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Future research directions at the intersection between cognitive neuroscience research and auditors' professional skepticism

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ABSTRACT

Drawing on the literature from cognitive neuroscience and auditing research on professional skepticism (PS), this paper identifies new research questions, determinants, and theories that may resolve current problem areas in PS research. We identify the following PS research areas that neuroscientific perspectives can potentially improve: 1) theory, 2) trust, 3) trait and state skepticism, 4) deception/fraud detection, and 5) skeptical judgment and action. The paper concludes with a discussion of the critical question of whether integrating a neuroscientific perspective in PS research is worthwhile and provides further direction for future research.

1. Introduction

The International Auditing and Assurance Standards Board (IAASB) defines professional skepticism (PS) as "an attitude that includes a questioning mind, being alert to conditions which may indicate possible misstatement due to error or fraud, and a critical assessment of audit evidence." (IAASB, 2009a, ISA 200.13.l). As such, PS is an important cornerstone of audit quality (IAASB, 2012; KPMGKL, 2012; PCAOB, 2012). Auditors are required to exercise the appropriate level of PS as prescribed by their professional standards (IAASB, 2009a). However, inspections reveal that auditors frequently fail to exercise an adequate level of PS (EU, 2010; IAASB, 2012; PCAOB, 2012).

Auditor professional skepticism has received a lot of attention in recent research (Aschauer, Fink, Moro, Van Bakel-Auer, & Rasmussen, 2017; Brazel, Jackson, Schaefer, & Stewart, 2016; Brazel & Schaefer, 2015; DeFond & Zhang, 2014). Despite these and related research efforts, PS remains a relatively ill-defined construct (Hurtt, Brown-Liburd, Earley, & Krishnamoorthy, 2013) and is often labeled a "black box" (DeFond & Zhang, 2014). We posit that the use of cognitive neuroscience to examine PS could offer new insights and a better understanding of the construct. Cognitive neuroscience focuses on high-order mental beliefs, thoughts, and behaviors and their corresponding brain areas, which are referred to as neural correlates (Camerer, 2003).[1] Recently, cognitive neuroscience has advanced many disciplines, such as psychology (Baars & Gage, 2010; Gallagher & Frith, 2003), economics (Glimcher & Fehr, 2014; Lee, 2008) and consumer research (Plassmann, Venkatraman, Huettel, & Yoon, 2015), but also accounting (Eskenazi, Hartmann, & Rietdijk, 2016; Farrell, Goh, & White, 2014). We argue that cognitive neuroscience can be equally successful in advancing our understanding of auditors' PS, because PS is formed in the auditor's brain. The purpose of this paper is to demonstrate how the neuroscientific perspective could inspire an improved understanding of PS and generate novel research oppor-

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[1] In this paper, we are not interested in any clinical aspects nor lesion studies or medical aspects of neuroscience.

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tunities in ways that traditional auditing research may not be able to do.[2,3] We do not suggest that research questions that arise at the intersection between these two disciplines will necessarily always require the use of neuroscientific methods. There may be instances where more traditional methods remain more appropriate. We aim to help all types of auditing researchers (and not only those aiming to use neuroscientific methods) in their efforts to improve PS models and the level of PS among auditors, and, ultimately, audit quality.

We first identify one major overarching PS research area that cognitive neuroscience can help to advance, which relates to the yet unknown nature of PS in the auditor's brain. The nature of PS is largely unknown because there are multiple definitions and perspectives of PS (e.g. Hurtt, 2010; Hurtt et al., 2013; Nelson, 2009). We suggest that using cognitive neuroscience can help to reconcile all these definitions, and to better conceptualize and define the nature of PS, thus helping researchers in their efforts to improve PS models, the level of PS among auditors and, ultimately, audit quality. Then, we identify the following PS research areas that can potentially be better understood using neuroscientific perspectives: (1) PS and theory, (2) PS and trust, (3) trait versus state skepticism, (4) deception/fraud detection, and (5) skeptical judgment and action.

First, we believe that the neuroscientific perspective can offer valuable insights about relevant theories and mechanisms (e.g. McCabe, Houser, Ryan, Smith, & Trouard, 2001; Mitchell, Macrae, & Banaji, 2006) that will help explain the workings of PS and expand PS models by including theories about the underlying PS process. Interestingly, neuroscientific research has been similarly successful in shedding light on concepts and theories related to supernatural believers and skeptics (Lindeman, Svedholm, Riekki, Raij, & Hari, 2013),[4] the concept of suspicion (Bhatt, Lohrenz, Camerer, & Montague, 2012), and the concepts of trust and distrust in IT information systems (Dimoka, 2010). Understanding which process theories explain the factors that trigger or inhibit PS will complement current PS models (e.g. Hurtt et al., 2013) and will ultimately help identify ways of improving the level of PS among auditors. Eventually, such theories can be included in training programs in audit practice to trigger higher levels of PS among auditors.

Second, despite the growing body of research on PS, scholars are still left with the challenging task of choosing an appropriate definition and conceptualization of PS in current PS models. For example, some auditing researchers suggest that PS is related to the presumptive doubt perspective (Nelson, 2009), but it may also be part of the neutral perspective (Hurtt, 2010). Other researchers map PS on the continuum of trust (Glover & Prawitt, 2014) and, according to auditing standards, exercising PS requires some level of *ex ante* distrust in the client's honesty (e.g., IAASB, 2009b, ISA 240.8). In the context of information systems, Dimoka (2010) used cognitive neuroscience to demonstrate that trust and distrust are different concepts. If this is the case, the two perspectives may complement each other. This has important implications for how researchers and practitioners should view PS. More specifically, researchers should perhaps not measure PS as the opposite of trust and practitioners may not need to distrust their clients to exhibit PS. Hence, the second research area that cognitive neuroscience can shed light on is concerned with unraveling the relationship between PS and *trust*.

A third PS research area of interest to us is the conceptualization of PS as a trait versus a state. This research area is inspired by Shaub (1996) and Hurtt (2010), who claim that PS is both. There are mixed views on the relative importance of trait skepticism, as well as about which perspective (i.e., a neutral perspective of PS or a presumptive doubt perspective) should be adopted when measuring trait PS in order to appropriately disentangle it from state PS (e.g. Hurtt, Eining, & Plumlee, 2008; Popova, 2012; Shaub, 1996). In addition, Hurtt et al. (2013) and others (Chung, Cohen, & Monroe, 2008; Nolder & Kadous, 2017; Olsen & Stuart, 2017) suggest that emotions may be part of PS. Prior neuroscientific research has mapped the biological basis of skepticism (Bhatt et al., 2012), trust (Krueger et al., 2007), and emotional/cognitive systems (Drobyshevsky, Baumann, & Schneider, 2006; Koch et al., 2007). Interestingly, neuroscientific research has been able to distinguish between trait (baseline) and state (situational) *suspicion* (Bhatt et al., 2012). Thus, such research is directly relevant to advancing our knowledge of the nature of PS with respect to distinguishing trait skepticism from state skepticism. We suggest that these findings can be extrapolated to auditing. Hence, the third proposed PS research area is concerned with disentangling PS as a *trait versus a state* because this would help researchers to better design their empirical studies, controlling for trait if state skepticism is the focus of their studies. In addition, better knowledge of what determinants constitute trait and state skepticism biologically may help draw a richer and more precise picture of the determinants of trait and state in PS models and to further elucidate the trait measurements of PS, such as the Hurtt Professional Skepticism Scale (HPSS) (Hurtt, 2010) and state professional skepticism scale (Robinson, Curtis, & Robertson, 2017).

[2] This paper focuses on the applications of neuroscientific research to the topic of PS rather than the technicalities underlying such applications. While we acknowledge that accounting researchers who employ neuroscientific methods in the accounting area lack the technical knowledge necessary to design all aspects of such a study, administer neuroscientific methods, and interpret the results arising from such methods, we suggest that this barrier can be overcome by collaborating with neuroscientists as, for instance, is done in social cognitive neuroscience (Cacioppo et al., 2008).

[3] Crossing disciplines has engendered novel insights into traditional research topics (Birnberg & Ganguly, 2012; Solnais, Andreu-Perez, Sánchez-Fernández, & Andréu-Abela, 2013). For instance, a decade of multidisciplinary research within consumer neuroscience contributed new insights to consumer research. Solnais et al. (2013) show that the main contribution consists of clarifying the neural basis associated with the inner responses to marketing stimuli in areas of consumer decision-making, emotional processing, attention and memory, and consumer motivation. Thus, consumer neuroscience has generated new research within consumer and marketing science.

[4] Using functional magnetic resonance imaging, Lindeman et al. (2013) examined the brain activity of supernatural believers versus skeptics. To recruit supernatural believers and skeptics, they contacted subjects who were at the extreme ends of the distribution of supernatural belief. Participants first pictured themselves in critical life situations and then watched emotionally charged pictures of lifeless objects and scenery. Supernatural believers reported seeing signs of how the situations were going to turn out in the pictures more often than skeptics did. Viewing the pictures activated the same brain regions among all participants. However, brain regions previously associated with cognitive inhibition were activated more strongly in skeptics than in supernatural believers. This suggests that differences in cognitive inhibition may explain why not everyone is a supernatural believer or a skeptic.

Our fourth research area of interest comprises deception and fraud detection. The detection of management deception or fraud is arguably an extreme case of auditors' PS. Both prior auditing research and extant neuroscientific research have looked into fraud and deception detection. Auditing studies have examined auditors' competence to detect fraud and how to improve auditors' level of PS in order to detect fraud (e.g. Brazel & Schaefer, 2015; Carpenter & Reimers, 2013; Harding & Trotman, 2017). Some studies have investigated how auditors assess fraud risk (Brazel & Schaefer, 2015; Holderness, 2014, 2017). According to auditing standards, auditors should be capable of exhibiting the appropriate level of PS to detect fraud. However, inspection reports indicate that fraud detection remains very difficult for auditors (e.g., PCAOB, 2010). Other research is endeavoring to find ways to improve auditors' PS level in order to detect fraud (Brazel, Jones, & Prawitt, 2014; Brazel & Schaefer, 2015; Carpenter & Reimers, 2013). Neuroscientific research, on the other hand, has advanced deception detection in many domains, but mostly on the deceiver side of deception (i.e., the person committing a fraud) rather than the receiver side (i.e., the person detecting a fraud). This gap could be filled in the auditing context by looking at factors (e.g., the auditors' skeptical behavior toward the client) that could improve auditors' level of PS and enable them to detect a client's deception.

The final research area of interest in this paper is the skeptical judgment and action stage of PS theory (Hurtt et al., 2013). While PS models enumerate several output measurements of PS, the final stage, skeptical action, is arguably the most interesting to accounting regulators and inspectors, since this action will translate into the inspected documentation or a conclusion in the audit engagement. Cognitive neuroscience suggests the existence of a "fight or flight" stage in skeptical action (Dimoka, 2010). We suggest that a skeptical auditor may fight (or flight) in the final stage of PS, either due to having (or lacking) the courage to act skeptically or because the audit environment may not encourage the auditor to materialize his or her skepticism (Brazel et al., 2016; Harding & Trotman, 2017; Nelson & Proell, 2016). We discuss whether additional determinants might have to be added to PS models between the stage of skeptical judgment and the stage of skeptical action. These determinants may hinder or encourage the skeptical judgment stage becoming a skeptical action stage.

The remainder of this paper is organized as follows. The next section presents examples of neuroscientific studies to provide a general understanding of how they can potentially advance our understanding of auditor PS. We also offer a critical disclaimer on the use of neuroscientific methods in future PS research. In Section 3, we briefly synthetize what we know about PS and identify PS research areas that can potentially be improved by neuroscientific perspectives. We also suggest avenues for future research. Finally, Section 4 concludes the paper.

2. The intersection of cognitive neuroscience and professional skepticism

The aim of this section is to offer a general overview of the potential intersection between the cognitive neuroscience perspective and PS, with the underlying goal of demonstrating how cognitive neuroscience can potentially advance our understanding of PS. We first provide a definition of neuroscience and cognitive neuroscience, followed by a brief overview of the most frequently used methods in neuroscientific studies.[5] Then we demonstrate the increasing use of cognitive neuroscience in various disciplines. Our focus is not on the application of cognitive neuroscience methods such as fMRI, but is more broadly aimed at identifying the intersection between the cognitive neuroscience perspective and our audit-specific topic. Nevertheless, for the sake of completeness, we conclude this section with a brief discussion of some of the limitations of using neuroscientific methods in the PS research area.

2.1. What is neuroscience?

Santiago Ramon y Cajal, a Spanish pathologist, is seen by many as the pioneer of neuroscience. He established the fundamental assumption that the nervous system is composed of neurons or nerve cells (Baars & Gage, 2010). A widely used definition of neuroscience according to the American Psychological Association is "the scientific study of the nervous system, including neuroanatomy, neurochemistry, neurology, neurophysiology, and neuropharmacology, and its applications in psychology and psychiatry" (APA, 2007).

Today we think of neuroscience as a branch of science that is interested in using neuroscientific methods to read and understand the brain. Poldrack (2017) speaks about neuroscience as viewing "the human brain in action and understand[ing] the processes that underlie mental functions such as decision-making" (p. 156). Cognitive neuroscience emerged from the intersection between neuroscience and biological psychology. It studies the neural mechanism of cognition (APA, 2007). The extensive application of cognitive neuroscience across different disciplines is due to the refinement of its methods and its theoretical integration with different models from psychology and economics, enabling the development of decision-making models (Ruff & Huettel, 2014).

Neuroscientists and cognitive neuroscientists use a variety of methods,[6] such as electroencephalography (EEG), magnetoencephalography (MEG), positron emission tomography (PET), and functional magnetic resonance imaging (fMRI). Chief among the

[5] For more technical descriptions of different tools in cognitive neuroscience, such as for the measurement and manipulation of the brain structure and function, the strengths and limitations of each technique, we refer the reader to Chapter 6 in Glimcher and Fehr (2014) and Chapter 4 of Baars and Gage's (2010) book "Cognition, Brain, and Consciousness: Introduction to Cognitive Neuroscience". For a brief overview of only fMRI (i.e., the neurophysiology behind it, its blood-oxygen-level dependent (BOLD) contrast mechanism, the fMRI design and analyses), see Logothetis's work (Logothetis, 2008; Logothetis, Pauls, Augath, Trinath, & Oeltermann, 2001), and for an even more in depth study of the fMRI technique, see the book "Functional Magnetic Resonance Imaging" by Huettel, Song, and McCarthy (2008).

[6] In this paper, we only mention non-invasive methods; however, neuroscientific methods also comprise invasive techniques. Invasive techniques induce a chemical or a device in the body such as single-unit recording (Ruff & Huettel, 2014). We do not discuss invasive techniques in this paper as it is unlikely that auditors will volunteer to undergo such treatment.

neuroscientific techniques is fMRI. Given that fMRI is the dominant neuroscientific method within interdisciplinary research and cognitive neurosciences (Baars & Gage, 2010), we provide a slightly more detailed description of the method here. Using MRI scanners, fMRI makes it possible to visualize the brain functions based on the brain metabolism (Purves et al., 2012). The scanner detects blood oxygenation level-dependent (BOLD) fluctuations in the magnetic resonance signal emitted by the hydrogen nuclei in surrounding water due to the paramagnetic properties of hemoglobin. When a brain region is activated by a task, the level of oxygen bound to hemoglobin in the draining veins rises, leading to local distortions in the magnetic field inducing the BOLD signal. The BOLD "fluctuations are detected using statistical image [analysis] techniques to produce maps of task-dependent brain function" (Purves et al., 2012, pp. 19–20). The popularity of fMRI among cognitive neuroscience techniques is partly due to the wide accessibility of MRI scanners at universities.

2.2. Application of neuroscientific methods to other disciplines

Neuroscientific methods, and fMRI techniques in particular, have been applied in a multitude of disciplines that employ psychological and (behavioral) economic models. In psychology and economics, neuroscientific methods are used to reach a better understanding of how information is processed in the brain, given different choices (Glimcher & Fehr, 2014). Neuroscientific methods have also proven useful in other, more applied, disciplines. Cognitive neuroscience has advanced the understanding of management accounting phenomena (Eskenazi et al., 2016; Farrell et al., 2014)[7] and marketing impacts on consumer behavior (Breiter et al., 2015; Karmarkar, Shiv, & Knutson, 2014). Some neuroscientific methods are currently even being considered for use as lie detectors (e.g. Langleben et al., 2016; Otte, Petit, & Campanella, 2013; Rusconi & Mitchener-Nissen, 2013).

We briefly elaborate on the recent use of neuroscience in management accounting, since it is closely related to auditing. Specifically, Eskenazi et al. (2016) use neuroscience and electroencephalography (EEG) to study the role of controllers' neurobiological characteristics (i.e., sensitivity to social pressure) when engaging in financial misreporting behavior. They find a positive association between the controller's sensitivity to social pressure and the propensity to engage in misreporting behavior. Another neuroscientific study in the field of management accounting investigates whether performance pay (as opposed to fixed pay) mitigates the influence of emotion on managers' cognitive processing and decisions, because the quality of managers' investment decision may be impaired by emotions (Farrell et al., 2014).

In the current paper, we are interested in cognitive neuroscience that applies models from economics and psychology, because they typically form the theoretical backbone of accounting and auditing research. Indeed, auditing scholars often borrow theories from economics (Bowlin, Hobson, & Piercey, 2015; Shaub, 1996) and psychology (Griffith, Kadous, & Young, 2015) to understand auditors' PS and judgment and decision-making. Related to this, we have identified some neuroscientific papers that indirectly study the concept of skepticism (Bhatt et al., 2012; Dimoka, 2010; Lindeman et al., 2013). For example, Lindeman et al. (2013) examine whether it is a cognitive default for people to believe in a supernatural agent (e.g., God) versus being skeptical in this regard. They use the fMRI technique to examine how skeptics differ from believers and find that skeptics have a more advanced cognitive inhibition than supernatural believers, leading them to suppress supernatural thoughts, biases, and intuitive thinking. It is unclear, however, whether this ability is a trait or a situation-specific process. The study by Lindeman et al. (2013) indicates that cognitive inhibition plays an important role in the formation of skeptics' mindset.

2.3. Challenges and limitations of using neuroscientific methods

As discussed, while we are open to the use of both neuroscientific and behavioral methods, for those PS researchers who choose to use neuroscientific methods to address some of the proposed research questions in our paper, there are some clear challenges and limitations in relation to using such methods. We briefly list some of the main challenges of using neuroscientific methods to increase awareness of these challenges among researchers. First, the interpretation of neural data, such as fMRI data, is problematic (Cacioppo, Lorig, & Nusbaum, 2008; Logothetis, 2008; Logothetis, Pauls, Augath, Trinath, & Oeltermann, 2001; Weisberg, Keil, Goodstein, Rawson, & Gray, 2008). One challenge is inferring the mental state from the activated brain area (Plassmann et al., 2015), since one mental process does not necessarily map into one specific brain area, but rather into several areas.

A second challenge raised by neuroscientists is "the problem of reversed inference", pointed out by Poldrack (2006) and also by Hugdahl, Raichle, Mitra, and Specht (2015), which states that inferences drawn from functional imaging data are asymmetric. Asymmetric inferences mean that it is not possible to reverse the inference from knowledge of the cognitive task to what the activation pattern should be. In other words, normal inference in functional imaging studies starts by knowing the cognitive task that was used to produce the particular activation pattern(s), but knowledge of the activation pattern, rather than the cognitive task, will yield inconclusive results.

Third, PS researchers may not always have the technical background necessary to conduct neuroscientific studies themselves. Ruff and Huettel (2014) indicate that, while researchers without a deep understanding of neuroscientific methods can conduct neuroscientific studies, this will produce research of little value because errors in data collection, analysis, and/or interpretation may lead to inaccurate results. Hence, collaboration with specialists is required.

A fourth challenge lies in choosing the neuroscientific method that is appropriate to the PS research question under investigation.

[7] Of note, Eskenazi et al. (2016) used another neuroscientific technique, electroencephalography (EEG), to study the role of controllers' neurobiological characteristics in engaging in financial misreporting behavior.

No single method can provide a comprehensive account of all research questions. The myriad of non-invasive measurement techniques available, such as electroencephalography (EEG), magnetoencephalography (MEG), positron emission tomography (PET), and functional magnetic resonance imaging (fMRI), are overwhelming. These neuroscientific techniques have varying abilities as regards capturing visual and timely data. For more explanation on each technique, see Ruff and Huettel (2014).

A final challenge is related to game theories that are widely used in cognitive neuroscience. A natural starting point for a neuroscientific study of PS might be to use game theory to probe neural activity (Lee, 2008) in auditors. However, we do not know whether and how well game theories translate to the auditing context. Such games remain a very abstract form of interaction, where players act on the basis of self-interest and gain, which may not be compatible with the (desired) mindset of auditors. Auditors are required to follow both regulations and codes of ethics when carrying out their duties. In an auditing context, the auditor's role is to serve the public interest (as opposed to the self-interest notion in game theory).[8]

In the following sections, we demonstrate how using a cognitive neuroscience perspective may bring new research opportunities to PS research.

3. Identifying PS research areas that can potentially be improved by cognitive neuroscience

Examining the intersection between PS research and cognitive neuroscience research, we elaborate on each of the five research areas identified in the introduction, i.e., (1) theory, (2) trust, (3) trait and state skepticism, (4) deception/fraud detection, and (5) skeptical judgment and action). We begin with the area of PS theory in order to offer a theoretical review of PS research, which is the basis for the subsequently discussed PS research areas. For each area, we review the relevant PS research and cognitive neuroscientific research that uses a theoretical paradigm from either economics or psychology. Then, we propose research questions for future research under each section. As mentioned, although those research questions arise from the intersecting multidisciplinary research areas of PS and neuroscience, they will not necessarily always require the use of neuroscientific methods. PS is without doubt formed in the auditor's brain and cognitive neuroscience research has investigated skepticism using its theories and methods. Our primary goal is to extrapolate research questions from this neuroscientific research that can resolve/improve problem areas within PS research, regardless of what research methods future research will use.

3.1. PS and theory

While PS is described by auditing standards as a "questioning mindset" (e.g., IAASB, 2009a; PCAOB, 2012), theoretically, its academic understanding is fragmented and influenced by disciplines outside of auditing that provide a broad understanding of the inputs and outputs of PS. Little is known, however, about the underlying process or theory that explains how PS is ultimately transformed into final judgments and decisions.[9,10]

In cognitive neuroscience, we identify the Theory of Mind (TOM), which can help explain how to improve the level of PS among auditors, complement PS models, and ultimately be part of training programs in audit practice. For instance, we believe that maintaining a skeptical mindset toward a client (a person) may require a different theory than maintaining a skeptical mindset toward evidence (an object) extrapolated from neuroscientific findings (McCabe et al., 2001). We first look at some theories currently used to explain the PS mindset in empirical PS research to show the link with TOM.

In empirical auditing studies of PS, researchers apply numerous theories from psychology and economics. Within psychology theories, Bauer (2015) uses Social Identity Theory as one mechanism to promote independence and increased PS among auditors. Further, Two Systems Theory explains the role of affect heuristics in triggering PS in auditors (Olsen & Stuart, 2017). Using Two Systems theory, Wolfe, Christensen, and Vandervelde (2014) show that intuitive processing may increase auditors' skepticism as opposed to analytical thinking. Intrinsic motivation is also suggested to improve skepticism among auditors (Kadous & Zhou, 2015).

From an economics theory perspective, Shaub (1996) views auditors' PS as an attitude toward a person. Shaub relies on the prisoner's dilemma (Rapoport & Chammah, 1965)[11] and Kee and Knox's (1970) model to explain auditors' PS. From a prisoner's

[8] Another challenge in personality studies, and thus potentially relevant when studying trait PS, is the selection bias that can explain the high correlation between social behavior and the activated brain regions (Vul & Pashler, 2012). This is coined "Voodoo Correlations in Social Neuroscience" (Vul & Pashler, 2012, p. 945). The main concern in such fMRI studies is the reported high correlations between social behavior and activated brain regions. Vul and Pashler explain these high correlations as being the result of selection bias, where researchers simply choose brain areas that will show high correlations with the social behavior under investigation. For a more technical explanation of this specific challenge in fMRI studies of individual differences in social behavior, see for example Vul & Pashler (2012).

[9] For instance, Mautz and Sharaf (1961) applied a philosophical lens and described PS as a logic through which an auditor obtains evidence, while Shaub's (1996) view of PS is based on Kee and Knox's (1970) prisoner's dilemma theory, where PS is defined as the opposite of trust. Moreover, Glover and Prawitt (2014) also studied PS as a point on a continuum ranging from complete doubt, via presumptive doubt, and a neutral attitude to trust, but they excluded complete trust from the continuum. Nelson (2009) similarly employs a "presumptive doubt" perspective and defines PS as "indicated by auditor judgments and decisions that reflect a heightened assessment of the risk that an assertion is incorrect, conditional on the information available to the auditor." (p. 1).

[10] Hurtt, Brown-Liburd, Earley, and Krishnamoorthy (2013) developed an input/output model of PS in which they rely on a more neutral view than the Nelson presumptive doubt perspective. Thus, there are conflicting views of whether PS is the opposite of trust or not. This multifaceted view of PS builds on the assumption that auditors' PS consists of two components (Hurtt, 2010): first, skepticism as a trait of the individual auditor ("trait skepticism") and, second, skepticism due to the situation ("state skepticism"). In her earlier work, Hurtt (2010) constructed the Hurtt Professional Skepticism Scale (HPSS) to measure trait skepticism through six dimensions.

[11] In the prisoner dilemma game, the players choose either to cooperate or defect, and the payoffs are symmetrical. The player maximizes his benefits when acting in a self-interested (and defect) way when the other chooses to cooperate. If both players choose to act in a self-interested way, the benefits are minimized, while if both choose to cooperate, the joint return is maximized but not the individual return.

dilemma's standpoint, the auditor must cross a certain threshold of trust before deciding whether to trust or not trust a client's management in order to exhibit trusting or suspicious behavior. Shaub's application of the Kee and Knox model implicitly assumes that the auditor bases his/her behavior on how the auditor perceives the management as a person. Interestingly, there is no mention of differences in PS when examining the management's integrity (a person) versus examining evidence (an object).

We suggest the Theory of Mind (TOM), a widely-used theory in cognitive neuroscience, as another lens through which PS can be examined. TOM further develops the idea of trying to read others' intentions, which was also proposed by Kee and Knox. According to Gallagher and Frith (2003), people have a distinctive ability to predict other people's states of mind, such as beliefs, intentions, emotions, and behavior. This ability to predict other people's unobservable mind states is called 'having a TOM' or 'mentalizing.' The ability to mentalize is particularly important in situations involving predicting others' deceiving behavior, because auditors are required to maintain a skeptical mindset when assessing fraud (IAASB, 2009b).

Typically, TOM or mentalizing is primarily a theory about another individual and not about an object. TOM is an interesting theory to fill the PS models' theoretical gap because it could show that researchers need to use different theories when examining PS toward clients or toward evidence. In fact, in a neuroscientific trust game study, McCabe, Houser, Ryan, Smith, and Trouard (2001) test whether mentalizing is indeed only possible about a person. The researchers informed participants that their counterparts were human beings or computers. The game had two players, where the investor and the trustee chose to either cooperate or not cooperate. McCabe et al. (2001) hypothesized that the medial prefrontal cortex, which had previously been found to be activated in TOM processing (Baron-Cohen, 1995), will be activated when players interact with people but not when interacting with computers. They found that cooperative players have higher activation of the medial prefrontal cortex (mPFC) when playing against a person compared to a computer. On the other hand, in the case of non-cooperative players, the activation of the medial prefrontal cortex was the same, regardless of whether the counterpart was human or a computer.

Since a person or a computer counterpart is exactly what the auditor bases his or her PS upon, TOM is an interesting process theory that can complement existing PS models. PS may be similarly geared toward a person (e.g., client representative) versus an object (e.g., digital/paper evidence/documentation). Thus, it is possible that forming a skeptical mindset toward a person is different from forming a skeptical mindset toward an object, such as a computer or evidence. In modern audit engagements, auditors may increasingly apply PS to objects such as to client's Big Data, Big Data analytics (Appelbaum, 2016; Appelbaum, Kogan, & Vasarhelyi, 2017), to advanced software (e.g, Robotic Process Automation, Artificial Intelligence and Blochchain) and digital audit evidence. To the best of our knowledge, this idea that auditors' PS may be different when PS is exhibited toward a person versus toward a piece of evidence has not yet been examined. This is an important question because, if the processes behind auditors' PS are different when faced with evidence (i.e., becoming more digitalized and impersonal) than when faced with a client representative, then the different processes may yield different PS levels in the auditor. This means that, to resolve the deficiencies reported by regulators due to a lack of PS among auditors, researchers and practitioners may use different means to improve their level of PS, depending on whether the auditor is faced with a questionable client or evidence, or both. Cognitive neuroscientific methods as well as behavioral methods could help auditing researchers to address the following research questions:

- Can TOM be used to better understand skeptical behavior?
- Are auditors' PS attitudes toward clients different than their PS attitude toward digital/paper evidence/documentation?

Research on TOM also suggests that whether one perceives the other as similar to oneself or not plays a role in their trusting behavior. For instance, Michell et al.' (2005, 2002, 2006) findings suggest that, when individuals use their own mental states to judge others' mental states that they perceive as being similar to their own, this activates one part of the medial prefrontal cortex (mPFC).[12] The process whereby individuals judge others' mental states differently when they perceive the others to be dissimilar to themselves will activate a different, more dorsal part of the mPFC. Interestingly, this suggests that how auditors judge the mental states of their client may depend on how similar/dissimilar they perceive the client to be in relation to themselves. This difference in perception of the client may influence auditors' PS and may be another important determinant of PS.

One probable scenario is that auditors who perceive the client's management as similar to themselves (e.g., because they have a similar background) may be more trusting of the client's management and less alert to conditions that might indicate material misstatements due to error or fraud. Indeed, PS research suggests that auditors who identify with a professional identity, as compared to auditors who identify more strongly with their clients, have heightened PS (Bauer, 2015). Favere-Marchesi and Emby (2017) find that auditors are more willing to agree with less conservative accounting policies on the part of clients that employ a former partner of their audit firm as a CFO. This suggests that auditors perceive management as more similar to themselves, which reduces auditors' skepticism. Following this line of thought, the auditor's TOM of the client's management as being similar to him or herself may reduce the auditor's level of PS toward the client's management when judging their explanations in inquiries, auditing fair value estimates, deciding on a going concern opinion, or in fraud assessments. We offer the following related research question:

- Do auditors' skeptical judgments and actions vary with auditors' TOM of the client's similarity to themselves?

[12] The directions within brain anatomy are as follows: Up = dorsal, Down = ventral, Side = lateral, Front = anterior, Back = posterior, Middle = medial – see Bars and Gage's book (2010).

Table 1
Summary of major research studies and questions for future research, by PS research area.

Studies by PS research area	Research questions
PS and theory	
PS: Mautz and Sharaf (1961) Shaub (1996) Kee and Knox (1970) Brazel and Schaefer (2015) Hurtt et al. (2013) Bauer (2015) Olsen and Stuart (2017) Kadous and Zhou (2015) Appelbaum (2016) Appelbaum et al. (2017) Neuroscience: Baron-Cohen (1995) McCabe et al. (2001) Gallagher and Frith (2003)	Can TOM be used to better understand skeptical behavior? Are auditors' PS attitudes toward clients different than their PS attitude toward digital/paper evidence/documentation?
Auditing: Bauer (2015) Favere-Marchesi and Emby (2017) Neuroscience: Michell et al. (2005, 2002, 2006)	Do auditors' skeptical judgment and action vary with auditors' TOM of the client's similarity to themselves?
Accounting: Farrell et al. (2014) Wolfe et al. (2014) Griffith, Hammersley et al. (2015), Griffith, Kadous et al. (2015) Olsen and Stuart (2017) Psychology: Kahneman (2003) Neuroscience: Lindeman et al. (2013)	Does the deliberative route improve or hinder the level of PS in audit judgments? Does the intuitive route facilitate or hinder the formation of auditors' level of PS? Under which conditions does this occur? Does inhibitory control enhance PS among auditors?
PS and trust	
PS: Shaub (1996) Hurtt et al. (2013) Glover and Prawitt (2014) Nolder and Kadous (2014) Quadackers et al. (2014) Aschauer et al. (2016) Neuroscience: Dimoka (2010)	How are trust, distrust, and PS related to each other? Can PS and trust coexist in auditors' judgment and decision-making?
PS trait and/state	
PS: Shaub (1996) Chung et al. (2008) Hurtt (2010) Hurtt et al. (2013) Nolder and Kadous (2014) Olsen (2015) Olsen and Stuart (2017) Robinson et al. (2017)	Can cognitive neuroscience disentangle and examine the relative importance of trait (baseline) PS and state (situational) PS? Are emotions part of trait or state PS, or both? Is situational PS related to auditors' experience and training on the job? Do auditors with high levels of fraud experience (e.g., forensic auditors) have higher levels of PS than auditors with less fraud experience?
Neuroscience: Damasio (1994) Bhatt et al. (2012) Neuroscience: Drobyshevsky et al. (2006) Koch et al. (2007)	Is the role of emotions in PS driven by auditors' gender, i.e., are females more emotional than males and does this trait difference affect their PS level? Are female auditors more (or less) skeptical than male auditors?

(*continued on next page*)

Table 1 (*continued*)

Studies by PS research area	Research questions
PS and deception (fraud) detection PS: Brazel et al. (2014) Brazel and Schaefer (2015) Carpenter and Reimers (2013) Holderness (2014, 2017) Neuroscience: Porter and ten Brinke (2010) Isoda and Noritake (2013)	What are the determinants of effective deception detection? Are the determinants of deception detection associate d with exhibiting high levels of PS?
Skeptical judgment and action PS: Hurtt et al. (2013) Mautz and Sharaf (1961) Proell (2016) Brazel et al. (2016) Neuroscience: Dimoka (2010)	Will additional determinants such as auditors' characteristics (e.g., the courage to act) interfere in the skeptical judgment stage, hindering skeptical judgment from becoming skeptical action? What are the determinants of the fight versus flight reaction?

Beside TOM, another promising theory that could further improve our understanding of the cognitive processes behind PS is Two Systems Theory (Kahneman, 2003). This theory has also been referred to and used in many previous fMRI studies (e.g. Evans, 2003) and accounting research (Farrell et al., 2014; Griffith, Hammersley, Kadous, & Young, 2015; Olsen & Stuart, 2017; Wolfe et al., 2014). According to Kahneman (2003), System 1 operations are intuitive and characterized as follows: "fast, automatic, effortless,

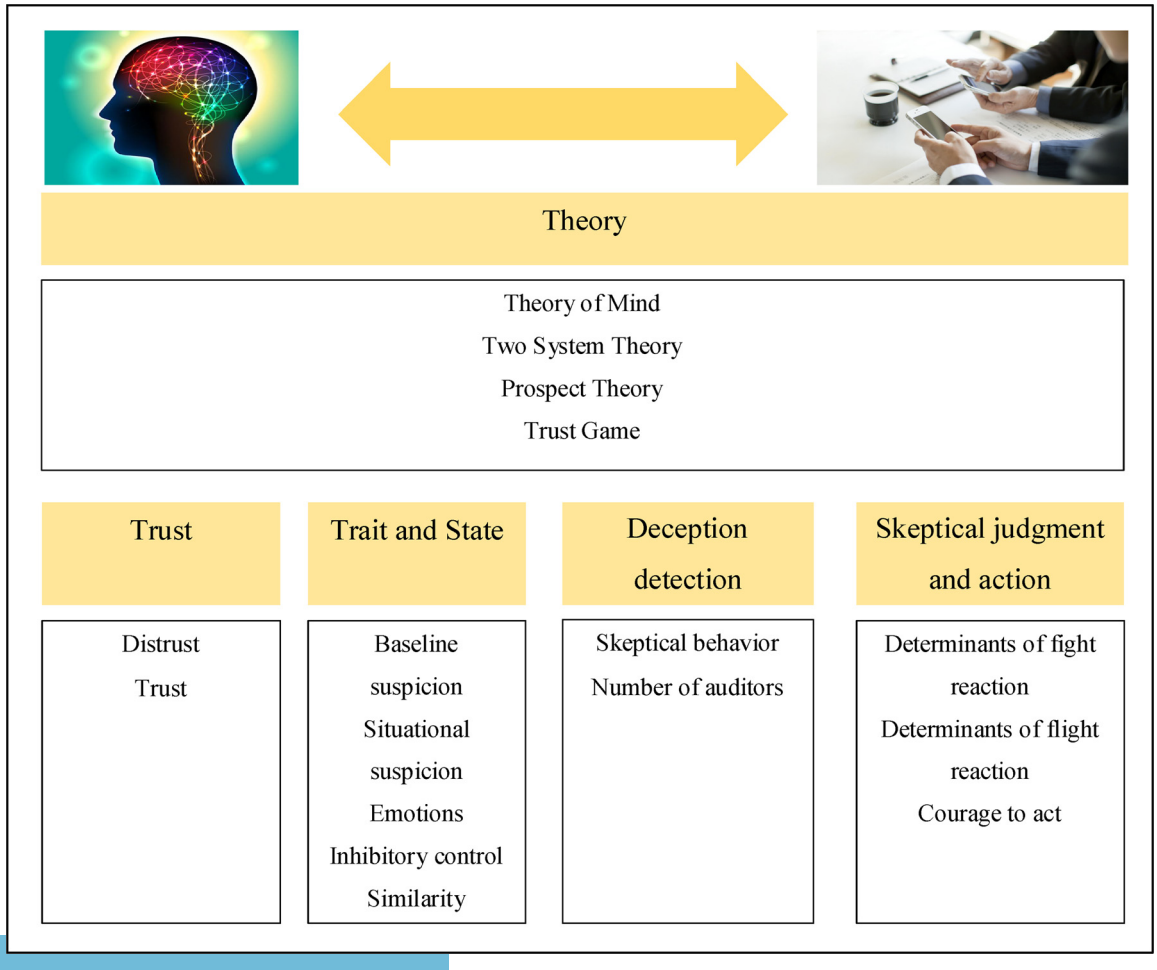

Fig. 1. Summary of theories and determinants by PS research area.

associative, implicit (not available to introspection), and often emotionally charged; they are also governed by habit and are therefore difficult to control or modify" (Kahneman, 2003, p. 698). System 2 operations are deliberate and characterized as being "slower, serial, effortful, more likely to be consciously monitored and deliberately controlled; they are also relatively flexible and potentially rule governed" (Kahneman, 2003, p. 698).

Farrell et al. (2014) find that paying incentives to managers improves the deliberate mindset (but does not entirely eliminate the System 1 intuitive mindset) in managers' investment choices. Griffith, Hammersley et al. (2015) behavioral experiment indicates that interventions inducing a deliberative mindset in auditors may increase the quality of audit decision-making. Olsen and Stuart (2017) induce affective states in auditors and find that both intuitive and deliberate auditors are influenced by affect in their skeptical judgments. Other research suggests that intuitive thinking improves auditors' ability to be skeptical (Wolfe et al., 2014). Thus, whether intuitive or deliberate thinking improves the PS level among auditors is an open question.

Moreover, cognitive neuroscience findings suggest that elements of Two Systems Theory may enhance skepticism. Lindeman et al. (2013) find that skeptics have a better cognitive inhibition than supernatural believers. This supports the Two Systems Theory because, when human beings engage in effortful reasoning, they use inhibitory control in such a way that they suppress supernatural and illogical thoughts, biases, and intuitive thinking. This suggests that inhibitory control in the deliberate route may improve the level of PS among auditors. Inhibitory control relates to the auditor's ability to defer judgment until adequate and sufficient evidence is gathered (Hurtt, 2010). Based on the prior discussion, we cannot be certain how Two System Theory explains the level of PS. Two System Theory has been widely investigated in cognitive neuroscience and these investigations suggest that neuroscience methods are predictive in identifying the route taken (deliberate vs. intuitive) (Kahneman, 2011). We propose the following research questions:

- Does the deliberative route improve or hinder the level of PS in audit judgments?
- Does the intuitive route facilitate or hinder the formation of auditors' level of PS? Under which conditions does this occur?
- Does inhibitory control enhance PS among auditors?

3.2. PS and trust

The implications of unraveling how PS and trust are related are important to both research and practice. They are important for future research because a consequence could be that PS should not be manipulated or measured as the opposite of trust, as previous research has done. These insights are also important to audit practice, as auditors may be able to build a trusting relationship with the client while maintaining high levels of PS.

Cognitive neuroscience can help illuminate PS at the construct level with respect to the relationship between PS and the construct of trust. As shown previously, some PS models claim that PS is the opposite of trust (Shaub, 1996), implies a presumptive doubt perspective (Nelson, 2009) or that PS lies on an inversed trust continuum (Glover & Prawitt, 2014), while other models do not mention trust but rather propose a neutral perspective of PS (Hurtt et al., 2013). Thus, PS models have conflicting perspectives regarding the relationship between PS and trust.

The same problem of PS and trust persists in empirical research, where some research suggests that PS is best reflected when auditors distrust the client (Quadackers, Groot, & Wright, 2014). Other research findings support a more nuanced picture of PS, where auditors' PS and trust can coexist (Aschauer et al., 2017). Aschauer et al. (2017) interview both auditors and audit clients and demonstrate that an auditor's trust and PS may not be opposites of each other that belong at opposite ends of the same continuum, despite the claims made by Shaub (1996) and Glover and Prawitt (2014). The findings suggest that the coexistence of PS and trust can even have benefits, at least for the client's perceptions of auditors' PS, implying that regulatory measures to impede client-auditor trust (such as independence requirements) may not necessarily increase PS, as frequently claimed.

Neuroscientific research has also discussed the issue of trust and skepticism in different contexts, which may help reconcile these inconsistencies. For example, Dimoka (2010), using neuroscientific methods, finds evidence that trust and distrust are not at opposite ends of a continuum and, hence, may be distinct concepts.[13] Similar methods could be applied to examine the overall research question:

- How are trust, distrust, and PS related to each other? Can PS and trust coexist in auditors' judgment and decision-making?

3.3. PS trait versus state

The question whether PS is a trait or a state or both (Hurtt, 2010; Robinson et al., 2017) is multifaceted. One facet of the problem is how to measure trait. We find extensive research on trait PS, but the findings using the Hurtt Professional Skepticism Scale (HPSS)

[13] Dimoka (2010) investigates whether trust and distrust activate the same areas of the brain, which would suggest that the two constructs are on a continuum, or whether each construct activates a distinct area of the brain, which would suggest that trust and distrust are distinct constructs. She uses fMRI, psychometric measures, and behavioral experiments to examine these issues. In the experiments, buyers and sellers interact in the impersonal exchanges on eBay auctions. The results show that trust and distrust indeed activate different areas of the brain. Trust is associated with brain areas linked to economic and social rewards (i.e., dorsal striatum, caudate nucleus, putamen, paracingulate cortex, orbifrontal cortex). These neural processes are cognitive in nature. Distrust is associated first with brain areas related to intense negative emotions (i.e., amygdala), which subsequently trigger more cognitive areas of the brain (i.e., insular cortex). This study also shows the relative effects of trust and distrust on price premiums by showing that the distrust brain areas amygdala and insular cortex have the strongest associations with price premiums.

are confusing because there are two perspectives of trait PS (i.e., neutral perspective and presumptive perspective). For instance, under conditions of high risk, Quadackers et al. (2014) find that the presumptive doubt perspective of PS (i.e., measuring PS as the inverse of trust using the Rotter Interpersonal Scale (Rotter, 1967)) is more predictive of auditors' skeptical judgments and decisions than the neutral perspective of PS measured by the HPSS. Popova's (2012) experiment uses the HPSS and reports that, while initial judgments are primarily driven by client experience, when no client experience is present, initial judgments are driven by trait skepticism. Another facet of the problem is to determine the appropriate weight to place on trait or state PS influencing PS actions. The findings regarding trait and state skepticism are also mixed as regards the relative importance of trait skepticism. For instance, under some conditions, Shaub (1996) finds that trait skepticism may not be as important as state skepticism, while under other conditions it may be important, or that audit experience may be more important than trait PS under other conditions (Popova, 2012). Thus, disentangling trait from state skepticism and considering the relative impact of trait and state skepticism are facets of the problem.

Auditing scholars have tried to disentangle trait from state PS. For instance, state skepticism is traditionally investigated by manipulating situational factors such as control risk, and trait skepticism is controlled for with a measurement of trait skepticism from the HPSS (Quadackers et al., 2014). Recently, Robinson, Curtis and Robertson (2017) created a scale for state skepticism based on the HPSS; this may be another way to measure state skepticism and disentangle it from trait skepticism. A final facet of the problem is whether trait and state PS are cognitive or emotional in nature (e.g. Hurtt et al., 2013; Nolder & Kadous, 2017).

Some of these issues could be resolved by examining cognitive neuroscience research areas related to skepticism. Neuroscientific research mapping the biological basis of skepticism (Bhatt et al., 2012), emotions (Damasio, 1994), and the role of gender (Drobyshevsky et al., 2006; Koch et al., 2007) suggests that such factors may also be important in determining the level of PS among auditors. Bhatt et al. (2012) investigate the neural basis of suspicion in individuals using a repetitive economic game involving two players. We have chosen to discuss this study because suspicion is a concept that is highly related to PS (Shaub, 1996). Bhatt et al. argue that suspicion is an important way of assessing the credibility of information in situations of information asymmetry between a buyer and a seller. Their findings suggest that suspicion is determined by both the individual's baseline suspicion level (similar to trait PS) and situation-induced suspicion (similar to state PS). Bhatt et al. find that participants' baseline suspicion is correlated with the amygdala activity in the brain, which plays a central role in the emotional part of trustworthiness judgments, fear, and emotional memories.

Bhatt et al.'s findings are directly relevant to the study of PS. They suggest that trait skepticism may be emotional and that situational skepticism is more cognitive in nature. This means that trait PS can best be measured using emotional scales. To the best of our knowledge, measuring trait PS based on emotional scales is not done in current PS research, but we note that some PS researchers suggest that emotions may play a role in PS. In fact, auditing scholars have suggested that emotions are related to PS determinants, as part of trait PS (Hurtt et al., 2013) or as a situational state (Olsen, 2017), or as a judgment and a decision outcome (Nolder & Kadous, 2017).[14]

Chung et al. (2008) link the effect of different mood states (i.e., positive versus negative) to auditors' conservatism when evaluating the client's inventory (Chung et al., 2008). Chung et al. (2008) find that positive-mood auditors had the least conservative judgment, while negative-mood auditors had the most conservative judgment. Although Chung et al. do not specifically mention PS in their study, these results suggest that negative mood states (e.g., the death of a friend and pressures to meet deadlines during the busy season could increase tension) will be associated with higher levels of conservatism and thus high levels of PS in judgments. Thus, it is unclear what role the emotions play in state PS and/or trait PS. The following research questions arise:

- Can cognitive neuroscience disentangle and examine the relative importance of trait (baseline) PS and state (situational) PS?
- Are emotions part of trait or state PS, or both?

Further, Bhatt et al. (2012) find that the situational component of suspicion activates the bilateral parahippocampal brain areas. The bilateral parahippocampus has previously been associated with trustworthiness judgments, as well as memory formation/retrieval and learning. Memory and learning on the job are closely related to experience. This finding is very interesting, as it suggests that state PS is driven by trust or distrust and audit experience gained on the job. It is conceivable that PS might be higher among more experienced auditors. While we are aware of research on the effects of audit experience on auditors' professional skepticism, this research was conducted before the emergence of the most recent PS models. For instance, Rose (2007) finds that audit experience does not predict auditors' attention to aggressive reporting or auditors' judgments about intentional misstatements. However, he reports that auditors with more fraud experience are more likely than auditors with less fraud-specific experience to believe that intentional misstatement had occurred when evidence of aggressive reporting exists. This suggests that greater audit experience does not imply higher levels of PS, but experience of fraud may imply higher levels of PS. We do not know whether this is due to their trait or state skepticism, since this research was carried out before Hurtt's conceptualization of trait and state skepticism. This leads us to propose the following research question:

- Is situational PS related to auditors' experience and training on the job?

[14] Affect is certainly part of what makes people make sound and unsound judgments (Forgas, 2001), as shown by Gage's famous brain lesion case (Damasio, 1994). Although Gage recovered from his brain lesion and his intellect was tested and found to be intact, his rationality and judgment, and decision-making were forever impaired because he could not experience emotions anymore.

Further, we suggest that experience of or training in fraud detection, which is arguably an extreme case of PS, could influence the level of PS. We know that fraud detection is difficult for auditors (Hammersley, Johnstone, & Kadous, 2011; Holderness, 2014, 2017), but also that auditors fail to modify their audit procedures in response to fraud (Hoffman & Zimbelman, 2012). Various sources have associated the ability to better detect fraud with PS (AICPA, 2002; Choo & Tan, 2000; Hurtt et al., 2013; IAASB, 2009b) and with audit knowledge, training, and experience (Asare, Wright, & Zimbelman, 2015). This gives rise to the following research question:

- Do auditors with high levels of fraud experience (e.g., forensic auditors) have higher levels of PS than auditors with less fraud experience?

Moreover, when considering the role of affect and emotions in trait and state PS, we cannot ignore the extensive neuroscientific literature suggesting that gender plays a role in determining the influence of emotions in PS. Specifically, using fMRI data, neuroscientific research finds significant gender differences in processing emotions (Drobyshevsky et al., 2006; Koch et al., 2007). For instance, Koch et al. (2007) report that negative emotions yield significantly more activation in females compared to males in brain regions associated with the processing of negative emotions (i.e., the insula). We believe that gender-based fMRI research can advance our knowledge on the role of gender and emotional systems in determining the level of PS. This is important for balancing the level of PS at the audit team level by manipulating the gender composition of the team. Given the lack of research linking affective states and emotions to PS, we propose the following research questions:

- Is the role of emotions in PS driven by auditors' gender, i.e., are females more emotional than males and does this trait difference affect their PS level?
- Are female auditors more (or less) skeptical than male auditors?

3.4. PS and deception (or fraud) detection

Detecting deception or fraud is arguably an extreme form of auditors' PS and important in auditing (Brazel & Schaefer, 2015). The link between fraud detection and PS is explicitly stated in the auditing standards. For instance, according to ISA 240, the auditor should be able to read the management's level of integrity and intentions in order to detect a client's deception (Brazel & Schaefer, 2015; Holderness, 2014). Auditors should be capable of exhibiting the appropriate level of PS to detect deception or fraud. However, inspection findings indicate that it is hard for auditors to detect fraud (PCAOB, 2010) and auditing research has examined ways of improving auditors' PS level in order to detect fraud (Brazel et al., 2014; Brazel & Schaefer, 2015; Carpenter & Reimers, 2013). While auditing research is struggling to find ways to improve fraud/deception detection among auditors, cognitive neuroscience applications aimed at improving deception detection are also used for national security purposes (Happel, 2005) and for commercial purposes to study how consumers process deceptive advertising (Craig, Loureiro, Wood, & Vendemia, 2012).

Auditing research has also examined auditors' competencies when considering deception and fraud detection (Brazel et al., 2014; Brazel & Schaefer, 2015; Carpenter & Reimers, 2013; Holderness, 2014). For instance, Carpenter and Reimers (2013) find that partners' attitude with respect to PS improves auditors' identification of risk factors and selection of audit procedures. Brazel et al.'s (2014) findings imply that auditors only react when both high fraud risk and prompts of inconsistent nonfinancial measures are present, compared to only high fraud risk. Other research has examined auditors' soft skills in deception detection. It suggests that dual auditor teams in client inquiries are better able to incorporate deceptive behavioral cues in their decision-making than if only one auditor were conducting inquiries (Holderness, 2014, 2017).

Deception detection is also a major area of neuroscientific research. It uses different methodologies (such as lie detectors, EEG, fMRI, etc.). There is a consensus that using different techniques, including neuroscientific methods, will ultimately provide insights and ecological validity (Happel, 2005; Porter & ten Brinke, 2010). The bulk of neuroscientific research focuses on the deceiver/liar side of deception (Porter & ten Brinke, 2010; Sip, Roepstorff, McGregor, & Frith, 2008), examining the brain processes of the *deceiver* (Isoda & Noritake, 2013) rather than the *receiver* side. This gap could be filled in the auditing context. For instance, PS research might investigate questions such as:

- What are the determinants of effective deception detection?
- Are the determinants of deception detection associated with exhibiting high levels of PS?

3.5. Skeptical judgment and action

PS models enumerate several output measurements of PS, such as skeptical judgments and the final stage of skeptical action (Hurtt et al., 2013), where a skeptical auditor may "fight or flight." Behavioral auditing research has investigated several types of skeptical judgments and actions. For example, Chung et al. (2008) find that positive-mood auditors made the least conservative (least skeptical) judgments, while negative-mood auditors make the most conservative (most skeptical) judgments. Griffith, Hammersley et al. (2015) demonstrate that deliberate thinking can improve auditors' ability to identify contradictory information from diverse parts of the audit and incorporate it into their analyses. This deliberate thinking improves their ability to think critically about the evidence. Thus, it seems that a deliberate mindset may increase auditors' PS level when assessing audit evidence. Auditing research thereby suggests that both emotions and cognition influence auditors' judgment and decision-making and, ultimately, skeptical action.

Skeptical action undoubtedly requires more than just examining the underlying cognitive and emotional processes. For instance, an important element of skeptical action is the courage to act skeptically in the audit environment. Mautz and Sharaf (1961, p. 35) state that the auditor "must have the professional courage not only to critically examine and perhaps discard the proposals of others, but to submit his own inventions to the same kind of detached and searching evaluation." However, being skeptical or having a skeptical judgment/intention, or a gut feeling that something is wrong, does not necessarily mean that an auditor would have the courage to act accordingly. Skeptical action is the final stage in PS models (Hurtt et al., 2013; Nelson, 2009) and we do not know until that stage whether the auditor's skepticism will translate into visible skeptical output or not.

For instance, in a series of survey and experimental studies, Nelson and Proell (2016) investigate how audit leaders react to subordinates behaving more skeptically by voicing their skepticism both at the moment an issue is raised and later when leaders provide performance evaluations. This research indicates that team leaders' reactions may hinder subordinate auditors from voicing their skepticism, because skepticism may hinder audit effectiveness and efficiency. We are inspired by this research, which shows that team leaders will react with irritation if a subordinate raises an issue that will hinder the effectiveness of the audit (Nelson & Proell, 2016), possibly favoring a flight reaction in an initially skeptical auditor. Another study that made us think about the courage to act finds that auditors' PS attitudes may be hindered by the evaluation systems of the audit firms (Brazel et al., 2016),[15] thus encouraging a flight type of reaction among skeptical audit subordinates.

Cohen, Dalton, and Harp (2017) provide troubling evidence on the effect of the neutral versus the presumptive doubt perspective of PS on auditors' future career that may be an additional barrier for auditors in relation to voicing their skepticism. The findings suggest that the neutral perspective (i.e., associated with maintaining a sustainable audit profession) has outcomes that are more positive for the auditors' career trajectory than adopting a presumptive doubt perspective that is often associated with better quality in fraud detection. This might suggest that the evaluation system in audit firms does not favor a fight reaction, such as auditors voicing their doubts. A fight reaction may not ensure an auditor a prosperous career.

Cognitive neuroscience explains the biological basis for why auditors may favor a fight or a flight reaction. It relates the courage to act (i.e., fight) or the lack of courage to act (i.e., flight) to a "fight or flight" reaction in the Amygdala part of the brain. The activation of the Amygdala in the brain may trigger the fight or flight reaction (Dimoka, 2010) in skeptical auditors. Dimoka contests that this finding is in line with prospect theory (Kahneman & Tversky, 1979). Prospect theory indicates that losses weigh more than gains. The strong association between distrust neural correlates (i.e., mainly the emotional amygdala in the brain) and flight/fight behavior is due to the secretion of the "fight or flight" hormones (i.e., the chemicals epinephrine and norepinephrine) secreted when danger, such as high risk, is present (Dimoka, 2010). Thus, cognitive neuroscience offers a neurological and a physiological justification for PS literature on the stronger effects of negative risky information on auditors and the existence of a "fight or flight" stage in auditors' skeptical action.

For various reasons, the skeptical auditor may fail to take skeptical action, such as failing to require more or better documentation or question management decisions. This suggests that additional determinants, such as the courage to act, or environmental structures, such as the team leader's behavior, may hinder the skeptical judgment from translating into a skeptical action. An auditor will "flight" (i.e., do nothing with his skeptical judgment) or will "fight back" in the skeptical action stage, for example, by requiring a change in the audit procedures or by voicing his or her skepticism in a brainstorming session. We suggest the following research questions:

- Will additional determinants such as auditors' characteristics (e.g., the courage to act) interfere in the skeptical judgment stage, hindering skeptical judgment from becoming skeptical action?
- What are the determinants of the fight versus flight reaction?

4. Concluding remarks

This paper has proposed research questions based on the intersection between the cognitive neuroscience research perspective and PS research, with the goal of advancing our understanding of PS. Throughout the paper, we have identified implications for both audit research and practice of using cognitive neuroscience in PS research, thereby contributing to both research on and the practice of PS in several ways.

First, we identified the following major PS research areas that may benefit from being investigated using neuroscientific methods: (1) PS and theory, (2) the relationship between PS and trust, (3) trait versus state skepticism, (4) PS and deception detection, and (5) PS skeptical judgment and action. Drawing on research on PS and cognitive neuroscience, we have suggested research questions that expand PS research in these five areas. Table 1 provides a summary of the suggested research areas and proposed research questions presented in this paper. The list is not intended to be exhaustive, but should rather be considered as a starting point that can spur future research on PS to take new directions using both neuroscientific and other behavioral methods. We emphasize that the proposed research questions may not always require the use of neuroscientific methods, and we acknowledge the challenges of using these methods.

[15] Brazel et al. (2016) held staff members' skeptical judgments and acts constant, and superiors on the engagement team evaluated the staff's skeptical behavior based on whether the staff's investigation of an issue ultimately identified a misstatement. The findings suggest that evaluators penalize auditors who employ an appropriate level of skepticism, but do not identify a misstatement. Although the auditors consulted with their superiors while exercising skepticism, thereby improving staff auditors' performance evaluations, consultation did not effectively mitigate the outcome effect on their evaluations. Additional evidence was gathered showing that auditors in the field anticipate that their superiors will be influenced by outcome knowledge when they evaluate their skeptical behavior.

We identified the potential of expanding PS models by including relevant theories and relevant determinants used in cognitive neuroscience, complementing current PS models (Hurtt et al., 2013). Fig. 1 summarizes what kind of PS research areas we looked at and the relevant theories and determinants of PS that we identified at the intersection of PS and cognitive neuroscience.

In summary, we identified auditing issues related to PS that could strongly benefit from following the neuroscientific path to identify ways of finding novel research opportunities worth investigating and thereby improve the level of PS among auditors.

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