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Literature Review

Involvement in the Development of Data Analytics and Auditors' Application of Professional Skepticism

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Introduction

Audit firms around the globe have invested heavily in a variety of audit technologies (e.g., Alles & Gray 2016; Deloitte 2016; KPMG 2016, 2019; EY 2017, 2018; PwC 2019; Bloomberg 2020; Eilifsen, Kinserdal, Messier, & McKee 2020; Austin, Carpenter, Christ, & Nielson 2021). Of these technological developments, audit data analytics (ADA) are receiving increased attention because they enable auditors to incorporate more diverse data and visualizations into their testing (i.e., graphical representations such as charts, scatter diagrams, trend lines, or maps). The American Institute of Certified Public Accountants (AICPA) defines ADA as "the science and art of discovering and analyzing patterns, identifying anomalies, and extracting other useful information in data underlying or related to the subject matter of an audit through analysis, modeling, and visualization for the purpose of planning or performing the audit" (AICPA 2015, p.92; 2017, p.1). The current study focuses on ADA visualizations, which can aid auditors when scrutinizing audit evidence and ultimately improve audit quality (e.g., AICPA 2017; Anders 2017; FRC 2017; O'Donnell, O'Mara, Rast, & Sand 2017).[1]

One promising area of applying ADA visualizations is during auditors' performance of substantive analytical procedures. Analytical procedures are usually regarded as a predecessor of ADA in the academic literature and standard setters' guidance (e.g., Messier, Simon, & Smith 2013; AICPA 2017; Koreff 2021). Therefore, applying ADA visualizations in the context of analytical procedures can be seen as an extension of more traditional approaches to analytical procedures. In traditional approaches to analytical procedures, auditors usually develop an account balance expectation by incorporating a limited set of data sources at a given time (e.g., multiplying the prior year account balance by an industry growth rate). ADA visualizations will enable auditors to simultaneously compare data from a wider variety of sources (e.g., prior year balances, budgets or forecasts, industry data, data from related accounts, and non-financial measures) as suggested by auditing standards such as ISA

[1] While ADA take many forms (e.g., visualizations, full population testing, regression analyses), we chose visualizations because they are employed by most audit firms, are relevant to our substantive analytical procedure task (e.g., Anderson, Hobson, and Peecher 2020), and are featured prominently in the AICPA's Guide to Audit Data Analytics (AICPA 2017). Further, practitioner interest in research examining the link between visualizations and skepticism is summarized by the following quote from a recent Center for Audit Quality listing of Topics of Interest (https://www.thecaq.org/rab-request-for-proposals-topics-of-interest-in-2020): "Suggested areas for research include the potential role and uses of data visualization tools; how the integration of these various tools can enhance critical thinking and professional skepticism…".

520 (IAASB 2018a) and AS 2305 (PCAOB 2020).[2] Hence, the use of ADA visualizations can facilitate auditors in gaining insights into their clients' data and obtaining a better understanding of their clients' business and environment, ultimately improving audit effectiveness during analytical procedures (e.g., Brown-Liburd, Issa, & Lombardi 2015; Cao, Chychyla, & Stewart 2015; Krahel & Titera 2015; Yoon, Hoogduin, & Zhang 2015; FRC 2017; IAASB 2020, 2021; Austin et al. 2021; PCAOB 2021).

The use of ADA visualizations which have already been developed on the engagement is also expected to lead to efficiency gains. Visualizations reduce the cognitive resources needed for processing the information, thus facilitating more efficient judgments (e.g., Hoffman, Nelson, & Houck 1983; Lohse 1993; Huang, Hong, & Eades 2006; Zhu & Watts 2010; Anderson, Hobson, & Peecher 2020). For example, graphical representations can help auditors quickly identify inconsistencies, exceptions, or red flags indicating higher risk of material misstatements, such as inconsistent patterns between financial measures and non-financial measures (e.g., Brazel, Jones, & Zimbelman 2009).[3] As such, ADA visualizations (vs. traditional audit approaches with tabular formats) are expected to reduce the demand on auditors' cognitive effort when *identifying* exceptions in the client's data, potentially leaving more resources available for *investigating* these exceptions further.

Motivated by these possibilities, in the proposed study we will examine auditors' use of ADA visualizations when performing substantive analytical procedures and the ADA's effect on auditors' professional skepticism. Prior literature identifies two distinct stages of professional skepticism: skeptical judgment and skeptical action (e.g., Shaub & Lawrence 2002; Nelson 2009). *Skeptical judgment* involves the cognitive assessment of information, such as identifying red flags in the client's data. *Skeptical action* involves the auditor's follow-up actions, such as the investigation of a red flag, additional testing, evidence accumulation, etc. Prior research indicates that only when skeptical judgment reaches a threshold does it evoke skeptical action (Nelson 2009). Importantly, prior studies offer evidence that higher levels of skeptical judgment may not always translate into matching levels of skeptical action, because skeptical actions that are *ex ante* considered appropriate may generate *ex post* costs (e.g., budget overruns, delays, or strained client relations) (e.g.,

[2] To maintain the information content constant between conditions in our experiment, participants in all conditions (including the no ADA condition) will be provided with the underlying data used in the visualizations.
[3] We use the terms inconsistency, exception, and red flag interchangeably. Each describes an instance where the auditor identifies a potential issue and decides whether to investigate it further.

Brazel, Jackson, Schaefer, & Stewart 2016; Brazel, Gimbar, Maksymov, & Schaefer 2019; Brazel, Leiby, & Schaefer 2021). If auditors fail to translate skeptical judgment into action, material misstatements may remain unidentified. We expect that the use of ADA visualizations may counter such concerns. Auditors using ADA visualizations require less cognitive effort in the skeptical judgment stage, hence achieving cognitive effort savings in this stage. By shifting their cognitive effort saved in the skeptical judgment stage to the skeptical action stage, auditors potentially have more cognitive resources available for the latter stage, motivating them to exercise greater skeptical action.

In the current proposal, we argue that through cognitive effort shifting, the cognitive effort savings achieved using ADA visualizations for skeptical judgment leads to greater availability of cognitive resources subsequently applied to skeptical action (e.g., investigating red flags). In the current study, we are interested in a setting where the material misstatement risk is heightened due to the presence of red flags and hence requiring auditors' effort and further investigation. This cognitive effort shifting process is especially important when there are red flags requiring auditors' further investigation. We examine whether the use of data visualizations (vs. no data visualizations) will lead auditors to effectively *shift* cognitive effort from skeptical judgment to skeptical action when the material misstatement risk is heightened due to the presence of red flags, and whether this shift will enhance the application of professional skepticism. By shifting their cognitive effort from skeptical judgment to skeptical action through the use of data visualizations, we expect auditors to more thoroughly investigate exceptions identified, ultimately improving skeptical actions and audit quality.

However, we argue that the beneficial effects of using ADA visualizations on auditor skepticism may be contingent on the extent to which an auditor has been personally involved in the development of the ADA tests. In the current study, we distinguish between a situation where an auditor uses ADA visualizations that he or she personally developed on the engagement ('develop') versus a setting where other team members have already developed ADA visualizations and therefore the individual auditor inherited the ADA ('inherit'). Auditors using inherited ADA visualizations potentially achieve greater cognitive effort savings in the skeptical judgment stage and hence are more likely to thoroughly investigate exceptions by shifting their cognitive effort from skeptical judgment to skeptical action. Auditors' personal involvement in developing a visualization (vs. inheriting it) requires more cognitive effort for skeptical judgment, potentially reducing cognitive effort savings in the

skeptical judgment stage and hence limiting their cognitive effort shifting to the skeptical action stage.

On the other hand, personal involvement in the development of ADA tests may lead to a higher level of psychological ownership of the ADA visualizations and more confidence in one's skeptical judgment. Development should then *increase* the auditor's motivation to investigate exceptions identified and, in turn, promote a higher level of skeptical action (e.g., Pierce, Kostova, & Dirks 2001; Van Dyne & Pierce 2004). This is particularly likely in the audit setting which is characterized by a variety of costs of skepticism, such as budget and time pressure, creating incentives to avoid costly skeptical actions (e.g., Kelly, Margheim, & Pattison 1999; Hatfield, Jackson, & Vandervelde 2011; Bennett & Hatfield 2017; Lambert, Jones, Brazel, & Showalter 2017; Bhaskar, Hopkins, & Schroeder 2019; Brazel et al. 2021).

As a result, we expect that auditors inheriting ADA visualizations are more likely to succumb to high budget or time pressure and reduce their skeptical action. As such, we predict that even though auditors inheriting ADA visualizations still achieve cognitive effort savings in the skeptical judgment stage, they are less motivated to shift their cognitive effort to the skeptical action stage when the costs of skeptical actions are high. However, we argue that when auditors are personally involved in the development of ADA, the psychological ownership and increased confidence in skeptical judgments will mitigate the adverse effects of high pressure. Combined, we posit that auditors who developed ADA visualizations will exercise more skeptical actions compared to auditors inheriting ADA visualizations when the costs of skeptical actions are potentially high.

It is uncertain whether every auditor will be involved in the development of ADA given the possibility that ADA development becomes centralized.[4] Given the resulting problems of potentially insufficient skeptical actions discussed earlier when auditors use inherited ADA visualizations, we propose low-cost interventions to improve auditors' application of skeptical action when using inherited ADA visualizations. Specifically, we expect that when auditors inherit ADA visualizations, being informed (vs. not being informed) about their team members' development process of the ADA (e.g., the number of hours and substantial effort spent) will increase their empathy to their peers and their affective attitude toward the ADA visualizations (e.g., Green & Brock 2000, 2002; Slater & Rouner

[4] Based on our talks with one participating firm, we learnt that the ADA development in that firm is currently centralized and performed by a special department within the firm.

2002; Van Laer, De Ruyter, Visconti, & Wetzels 2014). We expect that these emotional and attitudinal reactions will increase auditors' perceived responsibility and affective commitment to the ADA visualizations and, in turn, motivate auditors to investigate exceptions identified by the ADA, even when the costs of skeptical actions are potentially high (e.g., budget overruns or delays).

Theory and Predictions

We first review the auditing literature on ADA visualizations and professional skepticism and explain how ADA visualizations will enhance the application of professional skepticism. We then review the psychology literature related to psychological ownership and the related auditing literature to predict how auditors' involvement in ADA development will influence auditors' skeptical actions. Finally, we review psychology literature on mental imagery and empathy to illustrate why being informed about their team members' development process of the ADA visualizations potentially motivates auditors' application of professional skepticism when inheriting the ADA.

ADA Visualizations and Skeptical Judgment versus Skeptical Action

Professional skepticism is critical to audit quality (e.g., Nelson 2009; Hurtt, Brown-Liburd, Earley, & Krishnamoorthy 2013). The prior literature identifies two distinct stages of professional skepticism: skeptical judgment and skeptical action (Shaub & Lawrence 2002; Nelson 2009). *Skeptical judgment* involves auditors' cognitive assessments of information (e.g., identifying red flags or evidence inconsistencies), while *skeptical action* involves their follow-up actions (e.g., investigating the identified red flags). Insufficient skeptical judgment may diminish the motivation for skeptical action since prior research indicates that only when skeptical judgment reaches a threshold does it evoke skeptical action (Nelson 2009). However, higher levels of skeptical judgment may not always translate into matching levels of skeptical action. Given that skeptical action that is *ex ante* appropriate typically generates *ex post* costs (e.g., budget overruns, delays, strained client relations, or negative supervisor evaluations if the skepticism does not yield a misstatement), prior research finds that some red flags are identified, but not investigated (e.g., Brazel et al. 2016). As a result, material misstatements may remain undetected (e.g., Brazel et al. 2016; Brazel et al. 2019; Brazel et al. 2021). We expect that the use of ADA visualizations may counter such concerns about insufficient skeptical action.

Incorporating ADA visualizations into audit testing likely improves the *effectiveness* of auditors' skeptical judgments. ADA visualizations potentially provide more insights into the client's data than less visualized representations or tabulated data. Through data visualizations, auditors can effectively analyze the patterns of data points, their relationships, and their distributions, such that they have a better understanding of their client's data and outliers (e.g., Anderson et al. 2020). Therefore, auditors using ADA visualizations should make more effective skeptical judgments by identifying exceptions in the data. More effective judgments should motivate more skeptical actions.

Utilizing ADA visualizations would also enable cognitive effort savings in the skeptical judgment stage. Prior research generally argues that using ADA (vs. traditional audit approaches) can improve audit efficiency (e.g., Brown-Liburd et al. 2015; Cao et al. 2015; Earley 2015; Schneider, Dai, Janvrin Ajayi, & Raschke 2015; Vasarhelyi, Kogan, & Tuttle 2015; Yoon et al. 2015; FRC 2017; Anderson et al. 2020; Griffith, Kadous, & Young 2021). Traditional use of analytical procedures would typically involve auditors developing account balance expectations by incorporating only a limited number of data sources at a given time (e.g., multiplying the prior year account balance by an industry growth rate). ADA visualizations, on the other hand, enable auditors to simultaneously compare data from various sources and across a larger number of years (e.g., prior year balances, budgets or forecasts, industry data, data from related accounts, and non-financial measures) as suggested by auditing standards such as ISA 520 (IAASB 2018a) and AS 2305 (PCAOB 2020). Visualized representations (vs. tabular formats) also reduce the amount of cognitive effort needed for processing the information (e.g., Hoffman et al. 1983; Lohse 1993; Huang et al. 2006; Zhu & Watts 2010; Anderson et al. 2020). For example, graphical representations can help auditors more easily identify inconsistencies, exceptions, or red flags indicating a higher risk of material misstatement and therefore requiring auditor attention (AICPA 2017). As such, compared to traditional audit approaches, ADA visualizations are expected to reduce the demand on cognitive effort when assessing the client's data and identifying potential red flags, hence achieving cognitive effort savings during the skeptical judgment phase.

Since auditors using ADA visualizations (vs. traditional approaches) are likely to achieve cognitive effort savings in the skeptical judgment stage, we expect them to subsequently *shift their effort* into skeptical action specifically when the material misstatement risk is heightened due to the presence of red flags. Importantly, prior research

suggests that higher levels of skeptical judgment may not always translate into matching levels of skeptical action, because skeptical actions that are *ex ante* considered appropriate may generate *ex post* costs (e.g., budget overruns or delays). As previously stated, if auditors fail to translate skeptical judgment into action when the material misstatement risk is heightened due to the presence of red flags, material misstatements may remain unidentified (e.g., Brazel et al. 2016; Brazel et al. 2019; Brazel et al. 2021). With ADA visualizations, shifting effort from skeptical judgment to skeptical action provides auditors cognitive resources to more thoroughly investigate exceptions or red flags identified by ADA and improve the application of professional skepticism.

> **H1:** When there are inconsistencies, exceptions, or red flags indicating a higher risk of material misstatement, auditors using ADA visualizations, compared to auditors using traditional audit approaches, will be more likely to exercise skeptical action.

Inheriting ADA Visualizations versus Involving Auditors in Developing ADA Visualizations

The extent to which using ADA visualizations leads to cognitive effort savings in skeptical judgment and a shift of such resources to skeptical action likely depends on whether auditors are personally involved in the development of the ADA. On one hand, auditors may inherit ADA visualizations which are developed by another engagement team member. Inheriting ADA should lead to greater cognitive effort savings in the skeptical judgment stage. Specifically, auditors using inherited ADA visualizations are likely to have spent less cognitive effort deciding on data sources, collecting the data, verifying data reliability, evaluating the calibration of the ADA, and setting up the ADA visualizations. Therefore, compared to auditors developing their own ADA, auditors inheriting ADA avoid the costs of effort depletion and may therefore be more likely to thoroughly investigate exceptions by shifting their cognitive effort from skeptical judgment to skeptical action.

However, the audit setting is typically characterized by a variety of costs of applying professional skepticism (e.g., budget overruns, delays, strained client relations, or negative supervisor evaluations if the skepticism does not yield a misstatement), creating incentives to avoid skeptical actions and its related costs (e.g., Kelly et al. 1999; Hatfield et al. 2011; Brazel et al. 2016; Bennett & Hatfield 2017; Lambert et al. 2017; Bhaskar et al. 2019; Brazel

et al. 2019; Brazel et al. 2021). Psychology literature also suggests that given the fact that human cognitive resources (e.g., attention, effort, and working memory) are limited, there is a tendency to avoid exertion of cognitive effort (e.g., Kahneman 1973; Simons & Chabris 1999; Marois & Ivanoff 2005; Westbrook, Kester, & Braver 2013; Inzlicht, Schmeichel, & Macrae 2014). Such cognitive effort avoidance is increased with pressure and stress, as in many audit settings (e.g., Bogdanov, Nitschke, LoParco, Bartz, & Otto 2021).

Given the motivation for avoiding costly skeptical actions in the audit environment, auditors using *inherited* ADA visualizations under high budget or time pressure are expected to be less likely to shift their cognitive effort to the skeptical action stage, even though they achieve cognitive effort savings at the skeptical judgment phase. When the costs of skeptical actions are high, auditors who inherit ADA visualizations are less motivated to act skeptically. Instead of shifting cognitive effort to the skeptical action stage, auditors are more likely to avoid costly skeptical actions and saving their effort (i.e., no shifting) (e.g., Brazel et al. 2021).[5]

On the other hand, being involved in the development of ADA visualizations is less likely to lead to cognitive effort savings in the skeptical judgment stage, limiting the possibility of shifting their cognitive effort to the skeptical action stage. However, auditors' involvement in the development of ADA may offer other benefits in motivating them to further investigate exceptions or red flags identified by the ADA (i.e., engage in skeptical action). Involvement in developing an ADA visualization is likely to give rise to a higher level of individual psychological ownership toward the ADA, which subsequently may motivate auditors to more thoroughly investigate exceptions or red flags identified by the ADA (e.g., Pierce et al. 2001; O'driscoll, Pierce, & Coghlan 2006; Paré, Sicotte, & Jacques 2006). Psychological ownership is defined as "a state in which individuals feel as though the target of ownership or a piece of it is 'theirs'" (e.g., Rudmin & Berry 1987; Pierce et al. 2001; Van Dyne & Pierce 2004). The target in the current context is the ADA visualizations.

Psychological ownership develops through three potentially interrelated routes: control over the target, being associated with the target, and investing the self into the target. First,

[5] More consistent evidence is likely to be revealed in all conditions in our proposed experiment. However, we expect that inheriting ADA visualizations (vs. developing ADA visualizations) under high budget or time pressure likely motivates auditors to rely on the consistencies and reduce their attendance to inconsistencies, because they have higher tendency to avoid costly skeptical action.

control over the target, which means the ability to use the target, can give rise to a feeling of ownership (e.g., Rudmin & Berry 1987; Pierce et al. 2001). Second, association with the target, which can be obtained from an individual's intimate knowledge about the target, can also give rise to a feeling of ownership (e.g., Pierce et al. 2001). Third, investing energy, time, effort, and attention (i.e., the self) into the target can be key to psychological ownership toward the target (e.g., Pierce et al. 2001). Auditors developing ADA visualizations (vs. inheriting ADA visualizations) engage more with the ADA, and therefore are expected to have a higher level of psychological ownership toward the ADA.

Psychological ownership toward the ADA visualizations is likely to increase auditors' perceived responsibility and affective commitment to the ADA (e.g., VandeWalle, Van Dyne, & Kostava 1995; Pierce et al. 2001; O'driscoll et al. 2006; Paré et al. 2006; Mayhew, Ashkanasy, Bramble, & Gardner 2007). Therefore, auditors who develop ADA visualizations (vs. those that inherit the ADA) are likely more motivated to investigate any inconsistencies, exceptions, or red flags identified by the ADA (i.e., more skeptical actions). Auditors' personal involvement in the development of the ADA is also likely to increase their confidence in the ADA tests and hence exceptions identified by the ADA tests (i.e., more confidence in skeptical judgments), motivating them to further investigate those exceptions.

We argue that the higher level of psychological ownership arising from auditors' personal involvement in the development of ADA visualizations will mitigate the aforementioned negative effect of high budget or time pressure on skeptical actions. Although auditors who develop (vs. inherit) ADA visualizations are less likely to achieve cognitive effort savings in skeptical judgment (i.e., they lack cognitive effort savings to shift to skeptical action), they have a higher level of psychological ownership toward the ADA and are more confident in the exceptions identified by the ADA tests. These perceptions should motivate the investigation of any red flags identified by the ADA (i.e., more skeptical actions). Therefore, involvement in developing of ADA visualizations (vs. inheriting ADA visualizations) is likely to increase auditors' skeptical actions.

> **H2**: When there are inconsistencies, exceptions, or red flags indicating a higher risk of material misstatement, auditors who develop ADA visualizations, compared to auditors who inherit the ADA, will apply a higher level of skeptical action when using the ADA.

A Potential Solution for insufficient skeptical actions when inheriting ADA: Informing Auditors About the Development Process of ADA Visualizations

It is uncertain whether every auditor will be involved in the development of ADA given the possibility that ADA development becomes centralized. Given that auditors inheriting ADA visualizations may apply a lower level of skeptical action under high budget or time pressure, it is important to explore ways to mitigate this problem. We propose that being *informed* about their peers' development process of ADA visualizations (e.g., the number of hours and substantial effort spent) will increase their responsibility and commitment to the ADA, which is expected to motivate auditors' application of skeptical action (e.g., Cialdini, Brown, Lewis, Luce, & Neuberg 1997; Green & Brock 2000; Holmes, Mathews, Mackintosh, & Dalgleish 2008; Johnson, Cushman, Borden, & McCune 2013; Blackwell et al. 2015; Skottnik & Linden 2019).

Being informed about their team members' development process of ADA visualizations potentially evokes auditors' *mental imagery* of that process from a first-person perspective (e.g., Green & Brock 2002; Slater & Rouner 2002; Van Laer et al. 2014). Mental imagery is defined as "recreation of a perceptual experience in the absence of visual input", which is the ability to "see with the mind's eye" (Miyashita 1995, p. 1719). By developing a mental imagery of the actions that their team members performed, auditors tend to feel as though "they are experiencing the events themselves" (Van Laer et al. 2014, p.799).

Experiencing mental imagery about their team members' effort developing ADA visualizations potentially elicits auditors' emotional and affective responses (e.g., Holmes et al. 2008; Moore & Barresi 2013; Blackwell et al. 2015; Skottnik & Linden 2019). Specifically, we expect that auditors potentially experience *empathy* for their team members' hard work. Empathy is basically the ability to understand and share others' feelings, needs and concerns (e.g., Goleman 1995). Different from perspective-taking, which refers to *knowing* how the others feel, empathy is about *feeling* what others feel, as though their emotions are contagious.

We expect that empathy likely motivates auditors who inherit ADA visualizations to take on their team members' emotions and attitudes toward the ADA and hence increase their perceived responsibility and commitment to the ADA. We posit that this process should motivate auditors to investigate exceptions identified by the ADA, even when the costs of

skeptical actions are potentially high (e.g., budget overruns or delays). In addition, more knowledge about the ADA visualizations would improve auditors' confidence in the ADA tests and exceptions identified, motivating them to investigate exceptions identified. Overall, auditors inheriting ADA visualizations and *informed* about the development process of the ADA visualizations by other team members (vs. simply inheriting the ADA visualizations from team members) are more likely to investigate exceptions or red flags identified by the ADA (i.e., skeptical action).

> **H3:** When there are inconsistencies, exceptions, or red flags indicating a higher risk of material misstatement, auditors who inherit ADA visualizations and are informed about the development process of the ADA by team members, compared to auditors who simply inherit the ADA from team members, will apply a higher level of skeptical action when using the ADA.

Experimental Design

To test our hypotheses, we will employ a 3 (developing ADA visualizations vs. inheriting ADA visualizations vs. no ADA visualizations) + 1 (inheriting ADA and being informed about the development process of ADA visualizations) + 1 (inheriting ADA, being informed about the development process of ADA visualizations, and being primed about empathy) between-participants design.[6] In all conditions, budget or time pressure will be high, such that the potential costs of skeptical actions are high.[7] Participants will perform an audit task involving a substantive analytical procedure for sales, which is adapted from Barr-Pulliam, Brazel, McCallen, & Walker (2020) and Brazel, Gold, Leiby, & Schaefer (2021).

To manipulate *developing ADA* vs. *inheriting ADA*, participants either *develop* the ADA visualizations themselves or they *inherit* the ADA visualizations developed by another team member in the current year. Specifically, participants in the *developing ADA* condition will need to think about and write down how they would develop the ADA visualizations.

[6] Although empathy is regarded as an intuitive ability of human, it may not always just happen naturally for everyone, especially in a fast-paced society (e.g., the audit environment). But it can be developed with practice and a conscious choice to connect with others. So, we decided to use a prime to strengthen the effect of empathy.
[7] Our initial design was to also manipulate the level of pressure. But we later decided not because of several considerations: 1) The high-pressure setting is more pervasive in the audit environment; 2) Prior research shows that auditors' motivation for exercising skeptical action is reduced by high pressure (e.g., Brazel et al. 2019); 3) Investigating the effect of auditors' involvement in the ADA development on their application of professional skepticism when pressure is high has greater practical relevance.

They will also be told about the number of hours and substantial effort they have spent determining the data sources, collecting the data, verifying data reliability, and evaluating the calibration of the data. They will finally set up one visualization themselves.[8] Participants in the *inheriting ADA* condition will inherit the ADA visualizations which were developed by another team member in the current year. Participants in the *no ADA* condition will receive no information about the use of ADA. All participants (including the *no ADA* condition) will be given tables providing the underlying data used in the visualizations to avoid variances in information content between conditions.

Besides the three primary conditions, we also have two "solution" conditions. For the *inheriting & being informed ADA* condition, participants will inherit the ADA visualizations which were developed by another team member in the current year. In addition, participants will be informed about the development process of the ADA visualizations performed by another team member in the current year. For example, they will also be told that the team member has spent many hours determining the data sources, collecting the data, verifying data reliability, and evaluating the calibration of the data. Besides receiving the information given to the *inheriting & being informed ADA* condition, participants in *inheriting & being informed ADA & primed empathy* condition will also be primed to experience the development process as if they themselves were developing the ADA visualizations.

Our primary dependent variable is ***Skeptical Action***, which is coded as "1" if participants choose to perform additional testing, and "0" if not. For those participants choosing to perform additional testing, we will also ask about their detailed skeptical actions such as what additional testing would they perform and/or what questions they would inquire

[8] We control for potential confounding factors caused by the "set up one visualization" manipulation. First, participants in all ADA conditions are provided with the same set of visualizations (i.e., all five visualizations) as part of the information for developing their expectations. The difference is that participants in the *developing ADA* condition are told that they developed those visualizations, while participants in the *inheriting ADA* condition are told that another team member developed those visualizations. Such a design is to control for potential information content variations caused by some participants in the *developing ADA* condition set up and use one visualization different from the provided in the *inheriting ADA* condition. To further control for this potential confounder, participants in the *developing ADA* condition are told to set up a line graph (i.e., the same form of visualizations as provided in the *inheriting ADA* condition). Second, we purposely choose one visualization revealing no evidence inconsistencies for participants in the *developing ADA* condition to set up. In this way, we eliminate the possibilities that participants in the *developing ADA* condition fail to set up a visualization revealing evidence inconsistencies and as a result do not identify the red flag (vs. *inheriting ADA* condition) This design also helps to eliminate a potential confounder caused by the number of times participants encounter the inconsistencies. That is, if participants in the *developing ADA* condition (vs. *inheriting ADA* condition) set up a visualization reveling inconsistencies, the result may be due to that those in the *developing ADA* condition (vs. *inheriting ADA* condition) see the red flag twice (once when they were setting up the visualizations, and the other time when they were provided with all five visualizations).

of management (*Ask MGMT*). All participants will also be asked whether there is anything that they would communicate to their manager (*Inform MGR*).

After completing the audit task, participants will respond to questions in a post-experimental questionnaire. In this section, we will check whether our manipulations of our independent variables have been successful. We will also include questions that measure mediating variables (i.e., process variables), such as psychological ownership toward the ADA, perceived affective commitment and responsibility, mental imagery and empathy to team members who developed the ADA, and skeptical judgment, so that we can conduct process analyses. There will also be questions related to participants' audit experience and other demographics, which will be useful when conducting additional analyses.

Contributions to Literature and Audit Practice

Given the continued importance of exercising appropriate professional skepticism and the increasing application of ADA in audit practice, it is important to understand how auditors' use of ADA influences their skepticism. The current study will provide important findings to audit practice and contribute to an emerging auditing literature linking ADA and professional skepticism (e.g., Barr-Pulliam et al. 2020). By examining the skeptical actions of auditors who have been personally involved in developing ADA visualizations (vs. inherited ADA visualizations), the proposed study will improve our current understanding about auditors' application of professional skepticism when using ADA. We predict that auditors using ADA visualizations will shift their cognitive effort to undertake skeptical actions (e.g., investigating evidence inconsistencies, exceptions, and red flags), which will improve audit quality (e.g., FRC 2017; PCAOB 2021). However, we argue that when the costs of skeptical actions are high, this improvement in the application of skepticism is dependent on auditors' prior involvement in the development of the ADA.

Our proposed study may also identify a challenge associated with fully experiencing the benefits of ADA on audit engagements. Although inheriting ADA visualizations (vs. developing ADA visualizations) is likely to enable cognitive effort savings in skeptical judgment, auditors inheriting ADA may succumb to high budget or time pressure and curtail their skeptical actions. As such, we investigate a way of mitigating this problem. We will investigate whether informing auditors about the development process of ADA visualizations will improve their skeptical action when inheriting the ADA. Overall, the findings of the

proposed study should be of interest to audit practitioners, specialists in analytics, standard setters, regulators, educators, researchers, and others interested in the use of ADA in practice and its influence on professional skepticism.

References

AICPA (American Institute of Certified Public Accountants, Inc.) (2017). *Guide to Data Analytics*. Durham, NC: AICPA, Inc.

AICPA (American Institute of Certified Public Accountants, Inc.) (2015). *Audit Analytics and Continuous Audit Looking Toward the Future*. New York, NY: AICPA, Inc.

Alles, M., & Gray, G. L. (2016). Incorporating big data in audits: Identifying inhibitors and a research agenda to address those inhibitors. *International Journal of Accounting Information Systems,* 22, 44-59.

Anders, S. B. (2017). Audit data analytics resources. *CPA Journal*, July.

Anderson, S. B., Hobson, J. L., and Peecher, M. E. (2020). The joint effects of rich data visualization and audit procedure categorization on auditor judgment. Working paper, University of Illinois at Urbana-Champaign.

Austin, A. A., Carpenter, T. D., Christ, M. H., & Nielson, C. S. (2021). The data analytics journey: Interactions among auditors, managers, regulation, and technology. *Contemporary Accounting Research*, 38(3), 1888-1924.

Barr-Pulliam, D., Brazel, J. F., McCallen, J., & Walker, K. (2020). Data analytics and skeptical actions: The countervailing effects of false positives and consistent rewards for skepticism. Working paper, University of Louisville.

Bennett, G. B., & Hatfield, R. C. (2017). Do approaching deadlines influence auditors' materiality assessments? *Auditing: A Journal of Practice & Theory*, 36(4), 29-48.

Bhaskar, L. S., Hopkins, P. E., & Schroeder, J. H. (2019). An investigation of auditors' judgments when companies release earnings before audit completion. *Journal of Accounting Research*, 57(2), 355-390.

Blackwell, S. E., Browning, M., Mathews, A., Pictet, A., Welch, J., Davies, J., Watson, P., Geddes, J. R., & Holmes, E. A. (2015). Positive imagery-based cognitive bias modification as a web-based treatment tool for depressed adults: a randomized controlled trial. *Clinical Psychological Science*, 3(1), 91-111.

Bloomberg. (2020). Big four invest billions in tech, reshaping their identities. by michael kapoor, January 2, 2020. Available at: https://news.bloombergtax.com/financial-accounting/big-four-invest-billions-in-tech-reshaping-their-identities.

Bogdanov, M., Nitschke, J. P., LoParco, S., Bartz, J. A., & Otto, A. R. (2021). Acute Psychosocial Stress Increases Cognitive-Effort Avoidance. *Psychological Science*, *32*(9), 1463-1475.

Brazel, J. F., Gimbar, C., Maksymov, E. M., & Schaefer, T. J. (2019). The outcome effect and professional skepticism: A replication and a failed attempt at mitigation. *Behavioral Research in Accounting*, 31(2), 135-143.

Brazel, J. F., Gold, A., Leiby, J., & Schaefer, T. J. (2021). Can audit committee support improve auditors' application of professional skepticism? Working paper, North Carolina State University.

Brazel, J. F., Jackson, S. B., Schaefer, T. J., & Stewart, B. W. (2016). The outcome effect and professional skepticism. *The Accounting Review*, 91(6), 1577-1599.

Brazel, J. F., Jones, K. L., & Zimbelman, M. F. (2009). Using nonfinancial measures to assess fraud risk. *Journal of Accounting Research*, *47*(5), 1135-1166.

Brazel, J. F., Leiby, J., & Schaefer, T. (2021). Do rewards encourage professional skepticism? It depends. *The Accounting Review* (forthcoming).

Brown-Liburd, H., Issa, H., & Lombardi, D. (2015). Behavioral implications of Big Data's impact on audit judgment and decision making and future research directions. *Accounting Horizons,* 29(2), 451-468.

Cao, M., Chychyla, R., & Stewart, T. (2015). Big Data analytics in financial statement audits. *Accounting Horizons*, 29(2), 423-429.

Cialdini, R. B., Brown, S. L., Lewis, B. P., Luce, C., & Neuberg, S. L. (1997). Reinterpreting the empathy–altruism relationship: When one into one equals oneness. *Journal of personality and social psychology*, *73*(3), 481.

Deloitte. (2016). Perspectives. The power of advanced audit analytics: Bringing greater value to external audit processes. Available at: https://www2.deloitte.com/us/en/pages/deloitte-analytics/articles/us-the-power-of-advanced-audit-analytics.html.

Earley, C. E. (2015). Data analytics in auditing: Opportunities and challenges. *Business Horizons*, 58(5), 493-500.

Eilifsen, A., Kinserdal, F., Messier, W. F., & McKee, T. E. (2020). An exploratory study into the use of audit data analytics on audit engagements. *Accounting Horizons*, 34(4), 75-103.

EY (Ernst & Young). (2017). How big data and analytics are transforming the audit. Available at: https://www.ey.com/en_es/assurance/how-big-data-and-analytics-are-transforming-the-audit.

EY (Ernst & Young). (2018). EY to Spend US$1 Billion as Part of Its Innovation Drive. Available at: https://www.ey.com/en_gl/news/2018/08/ey-to-spend-us-1-billion-as-part-of-its-innovation-drive.

FRC (Financial Reporting Council). (2017). Audit Quality Thematic Review: The Use of Data Analytics in the Audit of Financial Statements. Available at: https://www.frc.org.uk/getattachment/4fd19a18-1beb-4959-8737-ae2dca80af67/AQTR_Audit-Data-Analytics-Jan-2017.pdf.

Goleman, D. (1995). *Emotional Intelligence: Why It Can Matter More Than IQ*. New York, NY: Bantam Books.

Green, M. C., & Brock, T. C. (2000). The role of transportation in the persuasiveness of public narratives. *Journal of personality and social psychology*, 79(5), 701.

Green, M. C., & Brock, T. C. (2002). "In the mind's eye: Transportation-imagery model of narrative persuasion." In M. C. Green, J. J. Strange & T. C. Brock (Eds.), *Narrative impact: Social and cognitive foundations*. (pp. 315-341). Mahwah, NJ: Lawrence Erlbaum.

Griffith, E. E., Kadous, K., & Young, D. (2021). Improving complex audit judgments: A framework and evidence. *Contemporary Accounting Research*, *38*(3), 2071-2104.

Hatfield, R. C., Jackson, S. B., & Vandervelde, S. D. (2011). The effects of prior auditor involvement and client pressure on proposed audit adjustments. *Behavioral Research in Accounting*, *23*(2), 117-130.

Hoffman, J. E., Nelson, B., & Houck, M. R. (1983). The role of attentional resources in automatic detection. *Cognitive Psychology*, 15(3), 379-410.

Holmes, E. A., Mathews, A., Mackintosh, B., &Dalgleish, T. (2008). The causal effect of mental imagery on emotion assessed using picture-word cues. *Emotion*, 8(3), 395-409.

Huang, W., Hong, S. H., & Eades, P. (2006). Predicting graph reading performance: a cognitive approach. *In ACM International Conference Proceeding Series*, 164, pp. 207-216.

Hurtt, R. K., Brown-Liburd, H., Earley, C. E., & Krishnamoorthy, G. (2013). Research on auditor professional skepticism: Literature synthesis and opportunities for future research. *Auditing: A Journal of Practice & Theory*, 32(Supplement 1), 45-97.

IAASB (International Auditing and Assurance Standards Board). (2018a). Analytical Procedures. International Standard on Auditing 200 (ISA 520). New York, NY: International Federation of Accountants (IFAC).

IAASB (International Auditing and Assurance Standards Board). (2020). Non-authoritative support material related to technology: Frequently asked questions (FAQ) regarding the use of automated tools and techniques in performing audit procedures. Available at: https://www.ifac.org/system/files/publications/files/IAASB-FAQ-Automated-Tools-Techniques.pdf.

IAASB (International Auditing and Assurance Standards Board). (2021). Non-authoritative Support Material Related to Technology: Frequently Asked Questions (FAQ) Addressing the Risk of Overreliance on Technology-Use of ATT and Use of Information Produced by the Entity's Systems. Available at: https://www.ifac.org/system/files/publications/files/IAASB-Automated-Tools-Techniques-FAQ.pdf.

Inzlicht, M., Schmeichel, B. J., & Macrae, C. N. (2014). Why self-control seems (but may not be) limited. *Trends in cognitive sciences*, *18*(3), 127-133.

Johnson, D. R., Cushman, G. K., Borden, L. A., & McCune, M. S. (2013). Potentiating empathic growth: Generating imagery while reading fiction increases empathy and prosocial behavior. *Psychology of Aesthetics, Creativity, and the Arts*, *7*(3), 306.

Kahneman, D. (1973). *Attention and effort*. Englewood Cliffs, NJ: Prentice-Hall.

Kelly, T., Margheim, L., & Pattison, D. (1999). Survey on the differential effects of time deadline pressure versus time budget pressure on auditor behavior. *Journal of Applied Business Research*, 15(4), 117-128.

Koreff, J. (2021). Are auditors' reliance on conclusions from data analytics impacted by different data analytic inputs? Auditor's reliance on data analytics using different inputs. *Journal of Information Systems* (forthcoming).

KPMG. (2016). Data, analytics and your audit. Available at: https://home.kpmg/us/en/home/insights/2016/02/data-analytics-audit-article.html.

KPMG. (2019). KPMG Expects to Invest US $5 Billion on Digital Leadership in Professional Services. Available at: https://home.kpmg/xx/en/home/media/press-releases/2019/12/kpmg-expects-to-invest-5-billion-on-digital-leadership-in-professional-services.html.

Krahel, J. P., & Titera, W. R. (2015). Consequences of Big Data and formalization on accounting and auditing standards. *Accounting Horizons*, 29(2), 409-422.

Lambert, T. A., Jones, K. L., Brazel, J. F., & Showalter, D. S. (2017). Audit time pressure and earnings quality: An examination of accelerated filings. *Accounting, Organizations and Society*, *58*, 50-66.

Lohse, G. L. (1993). A cognitive model for understanding graphical perception. *Human-Computer Interaction*, 8(4), 353-388.

Marois, R., & Ivanoff, J. (2005). Capacity limits of information processing in the brain. *Trends in cognitive sciences*, 9(6), 296-305.

Mayhew, M. G., Ashkanasy, N. M., Bramble, T., & Gardner, J. (2007). A study of the antecedents and consequences of psychological ownership in organizational settings. *The Journal of social psychology*, 147(5), 477-500.

Messier Jr, W. F., Simon, C. A., & Smith, J. L. (2013). Two decades of behavioral research on analytical procedures: What have we learned? *Auditing: A Journal of Practice & Theory*, 32(1), 139-181.

Miyashita, Y. (1995). How the brain creates imagery: projection to primary visual cortex. *Science*, 268(5218), 1719-1720.

Moore, C., & Barresi, J. (2013). Imagination and the self. In M. Taylor (Ed.), *The Oxford handbook of the development of imagination* (pp. 288–302). Oxford: Oxford University Press.

Nelson, M. W. (2009). A model and literature review of professional skepticism in auditing. *Auditing*, 28(2), 1-34.

O'Donnell, R., O'Mara, B., Rast, C., & Sand, H. (2017). Data and analytics in the audit: driving up trust in the capital markets. *KPMG International*.

O'driscoll, M. P., Pierce, J. L., & Coghlan, A. M. (2006). The psychology of ownership: Work environment structure, organizational commitment, and citizenship behaviors. *Group & Organization Management*, 31(3), 388-416.

Paré, G., Sicotte, C., & Jacques, H. (2006). The effects of creating psychological ownership on physicians' acceptance of clinical information systems. *Journal of the American Medical Informatics Association*, 13(2), 197-205.

PCAOB (Public Company Accounting Oversight Board). (2020). *Substantive Analytical Procedures: Auditing Standard 2305.* Washington, DC: PCAOB.

PCAOB (Public Company Accounting Oversight Board). (2021). Spotlight. Data and Technology Research Project Update, May 2021. Available at: https://pcaob-assets.azureedge.net/pcaob-dev/docs/default-source/standards/documents/evaluating-relevance-and-reliability-of-audit-evidence-obtained-from-external-sources.pdf?sfvrsn=48b638b_6.

Pierce, J. L., Kostova, T., & Dirks, K. T. (2001). Toward a theory of psychological ownership in organizations. *Academy of management review*, 26(2), 298-310.

PricewaterhouseCoopers (PwC). (2019). Investing in Technology and People: PwC's Global Annual Review 2019. Available at: https://michaelhannadesign.com/wp-content/uploads/2020/06/GAR2019_Print.pdf.

Rudmin, F. W., & Berry, J. W. (1987). Semantics of ownership: A free-recall study of property. *The Psychological Record*, 37(2), 257-268.

Schneider, G. P., Dai, J., Janvrin, D. J., Ajayi, K., & Raschke, R. L. (2015). Infer, predict, and assure: Accounting opportunities in data analytics. *Accounting Horizons*, 29(3), 719-742.

Shaub, M. K., & Lawrence, J. E. (2002). A taxonomy of auditors' professional skepticism. *Research on Accounting Ethics*, 8, 167-194.

Simons, D. J., & Chabris, C. F. (1999). Gorillas in our midst: Sustained inattentional blindness for dynamic events. *Perception*, 28(9), 1059-1074.

Skottnik, L., & Linden, D. E. (2019). Mental imagery and brain regulation — new links between psychotherapy and neuroscience. *Frontiers in Psychiatry*, 779.

Slater, M. D., & Rouner, D. (2002). Entertainment—education and elaboration likelihood: Understanding the processing of narrative persuasion. *Communication theory*, 12(2), 173-191.

Van Dyne, L., & Pierce, J. L. (2004). Psychological ownership and feelings of possession: Three field studies predicting employee attitudes and organizational citizenship behavior. *Journal of Organizational Behavior: The International Journal of Industrial, Occupational and Organizational Psychology and Behavior*, 25(4), 439-459.

Van Laer, T., De Ruyter, K., Visconti, L. M., & Wetzels, M. (2014). The extended transportation-imagery model: A meta-analysis of the antecedents and consequences of consumers' narrative transportation. *Journal of Consumer research*, 40(5), 797-817.

Vandewalle, D., Van Dyne, L., & Kostova, T. (1995). Psychological ownership: An empirical examination of its consequences. *Group & Organization Management*, 20(2), 210-226.

Vasarhelyi, M. A., Kogan, A., & Tuttle, B. M. (2015). Big data in accounting: An overview. *Accounting Horizons*, 29(2), 381-396.

Westbrook, A., Kester, D., & Braver, T. S. (2013). What is the subjective cost of cognitive effort? Load, trait, and aging effects revealed by economic preference. *PloS one*, 8(7), e68210.

Yoon, K., Hoogduin, L., & Zhang, L. (2015). Big data as complementary audit evidence. *Accounting Horizons*, 29(2), 431-438.

Zhu, B., & Watts, S. A. (2010). Visualization of network concepts: The impact of working memory capacity differences. *Information Systems Research*, 21(2), 327-344.