may not hold up under closer scrutiny.	5.45	4.70	1.30	0.100
I mentally checked the explanations as I thought of them to see if they made sense, and I eliminated those that didn't make sense.[c]	4.86	2.74	5.19	0.000
I consciously kept explanations on my list knowing that I could choose not to pursue them.	5.73	3.87	3.81	0.000
I think it's okay that some of the explanations on my list might not hold up under closer examination.	6.50	4.65	3.53	0.001
Average of the four consistency checking items to create a single consistency checking measure (Cronbach's alpha = 0.738).	5.64	3.99	4.79	0.000

[a] *Full Training*: Participants were trained in the use of the metacognitive skills of divergent thinking and convergent thinking; *Convergent Training*: Participants were trained in the use of the metacognitive skill of convergent thinking. All participants, regardless of condition, were trained in the use of procedural knowledge to develop expectations and identify conflicting evidence.

[b] Consistency Checking Items: The four items measured on seven-point Likert scales where 1 = completely disagree (i.e., indicates not deferring judgment of explanations until after the generation phase) and 7 = completely agree (i.e., indicates deferring judgment).

[c] This statement is designed so that agreeing with the statement (i.e., a higher score) indicates that judgment of explanations is not deferred until after the generation phase. The other three statements have the design that agreeing with the statement (i.e., a higher score) indicates that judgment of explanations is deferred. To facilitate comparison between the four items and to create the average of the four items, this statement has been reverse-coded so that a higher score will also indicate the deferment of judgment until after the generation phase.

upon, they may benefit from a more deliberate approach to thinking about APs. We propose and find that training auditors in metacognitive skills would help close the performance gap.

We identified two metacognitive skills shown to improve performance in tasks requiring creativity. These skills—divergent and convergent thinking—are also trainable. Training lower-level auditors in the proper use of these skills was expected to provide them with the problem-structuring knowledge that managers and partners acquire over time. We trained some auditors on how to employ divergent thinking followed by convergent thinking (full training), while others were trained in divergent thinking alone (partial training) or received no training (control).

Our results indicate that the training of divergent thinking followed by convergent thinking worked. Auditors who completed both divergent and convergent thinking training increased the number and quality of explanations in response to evidence inconsistent with their expectations. Training in both skills resulted in a greater ability to generate and ultimately choose the correct explanation. Nine of the 36 auditors trained to use both types of thinking correctly identified one of the two viable explanations in the final AP case, while just two of the 38 who received only divergent thinking training and none of the 36 who received neither type of metacognitive training identified one of two possible solutions. Put differently, auditors receiving both divergent and

convergent thinking training had a fourfold higher likelihood of identifying a logically viable explanation compared to those receiving divergent thinking training alone—and a vastly better likelihood than those having neither type.

Our supplemental experiment shows that one benefit of training in both divergent and convergent thinking is that it leads decision makers to generate more alternatives during divergent thinking. Those trained in both skills focus more on generating explanations when performing divergent thinking instead of simultaneously trying to sort out which alternatives "make sense" (the cognitive process known as consistency checking). They leave assessing the generated alternatives for the convergent thinking phase. An important implication of this finding is that if auditors try to do both kinds of thinking at once, then they compromise both, and neither receives its due effort. As a result, the best explanation for a problem might not be generated or might be prematurely discarded.

We provide four important findings to advance our understanding of auditors' judgment processes. We show that training auditors to control and direct their thinking with divergent and convergent processes increases their ability to reason diagnostically, and this ability should be useful across a broad range of audit tasks. Our research also expands the overall understanding of the hypothesis-generation process across diagnostic tasks. Our results show that auditors benefit from consciously disconnecting the explanation-generation process from the plausibility assessment because it allows them to generate a more complete set of explanations and process the implications of each more thoroughly. Also, we provide support that engaging in both divergent and convergent thinking can reduce the use of consistency checking, which is a process that can be detrimental for performance. Finally, we offer a potential route to increasing auditors' skeptical thinking. One definition of professional skepticism is that it involves the propensity of an individual to defer concluding (Hurtt 2010). Auditors trained to use both divergent and convergent thinking forestall eliminating explanations until a subsequent explicit evaluation. Training in both these metacognitive processes leads to a way of thinking that is consistent with being professionally skeptical.

Another setting in which we could see a potential advantage for auditors trained in both divergent and convergent thinking is in brainstorming sessions. Auditors trained in both skills and asked to engage in divergent thinking prior to the brainstorming sessions are likely to contribute a larger, higher-quality set of potential explanations because they avoid the natural tendency to consistency check.

From the firms' perspective, a possible concern is that auditors' use of this diagnostic process might create inefficiencies due to the time needed to generate and eliminate explanations. That is, the time saved by generating better explanations might not offset the time spent on engaging in the process. In our experiment, we measured the time to complete the final assessment, as well as the time to complete the scenarios in the first three modules, and no differences across conditions were found. Participants trained to use divergent and convergent thinking chose one of the correct solutions more often, generated better explanations, and eliminated more potentially time-wasting invalid explanations in the same amount of time that participants in the other training conditions took to arrive at their inferior answers.

Training auditors to employ specific cognitive skills requires identification of the appropriate skills and the development of effective instruction. We believe that we have chosen two critical skills—divergent and convergent thinking—and that training in both results in substantial improvements in AP performance. However, we acknowledge that other skills might also improve auditor diagnostic ability.

Our training required a substantial time investment on the part of the participants. While we demonstrated that the training worked, we cannot address its efficiency. Other methods for communicating cognitive skills might be more efficient. This remains an interesting and open

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question. Future research could continue to focus on training auditors to perform APs using different cognitive skills or training methods. In addition, we recognize that training might not be the only way to induce auditors to structure and conduct APs. Other approaches, such as improvements in workpaper design or introduction of new kinds of incentives, could also work.

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