

CEO COGNITIVE FLEXIBILITY, INFORMATION SEARCH, AND ORGANIZATIONAL AMBIDEXTERITY

Andreea N. Kiss
Frank L. Magee Distinguished Professor
Associate Professor
College of Business and Economics
Lehigh University
Bethlehem, PA 18015
Email: ank518@lehigh.edu
T: (610)758-2739

Dirk Libaers
Kennedy Family Professor of Entrepreneurship
Associate Professor
Muma College of Business,
University of South Florida
Tampa, FL 33620
Email: dlibaers@usf.edu
T: (813)974-7820
and
Business School, University of Aberdeen,
Aberdeen, Scotland AB24 3FX, GB

Pamela S. Barr
Professor
J. Mack Robinson College of Business
Georgia State University
Atlanta, GA 30302
Email: pbarr3@gsu.edu
T: (404)413-7527

Tang Wang
Assistant Professor
College of Business
University of Central Florida
Orlando, FL 32816
Email: Tang.Wang@ucf.edu
T: (407)823-5685

Miles A. Zachary
Assistant Professor

Raymond J. Harbert College of Business
Auburn University
Auburn, AL 36849
Email: maz0014@auburn.edu

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ABSTRACT

Research summary: Though prior research highlights the organizational and cognitive challenges associated with achieving organizational ambidexterity, there has been comparatively less empirical attention focused on the cognitive characteristics that may differentiate top managers of firms that achieve ambidexterity. We build on emerging research and identify cognitive flexibility as a cognitive characteristic with particular relevance to the challenges associated with ambidexterity and suggest that it works through CEOs' information search activities. We find that cognitively flexible CEOs are more likely to engage in effortful and persistent information search activities and rely to a greater extent on outside sources of information. In turn, effortful and persistent information search activities are associated with higher levels of organizational ambidexterity. Our study pushes forward the research agenda on cognitive micro-foundations of firm capabilities.

Managerial summary: Ambidextrous organizations, or organizations that have the capability to pursue both incremental and discontinuous innovation simultaneously tend to enjoy more sustainable competitive advantages. However, the achievement of organizational ambidexterity poses organizational and managerial cognitive challenges. We focus our attention on the role of the CEOs in this process and suggest that CEO cognitive flexibility is particularly relevant for organizational ambidexterity. We suggest and find that the relationship between CEO cognitive flexibility and organizational ambidexterity is indirect, and highlight the role of CEO information search activities, in particular where and how intensely CEOs search for information, in this relationship. Our study reinforces the importance of human factors in the executive office for the development of firm dynamic capabilities and the implementation of an innovation-based strategy.

INTRODUCTION

The increasing pace and level of sophistication at which innovation occurs in many organizations that successfully compete in the global marketplace has led to a recent surge in both media attention to, and management research on, firm innovation and its antecedents, and in particular a closer look at how firms achieve organizational ambidexterity. Organizational ambidexterity is a firm capability to pursue both exploratory and exploitative innovation (O'Reilly & Tushman, 2013; Tushman & O'Reilly, 1996). A large body of empirical evidence supports the contention that ambidextrous firms enjoy sustainable competitive advantages and thrive (Cao, Gedajlovic & Zhang, 2009; Gibson & Birkinshaw, 2004; He & Wong, 2004; Lubatkin *et al.*, 2006; Raisch *et al.*, 2009), particularly in more dynamic and uncertain technology-intensive settings (O'Reilly & Tushman, 2013).

Though recognized as useful, organizational ambidexterity also presents unique managerial challenges particularly when exploration and exploitation are pursued simultaneously. To understand how to best address the managerial challenges associated with ambidexterity, prior research has focused extensively on the role of resource, structural, and contextual factors (e.g., Cao *et al.*, 2009; Gibson & Birkinshaw, 2004; Jansen, Van den Bosch, & Volberda, 2006). This work has identified mechanisms such as structural separation of explorative and exploitative activities, behavioral integration (Lubatkin *et al.*, 2006), transactive memory systems (Heavey & Simsek, 2015), and transformational leadership styles (Jansen *et al.*, 2008) as factors that differentiate firms that successfully achieve ambidexterity. While these prior works have provided important insights, there has been comparatively less research on the cognitive aspects associated with managing an ambidextrous organization. Conceptual and qualitative work on this topic highlights that the successful pursuit of organizational ambidexterity may also imply on managers' abilities to recognize and manage the inherent conflicts or tensions that emanate when simultaneously pursuing exploitative and exploratory innovation, create and maintain organizational linkages, which present significant cognitive challenges (Danneels, 2011; O'Reilly & Tushman, 2008; Raisch, Birkinshaw, Probst, & Tushman, 2009; Smith & Tushman, 2005; Taylor & Helfat, 2009). Yet to date, there has been

comparatively less empirical attention devoted to the cognitive factors associated with a firm's top managers, in particular the CEOs that may facilitate the successful pursuit of ambidexterity.

This study represents an empirical inquiry into the relationship between cognitive characteristics of top managers, in particular the CEO, and the successful pursuit of organizational ambidexterity. Specifically, we suggest that a CEO's level of *cognitive flexibility*, or tendency to adapt her thinking, emotions, and behaviors to changing conditions (Martin & Rubin, 1995; Martin, Staggers, & Anderson, 2011; Stemme *et al.*, 2005; Taatgen *et al.*, 2008) may be an important factor in the successful pursuit of organizational ambidexterity. We highlight CEO cognitive flexibility as particularly relevant for the achievement of organizational ambidexterity, which implies an ability to simultaneously pursue and shift between exploratory and exploitative innovation. Cognitively flexible individuals are more likely to possess the ability to switch between different modes of thinking, find workable solutions to seemingly conflicting problems, and combine and recombine knowledge gleaned from different sources in new ways (Basadur, 1995; Martin & Rubin, 1995; Martin & Anderson, 1998), abilities that have been linked to innovation and ambidexterity in organizations (e.g., Heavey & Simsek, 2017; O'Reilly & Tushman, 2008; Raffaelli, Glynn, & Tushman, 2019, Smith & Tushman, 2005; Tushman & O'Reilly, 1996).

In developing our arguments, we draw on upper echelons theory and specifically a stream of research (Chen & Nadkarni, 2017; DeRue *et al.*, 2011; Herrmann & Nadkarni, 2014; Heyden *et al.*, 2015; Hogan & Kaiser, 2005; Nadkarni & Herrmann, 2010; Plambeck, 2012) that suggests that CEOs' cognitive characteristics influence organizational outcomes *indirectly* through activities and behaviors undertaken by leaders that, in turn, have an impact on organizational outcomes. We focus on *information search activity*, which includes search selection and search intensity, as the activity of interest in our study because new information is important to both the exploitation of current resources and capabilities required for exploitation, and the development of new resources and capabilities required for exploration. We test and validate our assumptions by using multiple data sources. Our main data source is a sample of 202 CEOs of

SMEs competing in technology-intensive industries in India. This data source is coupled with a survey conducted on a sample of 123 US MBA students and an experiment that uses 58 executives. The main study results show that cognitively flexible CEOs engage in more effortful and persistent information search activities (search intensity) and rely to a greater extent on outside information (search selection). We also find that effortful and persistent information search activities are associated with higher levels of organizational ambidexterity while the use of outside information plays a limited role. Further, CEO information search intensity fully mediates the effect of CEO cognitive flexibility on organizational ambidexterity. The subsequent survey and experiment support most of the links between CEO cognitive flexibility and information search while also suggesting interesting points of differentiation.

Our study makes several contributions. First, we provide empirical evidence that the cognitive characteristics of top managers, in particular cognitive flexibility, may play an important role in the successful pursuit of ambidexterity. In doing so, we advance research on organizational ambidexterity that seeks to uncover organizational and individual related factors associated with its successful pursuit (e.g., Benner & Tushman, 2002; 2003; Heavey & Simsek, 2017; Jansen *et al.*, 2008; Smith & Tushman, 2005). We also add to the growing body of research on the cognitive micro-foundations of firm capabilities (Eisenhardt, Furr, & Bingham, 2010; Gupta, Smith, & Shalley, 2006; Helfat & Peteraf, 2015; Powell, Lovallo, & Fox, 2011; Rafaelli, *et al.*, 2019), which increasingly points to the need to elucidate the processes through which leaders, as the cognitive focal points for their organizations, manage the inherent tensions associated with the development of capabilities needed to compete in increasingly uncertain markets.

Second, our work bridges and brings together disparate streams of the literature in psychology and strategic management in an effort to provide a more accurate perspective on the antecedents to CEOs' information search activity. More specifically, our work addresses calls for research (e.g., Greve & Taylor, 2000; Li *et al.*, 2013) that explains *why* managers engage in certain information search activities that affect

innovation-related outcomes, such as organizational ambidexterity, by suggesting that variations in managers' information search activities may be attributed to variations in their levels of cognitive flexibility.

This study also contributes to and extends work on strategic leadership (e.g., Chen & Nadkarni, 2017; DeRue *et al.*, 2011; Peterson, Galvin, & Lange, 2012), by focusing attention on constructs relevant for a firm's ambidexterity agenda. By examining both CEO characteristics and the intermediary mechanisms through which they affect strategic outcomes we respond to calls for research that deals with the black box of CEO characteristics and continues to refine the theoretical and empirical links between CEO characteristics and firm strategies (Hambrick, 2007; Lawrence, 1997).

THEORETICAL BACKGROUND

Organizational ambidexterity

Research on organizational ambidexterity encompasses three important streams of work: spatial, temporal, and contextual. Spatial organizational ambidexterity focuses on how two different activities are carried out in different organizational units (Tushman & O'Reilly, 1996). Temporal organizational ambidexterity examines how managers organize activities in temporal, back-and-forth, or sequential cycles (Nickerson & Zenger, 2002; Raisch *et al.*, 2009). Contextual organizational ambidexterity, which we examine as well, is concerned with how managers and firms address dualities such as exploration and exploitation simultaneously (Gibson & Birkinshaw, 2004; Tushman & O'Reilly, 1996). Seen from this perspective organizational ambidexterity refers to a firm's ability "to simultaneously pursue both incremental and discontinuous innovation that results from hosting multiple contradictory structures, processes, and cultures within the same firm" (Tushman & O'Reilly, 1996: p. 24). Incremental or exploitative innovation refers to a firm activity that builds on existing knowledge and extends existing products and services for existing customers (Benner & Tushman, 2002; 2003); discontinuous or exploratory innovation refers to a firm activity that pursues new knowledge creation and develops new products and services for emerging customers or markets (Jansen *et al.*, 2006). Organizational ambidexterity is of key strategic importance to

firms because it allows them to successfully adapt to changing circumstances in their market environment, without losing their competitive edge (O'Reilly & Tushman, 2008; 2013; Tushman & O'Reilly, 1997, 2002).

Despite its advantages, organizational ambidexterity is difficult for firms to achieve. Engaging in “sufficient exploitation to ensure its current viability, and, *at the same time*, devote enough energy to exploration to ensure its future viability” (March, 1991, p. 105, emphasis added) requires that a firm's managers balance the distribution of attention and resources between activities that support exploitation (Leonard-Barton, 1992), with its more predictable returns, and also engage in those activities that support exploration with all its inefficiencies, including an increase in bad ideas, and more uncertain returns (Levinthal & March, 1993).

Scholars have identified several different mechanisms associated with the achievement of organizational ambidexterity. Much of this work has highlighted the importance of structural separation and differentiation of units that focus on exploitative and exploratory innovation, as well as the formal and informal mechanisms such as systems, processes and culture that enable separation and differentiation (e.g., Gibson & Birkinshaw, 2004; Jansen *et al.*, 2006, 2009; Tushman & O'Reilly, 1996, 2002). Others have drawn attention to the role of managers in the successful pursuit of exploratory and exploitative innovation (Mom, van der Bosch, & Volberda, 2009; Smith & Tushman, 2005; O'Reilly & Tushman, 2013; Taylor & Helfat, 2009). In that vein, scholars have highlighted the role played by various TMT level mechanisms and characteristics. For example, Lubatkin *et al.* (2006) find that high levels of TMT behavioral integration lead to a better understanding of the knowledge needed to manage conflicts and develop the competencies necessary to simultaneously pursue exploratory and exploitative innovation and Heavey and Simsek (2017) identify TMT transactive memory systems as a mechanism that bolsters the generation, differentiation, and integration of knowledge needed to implement organizational ambidexterity. Cao and colleagues (Cao *et al.*, 2009) focus on the CEO as a key member of the TMT and find that the extensiveness of the CEO's network is positively associated with organizational ambidexterity.

While much of the extant research on organizational ambidexterity has focused on identifying the structures and processes at the organization and TMT level required to manage the complexity associated with its successful pursuit, recent work suggests that cognition and personality related factors may also play a role (e.g., Kammerlander, Burger, Fust, & Fueglistaller, 2015; Mom et al., 2009; Smith & Tushman, 2005; Taylor & Helfat, 2009). This emerging stream of research is particularly relevant because the tasks associated with pursuing organizational ambidexterity have been shown to be cognitively challenging (Danneels, 2011; Tripsas & Gavetti, 2000) and may require cognitive and information processing abilities that differ from those required for the pursuit of less complex strategic initiatives. Preliminary work suggests that to successfully implement and manage organizational ambidexterity, leaders need paradoxical cognitions, the ability to develop and maintain paradoxical cognitive frames (Mom et al., 2009; Raisch et al., 2009; Smith & Tushman, 2005), that allow them to embrace, rather than avoid, the inherent tensions and contradictions associated with simultaneously pursuing organizational exploration and exploitation. Work linking neuroscience to explorative and exploitative decisions has found that each type of behavior is associated with activity in a different region of the brain and that attention control is key to the ability to switch between different forms of thinking (Laureiro-Martinez, Brusoni, & Zollo, 2009; Laureiro-Martinez *et al.*, 2015).

We contribute to the emerging work that links leadership cognition and personality to organizational ambidexterity by focusing attention on a cognitive characteristic of top managers, cognitive flexibility, as a potentially differentiating factor in their ability to successfully navigate the cognitive challenges associated with ambidexterity. We focus on the CEO as the top manager of interest because it is the CEO who is tasked with attending to and managing the issues that emanate from the simultaneous pursuit of exploration and exploitation, balancing different organizational architectures, and orchestrating the allocation of resources from existing to new business domains (Cao, Simsek, & Zhang, 2010; Tushman, Smith, & Binns, 2011; Tushman & O'Reilly, 2013).

CEO cognitive flexibility

Flexibility has been viewed as a hallmark of human cognition and intelligent behavior (Ionescu, 2012; Jordan & Morton, 2008; Karmiloff-Smith, 1992) and a key component of early models of creativity and intelligence (Guilford, 1962; Thurstone, 1951). Of particular relevance to the management of ambidexterity, flexibility in cognitive processes has been associated with the ability to readily switch between various thought processes, engage in divergent thinking and dispersed attention (Guilford, 1962), and is viewed as an important characteristic that allows humans to pursue complex tasks such as multitasking and finding solutions to new, changing, or unexpected conditions in the environment (Canas *et al.*, 2003; Ionescu, 2012).

Research has focused on both gaining a better understanding of the neurological underpinnings of cognitive flexibility or *how* individuals switch attention when confronted with specific types of tasks (e.g., Hirt, Devers, & McCrea, 2008; Stroop, 1935; Laureiro-Martinez & Brusoni, 2018; Lin *et al.*, 2014; Taatgen *et al.*, 2008) and on how it impacts *behaviors* such as relationship-seeking strategies and information seeking and communication patterns (e.g., Martin & Anderson, 2001; Martin & Myers, 2006; Martin *et al.*, 2011), goal setting and acceptance (Chung, Su, & Su, 2012), and decision-making styles (e.g., Miller & Toulouse, 1986).

One of the most widely used definitions of cognitive flexibility, which we adopt in this study, was developed by Martin and Rubin in 1995. They define cognitive flexibility as a person's "a) awareness that in any given situation there are options and alternatives available, b) willingness to be flexible and adapt to the situation, and c) self-efficacy in being flexible" (Martin & Rubin, 1995, p. 623). Research has linked cognitive flexibility to a number of individual behaviors. Individuals with high levels of cognitive flexibility have been found to use more affinity-seeking strategies in their interpersonal relationships both inside and outside of work settings (e.g., Martin & Anderson, 2001; Martin & Myers, 2006) and are able to seek, listen, and adapt to a diversity of viewpoints, which further contributes to the positive outcomes of group-related

work (Myers *et al.*, 2009); they have a higher level of tolerance for disagreement, are more argumentative and assertive, and less apprehensive (e.g., Martin, Anderson, & Thweatt, 1998; Madlock *et al.*, 2007). Cognitively flexible individuals are less likely to refute arguments and information that contradicts their long-held beliefs and are more likely to consider information alternatives (Martin *et al.*, 2011). Furthermore, cognitively flexible individuals actively seek and enjoy situations that present information that is controversial or contradicts their viewpoints and are less likely to be apprehensive about the information received (Wheeles & Schrodt, 2001). Research has also shown that cognitively flexible individuals have a higher need for cognition (i.e., inclination toward effortful cognitive activities), are less anxious about new or controversial situations, and welcome the addition of new information and ideas (Helton-Fauth, 2003; Martin *et al.*, 2011). Research conducted at the CEO level highlights that CEOs who score high on flexibility are more likely to seek out new information when making strategic decisions and adopt strategies that are in sync with changing environments (Miller & Toulouse, 1986).

In sum, results from research on cognitive flexibility suggest that it may have an important influence on the information processing activities related to attaining organizational ambidexterity. Work on organizational activity conducted from an information processing perspective (Daft & Weick, 1984) suggests that CEOs, as chief information processors for their organizations, seek to gather and interpret timely, relevant, and accurate information about the firm and its operating environment in order to make effective decisions. Relatedly, successful attainment of organizational ambidexterity has been associated with leaders' ability to acquire, share, differentiate, and skillfully integrate distinct knowledge originating from inside and outside the firm across a variety of organizational members (Heavey & Simsek, 2017; Mihalache, Jansen, Van Der Bosch, & Volberda, 2014). This suggests that one mechanism through which CEO cognitive flexibility influences organizational ambidexterity is through their information search activities. We next review CEO information search activities that are particularly relevant in the context of organizational ambidexterity.

Innovation and CEO information search

Information search is a controlled, proactive process (Kahneman, 1973) and a critical task for the CEO (Aguilar, 1967; Daft, Sormunen, & Parks, 1988), the individual responsible for the alignment of the firm's activities with the requirements of changing and often uncertain environments (Hambrick, 1982; Huber & Daft, 1987; Kiss & Barr, 2017). Although CEOs engage in a variety of information searches, in this study we are interested in information search undertaken for the purpose of simultaneously creating and implementing exploitative innovations and exploratory innovations. Prior research has indicated that the informational needs associated with exploitative innovations differ from those required for exploratory innovation: while exploitative innovations are usually based on existing knowledge that already resides within the firm, exploratory innovations rely to a greater extent on new (outside) knowledge and the combination of new with existing knowledge (Benner & Tushman, 2002, 2003; Danneels, 2002; Levinthal & March, 1993).

The innovation literature has identified two dimensions of search – *search selection* and *search intensity* as being particularly relevant for firm innovation (Li *et al.*, 2013; Katila & Ahuja, 2002). Search selection refers to the sector of the operating environment the CEO directs her attention to (Anand, Manz, & Glick, 1998), while search intensity refers to the cognitive effort and persistence CEOs apply in the search for information (Fiske & Taylor, 2008; Li *et al.*, 2013). *Search for outside information or terrain distance* is a key component of search selection with important implications for firm innovative activities (Li *et al.*, 2013). Although information gleaned from sources external to the firm such as competitors, customers, suppliers, shareholders, and other external stakeholders is more challenging to search for, acquire, and absorb, it may also lead to more productive outcomes especially from an exploratory innovation perspective (e.g., Daft *et al.*, 1988; Katila & Ahuja, 2002; Li *et al.*, 2013; Rosenkopf & Almeida, 2003; Leiponen & Helfat, 2010). There is also evidence that externally acquired information has a complementary and synergistic impact on internal information (Cassiman & Veugelers, 2006; Chatterji &

Fabrizio, 2014), suggesting that CEOs who acquire external (distant) information may also enhance exploitative innovations.

Search effort and *search persistence* are key components of CEO search intensity (Kahneman, 1973; Li *et al.*, 2013; Weick, 1995). Search effort refers to the extent to which CEOs allocate cognitive capacity to search processes relative to other tasks (Ocasio, 2011), whereas search persistence refers to the duration over which attention is exerted to search for information (Kahneman, 1973; Weick, 1995). Effortful and persistent information search activities allow searchers to be exposed to a higher quantity of information and, thus, increase the likelihood that the searcher will notice and apply useful knowledge to the development and deployment of new products consistent with exploration, and that they make better connections between, and more useful recombinations of existing knowledge, consistent with exploitation (e.g., Greve, 2003; Smith, Collins, & Clark, 2005).

Taken together this stream of research suggests that CEOs' information search activities, and in particular search selection and search intensity, have important implications for their firms' exploratory and exploitative innovation activities and thus for the achievement of organizational ambidexterity.

To summarize, our theory is premised on a process model approach that links CEO cognitive flexibility to information search activities and organizational ambidexterity, and is based on the assumption that CEO cognitive characteristics influence organizational outcomes indirectly through specific behaviors and activities (Avolio, 2007; Chen & Nadkarni, 2017; DeRue *et al.*, 2011; Hogan & Kaiser, 2005; Zaccaro, 2001). Our conceptual model is depicted in Figure 1 below. We explore the more specific links among the various components of the model in the next section.

<Insert Figure 1 about here>

HYPOTHESES

CEO cognitive flexibility and information search

We expect CEO cognitive flexibility to be positively related to search for outside information, information search effort, and information search persistence. First, we suggest that higher levels of CEO cognitive flexibility are associated with greater information *search effort and persistence*. Cognitively flexible individuals have a higher need for cognition and are less concerned or anxious about information that is not consistent with their existing beliefs (Miron-Spektor & Beenen, 2015; Martin *et al.*, 2011). Cognitively flexible individuals also are more diligent in their efforts to sustain their information search activities (Martin & Anderson, 1998; Martin *et al.*, 2011), and maintain their focus until a resolution to a problem is achieved (Feltovich, Spiro, & Coulson, 1989). This suggests that cognitively flexible CEOs are more likely to engage in exhaustive and effortful information search activities, and to persist in their search until they believe that they have a full understanding of the causes and consequences of an ill-structured business problem. Their efforts will be further amplified by their openness to complex and divergent organizational goals and higher attachment to their organizations (Chung, Su, & Su, 2012).

Second, we suggest that higher levels of CEO cognitive flexibility are associated with greater *search for outside information*. Cognitively flexible individuals seek out and enjoy situations that present controversial or contradictory information (Wheeles & Schrodt, 2001). Relatedly, they are able to effortlessly switch the focus of their attention from routinely used information sources to consider and search for information that allows for different, alternative ways of framing ill-structured problems (Martin & Rubin, 1995; Martin *et al.*, 2011; Miron-Spektor & Beenen, 2015). This suggests that cognitively flexible CEOs are motivated, and able, to direct their attention away from familiar and established internal sources of information and tap into more distant and external sources in order to fully understand ill-structured business problems. Due to the openness to experience and tolerance for disagreement associated with cognitively flexible individuals, cognitively flexible CEOs would also be more willing to reach out to different external actors that hold new, sometimes contradictory, information and be confident that in doing so they might acquire and use valuable information (Bandura, 1989; Chung, Su, & Su, 2012; Lippard-Justice, 1989;

Martin & Rubin, 1995). Because cognitively flexible individuals are confident about communicating and interacting with actors in different, unfamiliar information environments, cognitively flexible CEOs would also be open to, and effective in, absorbing a diversity of information, and less likely to be dogmatic about not accepting and using information that challenges their long-held beliefs (Martin & Anderson, 1998; Rubin & Martin, 1994; Wheelles & Schrod, 2001).

In contrast, less cognitively flexible individuals fail to adapt their information search activities and consider only a few, familiar information alternatives (Martin *et al.*, 2011). This suggests that CEOs with low levels of cognitive flexibility will find it more difficult or even fail to turn their attention to and search for information originating outside the organization and in different sectors of the business environment. By primarily searching for internal, familiar information, less cognitively flexible CEOs are unable to form broad, holistic understandings of the challenges that they are confronted with or provide potential innovative solutions to it (Laureiro-Martinez *et al.*, 2009). Further, individuals with lower levels of cognitive flexibility allocate less cognitive capacity to their information search activities, which means that they engage in less effortful and more cursory information searches that lead to constrained, narrow information bits that may not fully illuminate the total complexity of the problems that they are confronted with (Spiro *et al.*, 1988; Spiro *et al.*, 1989). This suggests that less cognitively flexible CEOs will dedicate less time and attention to searching information for complex organizational issues and, as a result, may deem them simpler than they actually are. Hence, we posit that:

H1: CEO cognitive flexibility is positively related to a) information search effort b) information search persistence and c) search for outside information.

CEO information search and organizational ambidexterity

We suggest that more *persistent and effortful information search* activities on the part of the CEO are associated with higher levels of organizational ambidexterity. Although search selection is important in characterizing where the CEO directs her attention, search intensity captures the extent to which CEOs

devote attention to exerting effortful information search relative to other activities and persist in focusing attention on information search over time (Kahneman, 1973; Li *et al.*, 2013; Ocasio, 2011). Thus, search intensity is a reflection of the attentional capacity available to notice, interpret and make sense of (new) information (Kahneman, 1973; Weick, 1995). CEOs with increased attentional capacity contribute to organizational ambidexterity in three ways. First, they notice, process, and interpret greater amounts of information (Weick, 1995). Both exploitative and exploratory innovation require knowledge combination and recombination – exploitive innovation employing existing knowledge in familiar ways, and exploratory innovation employing novel combinations that leverage varied and dispersed knowledge (Taylor & Greve, 2006; Wadhwa & Kotha, 2006). More information leads to a larger set of potential combinations and recombinations of different information bits beneficial for both exploitative and exploratory innovations (Bantel & Jackson, 1989; Yu, Engleman, & Van De Ven, 2005). Second, increased attentional capacity enables CEOs to make better sense of the environmental context and the requirements and demands of both current and new customers, and thus contributes to improved and new offerings (Thomas, Clark, & Gioia, 1993). Third, CEOs engaged in persistent information searches, do not stop searching once they have identified a satisfactory amount of information because they are aware that they may miss out on higher quality and more novel bits of information, the recombination of which prior research (e.g., Li *et al.*, 2013) suggests may lead to higher levels of organizational ambidexterity. We further argue that CEOs' *search for outside information* is positively related to organizational ambidexterity. Search for outside information represents “a conscious effort to move away from current organizational routines and knowledge bases” (Katila & Ahuja, 2002, p. 1184). Extensive use of outside information enables the recombination of existing and new knowledge (Fleming, 2001; Kogut & Zander, 1992; Rosenkopf & Nerkar, 2001; Rosenkopf & Almeida, 2003) that leads to both exploratory innovations and improvements to existing innovations (March, 1991). In addition, research suggests that externally sourced information can also enhance a firm's exploitative capabilities (Cassiman & Veugelers, 2006; Chatterji & Fabrizio, 2014; Zhou &

Li, 2012). Specifically, internal information, which is primarily applied to create exploitative innovations, can be combined with external information to improve and extend exploitative innovations (Bierly, Damanpour, & Santoro, 2009). Since organizational ambidexterity is manifested in the simultaneous pursuit of both exploratory and exploitative innovation as directed by the CEO (Tushman *et al.*, 2011), we conjecture that *more* use of outside information should, on average, lead to a *higher* level of organizational ambidexterity.

In contrast, CEOs engaged in less effortful and persistent information search often fail to elucidate pertinent cause-effect relationships because of a more limited amount of collected information (Griffith, 1999). Thus, the insights gleaned from the information may not be adequate to formulate and create new or improved offerings. Further, CEOs engaged in cursory information search efforts focus mostly on familiar, inside sources which may lead to investment in suboptimal outcomes, and result in the firm's falling in a competence trap (Levitt & March, 1988), and reducing the motivation to engage in exploratory activity. We therefore posit that:

H2a: CEO information search effort is positively related to organizational ambidexterity.

H2b: CEO information search persistence is positively related to organizational ambidexterity.

H2c: CEO search for outside information is positively related to organizational ambidexterity.

CEO cognitive flexibility, information search, and organizational ambidexterity

We next argue that the impact of CEO cognitive flexibility on organizational ambidexterity is mediated by CEO information search activities. We base our arguments on two interrelated premises. First, research on strategic leadership is based on the assumption that “who we are” influences “what we do”, which in turn influences firm strategies (outcomes). In other words, CEOs influence organizational outcomes, including innovation, indirectly through different activities and behaviors (e.g., Chen & Nadkarni, 2017; Colbert, Barrick, & Bradley, 2014; DeRue *et al.*, 2011). Second, strategy research linking CEO cognitive characteristics to firm innovation (e.g., Kiss & Barr, 2017; Nadkarni & Chen, 2014; Tushman & Nadler, 1978) suggests that in the context of firm innovation, the intervening process between executives' cognitive characteristics and firm strategic outcomes largely fall in the realm of information processing. We therefore

suggest that cognitively flexible CEOs are more likely to search for outside information and engage in effortful and persistent information search when confronted with ill-structured, complex business problems associated with organizational ambidexterity. In doing so, cognitively flexible CEOs are more likely to collect and process a higher quality and quantity of information that allows them to engage in new knowledge generation pertinent to exploratory innovation, and new and existing knowledge recombinations that are also pertinent to exploitative innovation. We suggest that:

H3a: CEO information search effort mediates the relationship between CEO cognitive flexibility and organizational ambidexterity.

H3b: CEO information search persistence mediates the relationship between CEO cognitive flexibility and organizational ambidexterity.

H3c: CEO search for outside information mediates the relationship between CEO cognitive flexibility and organizational ambidexterity.

METHOD

Sample and data collection

To test our hypotheses we employed a survey design and collected data from a sample of 202 CEOs of technology-intensive private and public SMEs operating in India. Our sample choice was motivated by several factors. First, we followed prior research on the role of CEOs in firm strategy (e.g., Kets de Vries & Miller, 1984; Kiss & Barr, 2017; Lubatkin *et al.*, 2006; Herrmann & Nadkarni, 2014) and selected a sample of SMEs because in these types of firms CEOs are more likely to be directly involved in the formulation and implementation of firm strategy than in larger, more diversified firms (Finkelstein & Hambrick, 1996). Prior research also suggests that in SMEs, CEOs have a central role in decision making and agenda setting which manifests through their cognitive characteristics, attitudes, and goals (Kets de Vries & Miller, 1984; Kiss & Barr, 2017; Miller & Droge, 1986). Second, prior research has empirically validated relationships between CEO level and firm level constructs in the context of Indian firms and has suggested that the higher power distance orientation of Indian CEOs increases the likelihood that CEOs will have a strong impact on firm strategy (e.g., Nadkarni & Herrmann, 2010). Third, the accumulated body of empirical

evidence on organizational ambidexterity suggests that ambidexterity is more likely to be pursued and play a significant role in firms competing in uncertain and dynamic settings (Junni *et al.*, 2013; O'Reilley & Tushman, 2013). We conjectured that due to their focus on adaptation to rapidly evolving industry conditions technology-intensive Indian SME are likely to pursue an ambidextrous approach where exploratory and exploitative innovation are simultaneously pursued (Khanna & Palepu, 2006; Li *et al.*, 2013). Fourth, we wanted to avoid secondary data bias issues resulting from the use of demographic or other firm level proxies to capture cognitive flexibility and information search, as well as alleviate causality issues. We therefore needed to focus on a sample of firms that allowed us to access CEOs at multiple points in time in addition to providing information on their firm's innovation activities.

We used Fundoodata, a database that provides online directory-type firm information on Indian companies, as the main data source to identify our sample. The database lists over 75,000 firms. Among the listed firms 55,286 are private and public SMEs that operate in various industry segments. The information listed in the database was supplemented with information from Dun & Bradstreet India, the Federation of Indian Chambers of Commerce & Industry, the Software Technology Parks of India (STPI), and the Karnataka Small Scale Industries Association (KASSIA). The targeted firms match the SME definition specified in the Micro, Small & Medium Enterprises Development (MSMED) Act adopted in 2006¹ and are representative of the Indian SME sector. The firms operate in technology-intensive sectors (Acs, Anselin, & Varga, 2002) such as electronics, semiconductors, chemicals, biotech and pharmaceuticals, software, and IT solutions; approximately half of the firms are publicly traded. We focused on firms originating in India's major cities (e.g., Bangalore, Bhopal, Delhi, Mumbai, Chennai, Hyderabad, Ahmedabad). We generated a list of 628 firms through random selection and contacted them by email and

¹ The MSMED definition focuses on the amount of investment (rupees) in plant, machinery, and equipment rather than number of employees to classify firms into micro, small, medium, and large enterprises.

telephone. We requested the CEO's agreement to participate in a survey focusing on their firm's innovation activities. We received confirmation of participation from 226 CEOs.

To begin to alleviate common method and reverse causality issues, we collected information related to our independent and dependent variables at three points in time. We first collected data on CEO's cognitive flexibility, CEO demographic data, and additional firm characteristics not available through the databases. Data collection for this initial survey was completed at the beginning of 2016. Three months later we collected data on the CEO's information search activities. At the beginning of 2017, approximately one year from initial data collection initiation, we requested information on the firm's exploratory and exploitative innovation. We made appointments by telephone with the CEOs in each period, and personally delivered and collected the questionnaires from each firm at the agreed times. A total of 202 firms provided all the requested information. Our final response rate of 32% is higher than the 12-14 % rate typically found in studies using CEO samples (e.g., Carpenter, Geletkanycz, & Sanders, 2004). We tested for but did not find any differences in firm age, ownership type, and size between the firms included in the final sample and nonresponding firms.

Measures

Cognitive flexibility. We used the Cognitive Flexibility Scale developed and validated by Martin and Rubin in 1995; the scale has since been used and revalidated in multiple studies (cf., Martin *et al.*, 2011). The Cognitive Flexibility Scale consists of 12 items that respondents rated on a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Examples of items included in the scale include: "I can find workable solutions to seemingly unsolvable problems", "I avoid new and unusual situations", "I am willing to listen and consider alternatives for handling a problem", "I am willing to work at creative solutions to problems", "I have difficulty using my knowledge on a given topic in real life situations", and "I have the self-confidence necessary to try different ways of behaving." We pilot-tested the scale on a sample of 10 managers who were not included in the study. They were asked to review items for clarity, content (wording),

meaningfulness, and construct measurement (Bagozzi, 1980). The pilot test did not reveal any issues and all items were retained and administered in the subsequent survey. The Cronbach's Alpha for this study was 0.75.

Information search activity. To capture CEO information search activity, we used the measures developed and validated by Li and colleagues (Li *et al.*, 2013). *Search effort* was measured with a scale consisting of four items (Cronbach alpha 0.73). Respondents were asked to rate their level of agreement with the following items: "I would invest a great deal of personal effort into gathering potentially valuable information," "I would devote a large percentage of my time to searching for information," "When searching for information, I would make looking for new information a top priority for how I would spend my time," and "I would go out of my way to find information sources that may have relevant information." *Search persistence* was measured through a four-item scale (Cronbach alpha 0.75). Respondents were asked to rate their level of agreement with the following items: "[When searching for information, I would] continue searching until I was satisfied that I had identified all relevant information," "persist until I found all the information pertaining to this problem," "take as much time as needed to identify all available information," and "exhaustively search and study every possibility." The use of *outside information* was captured through a survey item in which the respondents were asked to rate their level of agreement on a scale from 1 to 7 with the following statement "When searching for information, I would concentrate on information outside my own organization." Following Li *et al.*, 2013 we validated this measure with a second item in the survey where respondents were asked to allocate 100 points to different sources of information inside the organization, intra-industry, and outside the industry.

Organizational ambidexterity. To capture organizational ambidexterity, we used a measure developed and validated by Jansen and colleagues (Jansen *et al.*, 2006), which combines (i.e. addition) organizational exploration and organizational exploitation. Each scale consists of seven items ranked from 1 ("strongly disagree") to 7 ("strongly agree"). Items associated with the organizational exploitation scale (Cronbach

alpha 0.77) include: “We frequently refine the supply of existing products and services”, “We regularly implement small adaptations to the existing products and services”, “We introduce improved, but existing products and services for our local market” or “We expand the services for existing clients.” Items associated with the organizational exploration scale (Cronbach alpha 0.74) include: “Our organization accepts demands that go beyond the existing products and services”, “We invent new products and services”, “We regularly seek and approach new clients in new markets” or, “We experiment with new products and services in the local market.”

We used prior research on information search and organizational ambidexterity to guide our choice of control variables and included several firm and CEO level variables. We controlled for *firm size*, measured as the natural logarithm of the number of employees in the firm, and *firm age*, measured as the number of years since firm founding; larger and older firms are more likely to have the required capabilities to successfully compete on innovation and engage in organizational ambidexterity (O’Reilly & Tushman, 2013). We also controlled for *prior performance* (sales level), as firms with higher performance are more likely to engage in organizational ambidexterity (Simsek, 2007). We asked respondents to provide information on prior sales levels. CEO of firms with higher *financial slack* levels are also more likely to engage in various information search activities and pursue organizational ambidexterity. We therefore included a survey question that assessed availability and ease of accessing financial resources (cash, short-term credit, etc.) (Plambeck, 2012). We also asked respondents to assess *R&D intensity* as a percentage of R&D expenses of their sales for the previous year. Firms that allocate higher levels of investments to research and development are more likely to focus on exploratory activities and innovation (Rajagopalan & Datta, 1996).

CEOs with higher levels of prior industry experience are more likely to engage in intense and effortful information search in their areas of expertise and may lead their firms into pursuing innovation in that domain area (Simsek, 2007). *CEO prior industry experience* was measured as the number of years worked

in the industry. CEOs who have had a long tenure with a specific organization may be less likely to engage in outside information search and exploratory projects but may be more inclined to focus on intense and effortful information search inside the organization and pursue exploitative efforts (Simsek, 2007). We measured *CEO tenure* as the number of years spent with the organization. Differences in *CEO age* and *gender* may also influence the pattern of effects observed, so we also controlled for these. Further, prior research on firm strategy conducted from an information processing perspective (Kiss & Barr, 2015; Nadkarni & Barr, 2008) suggests that a CEO's level of cognitive complexity, or her ability to understand issues from multiple perspectives is also likely to influence information processing patterns and innovation related outcomes. *CEO cognitive complexity* was captured using Bieri's modified role construct repertory (REP) test (Bieri *et al.*, 1966). Cognitive complexity is typically conceived as a constellation of several related concepts. However, Bieri's REP test is considered a measure of "differentiation" and relative independence of constructs in an individual's cognitive system (Goldstein & Blackman, 1978; Bieri *et al.*, 1966). The respondents were provided with a matrix of familiar roles (e.g., mother, father, friend, etc.) and bipolar adjectives (e.g. interesting 1 – dull 6) and were asked to rank each person using the bipolar adjectives. The complexity score was derived based on overall similarity (i.e. ties) in ratings across roles and adjectives. A low score reflects high levels of cognitive complexity and it suggests more differentiation among constructs. Finally, CEOs who are part of larger top management teams (TMTs) may gain more insights into various areas in which they could intensify their information search efforts as well as be encouraged to simultaneously pursue organizational exploration and exploitation (Jansen *et al.*, 2009). We measured *TMT size* as the number of direct reports to the CEO.

Results

We tested the first and second set of hypotheses using a hierarchical regression approach. We tested the last set of hypotheses by using mediation analysis techniques. Table 1 includes information on variable

means, standard deviations, and zero-order correlations among study variables. Table 2 shows regression results for our hypotheses.

Insert Tables 1, 2 here

As shown in models 2, 4, and 6, in table 2, CEO cognitive flexibility is positively related to information search effort ($b^2=0.262$, $\beta=0.253$, $p=0.001$), information search persistence ($b=0.227$, $\beta=0.215$, $p=0.004$), and outside information search ($b=0.264$, $\beta=0.117$, $p=0.088$) lending support to hypotheses 1a, 1b, and marginal support to 1c. Analysis of the standardized regression model coefficients suggests that a one standard deviation increase in cognitive flexibility equates to a 25% and 22% standard deviation increase in search effort and search persistence, respectively, and a 12% standard deviation increase in outside information search. Model 9 shows regression results for our second set of hypotheses. As expected, information search effort ($b=0.536$, $\beta=0.234$, $p=0.005$) and persistence ($b=0.435$, $\beta=0.193$, $p=0.015$) are positively related to organizational ambidexterity. A one standard deviation increase in information search effort is associated with a 23% standard deviation increase in organizational ambidexterity while a one standard deviation increase in information search persistence is associated with 19% standard deviation increase in organizational ambidexterity. However, we did not find supporting evidence for a relationship between outside information search and organizational ambidexterity. Thus, hypotheses 2a and 2b are supported while hypothesis 2c is not supported.

We used the four-step methodology advanced by Baron and Kenny (1986) and bootstrapping to test our mediation hypotheses. In the first step (model 8), typically unnecessary, we established the existence of a correlation between the independent variable, cognitive flexibility and the dependent variable, organizational ambidexterity ($b=0.354$, $\beta=0.149$, $p=0.032$). In the second step (models 2, 4, and 6) we showed that a relationship exists between the independent variable and the mediators (i.e. information

² b denotes unstandardized regression coefficients and β denotes standardized regression coefficients

search activities). In the third step (model 9), we established that a relationship exists between the mediator variables and the dependent variable. In the last step (model 10), we assessed whether the effect of the independent variable, cognitive flexibility, on the dependent variable, organizational ambidexterity, is reduced when the mediators were included in the model ($b=0.108$, $\beta=0.046$, $p=0.490$). The analyses suggested full mediation and support for hypotheses 3a and 3b but no support for hypothesis 3c.

The Baron and Kenny's (1986) approach has been criticized for not providing an explicit test of mediation. To address this limitation, we implemented the bootstrapping test of the indirect effect. This test does not impose the assumption of normality on the sampling distribution and draws random samples with replacement from the original sample. It calculates the indirect effect for each sample and yields a sampling distribution that is then used to build a confidence interval. The confidence interval provides evidence of mediation when it does not include zero. This test provides additional, stronger support for the mediation hypotheses. To assess the indirect effects of CEO cognitive flexibility on organizational ambidexterity, we used Hayes's (2013) "PROCESS" macro. The 95% confidence intervals obtained with the bootstrapping approach performed on 1000 subsamples for search effort ($b=0.135$, $SE=0.062$, $CI=0.033, 0.273$) and search persistence ($b=0.097$, $SE=0.050$, $CI=0.005, 0.197$) do not include zero such that indirect effects can be assumed. The 95% confidence interval for search outside ($b=0.014$, $SE=0.027$, $CI=-0.039, 0.076$) contains zero. Thus, hypotheses 3a and 3b are supported and hypothesis 3c is not supported.

Effect size considerations

To examine whether the influence of cognitive flexibility and information search processes on organizational ambidexterity is meaningful, we calculated partial eta-squared (η^2) estimates³, which report the partial variance explained by a particular coefficient in a linear equation. While explaining effect sizes in terms of

³ While partial eta-squared is a common measure of effect size, Field (2013) points out that its estimates can sometimes be biased in smaller sample sizes, and suggests omega-squared as an unbiased alternative. Although our sample size should be large enough to minimize bias, we also calculated omega-squared estimates, which were nearly identical to the partial eta-squared estimates.

“small” or “large” is somewhat controversial, Cohen (1988) suggested that measures of η^2 typically range from 0.01 (i.e., small effect size) to 0.09 (i.e., large effect size) in social science research. The η^2 estimates of the influence of cognitive flexibility on information search effort, information search persistence, and outside information search were 0.06, 0.04, and 0.02, respectively, suggesting medium effects on search effort and persistence and smaller effects on outside information search. In the mediation model, the effect sizes of information search effort and information search persistence on organizational ambidexterity was 0.04 and 0.03. These effect sizes are moderate and consistent with or larger than effect sizes in extant research related to organizational ambidexterity (e.g., Drach-Zahavy & Freund, 2007; Gibson, Birkinshaw, Sumpter, & Ambos, in press). Perhaps more importantly, the effect sizes of cognitive flexibility, information search effort, and information search persistence are similar or larger than other variables in our models known to be meaningfully related to organizational ambidexterity, including financial slack (0.06), prior performance (0.01), and CEO characteristics such as age (0.06), experience (0.06), and cognitive complexity (0.01).

Robustness checks

We conducted several additional tests to confirm the robustness of our findings. First, given the lack of support for a mediating relationship found for search for outside information when using the full survey data of 202 CEOs, we performed two additional tests. We employed an alternative measure that captured through a point system the number of points (up to 100) allocated by managers to inside, intra-industry, and outside information search (Li *et al.*, 2013). The results were consistent with our original analysis. Given the important role attributed in prior research (e.g., Rosenkopf & Almeida, 2003) to search for outside information in firm innovative activities, we also tested each mediator separately, as suggested by Kenny and colleagues (1998). Although we found that search for outside information acts as a mediator of the CEO cognitive flexibility-organizational ambidexterity relationship when tested in isolation from information search

persistence and information search effort, prior research conducted at the *individual/managerial* level of analysis (e.g. Kahneman, 1973; Li *et al.*, 2013) suggests *joint* effects of various information search activities on firm innovation. This is the approach emphasized in our theory development and original analyses. Second, we conducted an endogeneity check. The attraction-selection-attrition theory (Schneider, 1987) suggests that CEOs displaying certain attributes may be attracted to firms displaying certain qualities (i.e. firms that offer opportunities for growth, travel etc.) while avoiding others. As such, we used instrumental variable (IV) regression with a 2SLS estimator to examine whether cognitive flexibility is endogenous. Following the guidance of Semadeni and colleagues (2014), we identified a relevant exogenous instrument: a firm's level of international diversification, captured as the number of countries in which the firm does business. Although firms may benefit from knowledge and other resources acquired from international markets to push innovation, this transfer requires additional firm mechanisms in place. Further, most SMEs in emerging economies (including firms in our sample) are simple exporters (Wright *et al.*, 2005). Thus, the mere number of countries in which they sell products is not an indicator of their ability to simultaneously pursue exploratory and exploitative innovation. In addition to its conceptual relevance, it is important to note that an instrument should be technically adequate (i.e. sufficiently correlated with the endogenous covariate and uncorrelated with the dependent variable) (Kennedy, 2008). The variable was correlated with cognitive flexibility ($r_{\text{IntCount}} = -0.23$, $p = 0.00$) but was uncorrelated with organizational ambidexterity ($r_{\text{IntCount}} = 0.09$, $p = 0.20$). Furthermore, the results of the first stage F-test suggest that the selected instrument is valid ($F = 6.22$, $p = 0.01$). Additionally, the Durbin and Wu-Hausman tests of endogeneity revealed that the cognitive flexibility variable is actually exogeneous (Durbin $\chi^2 = 0.03$, $p = 0.87$; Wu-Hausman $F = 0.03$, $p = 0.87$), suggesting that endogeneity is not a concern in our model.

Common method bias and alternative explanations

Data generated from surveys with a single respondent may introduce common method variance (CMV) into analyses and may not allow researchers to capture a large number of variables that reflect potential alternative explanations for a study's findings. Although these issues may not be completely eliminated, there are several strategies that can be employed to alleviate, correct, and partially address them at various steps in the research design. To begin to address these issues, we followed guidelines suggested by Podsakoff and colleagues (Podsakoff *et al.*, 2003) and Spector (2006) and implemented procedural remedies at the survey design and data collection stages. We also conducted additional statistical tests based on CFA models (Harman one-factor test and the latent-factor test) to assess the severity of these potential issues and correct for it. These tests did not provide evidence that CMV in our study is an important concern and the SEM analyses yielded findings similar to the regression models. The results are summarized in the online supplement.

Further, we engaged in additional data collection efforts to derive an alternative measure, obtained from a different source than the survey, for our key dependent variable. Although most prior research captures organizational ambidexterity through self-reported measures (Junni *et al.*, 2013) a few studies have used patent citation data (Chang, Yang, & Chen, 2009; Cui, Ding, & Yanadori, 2019; Katila & Ahuja, 2002). However, these measures have been criticized for failing to capture the firm's entire innovation portfolio (Ahuja & Katila, 2001), including ongoing work and work that is not patented yet, the fact that patenting varies significantly across industries (Cohen, Nelson, & Walsh, 2000), and for their limited applicability outside the US, in countries with weaker or developing patent systems (Park, 2008). More recently scholars (Uotila *et al.*, 2009; Mathias, McKenny, & Crook, 2018; Luger, Raisch, & Schimmer, 2018) have adopted CATA (computer aided content analysis) techniques to capture organizational ambidexterity. To construct our measure using this approach, we looked for publicly available information related to our firms. We located annual report data for 95 public firms in our sample which we content-analyzed to derive

this measure. We used a modified version of the dictionary developed by Uotila *et al.*, 2009 to derive this measure. We first counted the total Exploration (root words include explor*, variation*, risk*, experiment*, play*, discover*, innovat*) and Exploitation (root words include exploit*, refine*, choice*, production*, efficien*, implement*, execut*) words in the firms' annual reports. We then ranked WordCount(Exploration) and WordCount(Exploitation) and assigned a score from 1 to 5 based on quantiles (1=0-20%, 2=21%-40%, 3=41%-60%, 4=61%-80%, 5=81%-100%) to ensure comparability across firms (Chen *et al.*, 2015; Hubbard *et al.*, 2018). Finally, we added the two scores together to create the ambidexterity variable. We estimated our models and found a pattern of effects relatively similar to the one obtained using the survey data (online supplement, p. 3, Table 2). More specifically, we found support for hypotheses 1a, 1b and 1c. We also found support for hypotheses 2b, 2c, 3b, and 3c but did not find support for 2a and 3a. We discuss these results in more detail in our discussion section.

Although we took great care to include controls derived from prior research when estimating our models, it is possible that additional cognitive characteristics, in particular cognitive flexibility covariates, play a role in how individuals (managers) search for information. Further, analyses conducted in different country contexts might yield different results. We therefore conducted a validation survey for the first set of hypotheses with a sample of 123 MBA students enrolled at two business schools in the US. In addition to including the original scales for cognitive flexibility and information search, we also captured self-efficacy (Sherer *et al.*, 1982), emotional regulation (Gross & John, 2003), core self-evaluations (Judge *et al.*, 2003), mindfulness (Brown & Ryan, 2003), and self-esteem (Rosenberg, 1965). Individuals who score high on self-efficacy believe in their abilities to perform a variety of tasks more effectively including information seeking activities (Brown, Ganesan & Challagalla, 2001). Low-esteem individuals have a more humble approach to problem-solving and may similarly engage in a variety of information search activities (Weiss & Knight, 1980). In contrast, individuals with high core self-evaluations engage in less comprehensive decision-making and therefore may restrict their information search (Hiller & Hambrick, 2005). Mindfulness

broadens individuals' environmental scanning efforts and may positively impact information search activities (Weick & Sutcliffe, 2011). Lastly, individuals who effectively manage (i.e. regulate) their emotions may engage in a wider range of information search activities (Lord & Harvey, 2002).

Convergent and discriminant factor analyses conducted on this sample confirmed that these constructs are distinct from cognitive flexibility. Further, SEM analyses showed that the relationship between cognitive flexibility and each information search activity continues to exist in the presence of these additional dispositional factors. The results of these analyses are summarized in the online supplement.

We aimed to further address the issue of common method bias and alternative disposition explanations by adopting an experimental design. Sixty participants (46 males, 13 females, and 1 declining to report gender) enrolled in an Executive MBA program at a university in the southeastern United States completed the experiment as partial fulfillment of a course requirement. The experiment was conducted in two stages separated by two days. On Day 1, participants completed an online questionnaire regarding work history, demographic information, and cognitive flexibility using the Martin & Rubin (1995) scale⁴. On Day 3, participants were randomly assigned to a treatment or a control group. Participants in the treatment group received a counterfactual scenario activity designed to manipulate cognitive flexibility (Galinsky & Moskowitz, 2000; Kray & Galinsky, 2003). Counterfactual primes work by increasing individuals' awareness of different alternatives and have been shown to increase individuals' propensity to engage in search for disconfirmatory information (Kray & Galinsky, 2003). These effects tend to last beyond the counterfactual event itself (Galinsky & Moskowitz, 2000), and make them a suitable choice for our experiment. Participants in the control group received a similar scenario, but it did not include the cognitive flexibility improvement activity. Immediately following this procedure, all participants completed an Unusual Uses Task (UUT), a common measure developed in the creativity literature by Guiford (1967) that has been used

⁴ We administered the scale on Day 1 in order to compare its predictive validity to an experiment (task)-derived measure.

to capture cognitive flexibility in an experimental setting (e.g., Baas, De Dreu, & Nijstad, 2008; Ritter *et al.*, 2012). The UUT asked participants to generate a list of as many unusual uses or sources as possible for what makes sound in a predetermined amount of time (two minutes). Responses were recorded in a text field in Qualtrics that automatically advanced after two minutes. The lists were coded into unique categories by two coders blind to the study's hypotheses (IRR=0.97). The diversity of categories reflects cognitive flexibility. Before moving on to the search task participants were asked to complete an affect task. This step ensured that we can test how mood/affect influences the effects observed in the experiment (Ritter *et al.*, 2012).

We assessed information search using a case experiment research design that is common in strategy research (Lovallo, Clark & Camerer, 2012; Powell, Lovallo & Fox, 2011). After completing the UUT, we provided participants with a case study assignment surrounding the electric vehicle and renewable energy company Tesla, Inc. The case asked participants to review information on a website created by the experimenters and then write a case report on the future of Tesla as if they were its newly appointed CEO. More specifically, participants were asked to provide a substantiated answer to the question: "What is next for Tesla? As the new CEO, will you focus your company's resources on developing new models and expanding its scope of products? Or will you scale production to lower costs and improve existing offerings? Or both?" The website included a wide variety of information about Tesla, its competitors, communities in which it operates, customers, employees, investors, regulators, and its various industries and the general environment. We carefully structured the website to balance both internal and external information and stratify information from generic to highly specific as participants clicked deeper into the website. Participants had ninety minutes to review the website and complete the case report.

We used tools in Google Analytics to observe and quantify how participants searched the website for information. Each participant accessed the case using a unique link that allowed us to follow search activities individually. We measured *search effort* as the total time allocated to searching the website for

information (in minutes). To measure *search persistence*, we created a summed weighted-average of search time allocated to individual pages using the following:

$$\text{Search persistence} = \sum_{p=1}^N \left(\frac{t_p}{T} \right) \gamma_p$$

where t_p is the time allocated to page p (in minutes), T is the total search time (i.e., search effort), and γ_p is the weighting reflecting the spatial hierarchy of page p (ranging from 1 at the most general level and 4 at the most specific level). We generated alternative measures for search persistence including total number of page views and maximum time on a single page. Lastly, we measured *search outside* as the total time allocated to pages reflecting external information (e.g., competitor or industry information). Using this case study experimental design allowed us to objectively and unobtrusively measure how participants searched for information online to complete the assignment.

We used seemingly unrelated regression (SUR) to estimate our effects. SUR is a simple generalization of a linear equation model in which multiple regression equations with different dependent variables but sharing similar sets of independent variables (i.e., the linear predictor η) are simultaneously estimated (Zellner, 1962). The SUR estimation procedure takes into account the cross-equation error correlation, and so the SUR estimator is less biased than traditional OLS regression, which does not account for correlated errors between equations (cf. Shan, Fu, & Zheng, 2017). The results (available in the online supplement) generally mirror the results obtained in the main study. More specifically, we found a positive relationship between the cognitive flexibility treatment and search outside and search effort, and a positive relationship with search persistence when measured as amount of time spent on a single page. These results further support Hypothesis 1. We also examined the efficacy of our counterfactual scenario manipulation to provide further evidence of the relationship between cognitive flexibility and information search and found that following the manipulation, participants in the treatment group demonstrated

statistically higher levels of cognitive flexibility than participants in the control group. Considering that the counterfactual scenario manipulation was randomly assigned and demonstrated improved cognitive flexibility, we can be more confident in our results that suggest a positive relationship between cognitive flexibility and information search. We discuss in more detail the implications of our study and the results generated across different samples in the next section of the manuscript.

DISCUSSION

This study was undertaken as an initial inquiry into the role of cognition, and more specifically the role of cognitive factors related to CEOs as chief cognizers and decision makers for their organizations (Calori *et al.*, 1994), in achieving organizational ambidexterity. The results suggest that CEO cognitive flexibility may play an important role in information search processes that, in turn, influence the degree to which firms simultaneously pursue exploratory and exploitative innovation.

The results derived from our surveys indicate that CEO cognitive flexibility is positively related to three dimensions of information search: search effort, search persistence, and search for outside information and that this relationship holds across different country contexts, with different samples of managers, and in the presence of additional cognitive flexibility covariates. The experiment-derived results, set in the context of a more narrowly defined task that constrains search activities to online information, further validate and isolate the effect of cognitive flexibility on search effort and search for outside information, and to some extent search persistence. Taken together, these results suggest that cognitively flexible CEOs allocate more of their attentional capacity to thorough and exhaustive information search activities and suggest an expanded role for CEO cognitive characteristics across a variety of information search activities (both broadly and narrowly defined) that may be undertaken when firms pursue various innovation efforts.

We also found that effortful and persistent information searches conducted by CEOs are associated with increased levels of organizational ambidexterity. This suggests that the quality (volume, richness, and completeness) of the information obtained through such effortful and persistent information search activities

may, in turn, allow CEOs to reach more complex and finer-grained understandings of ill-structured business problems, such as those associated with simultaneously pursuing exploratory and exploitative innovation, and to formulate solutions that allow firms to successfully pursue ambidexterity. However, the results generated from our public firm subsample using an alternative organizational ambidexterity measure, signal potential differences in how public firms use the information generated through various search activities to achieve organizational ambidexterity. Public firms seem to rely more on outside information and information obtained through persistent searches rather than information obtained through effortful search. These results may be attributed to differences in organizational structures and systems in place to help assist information search and dissemination processes, which may be more developed and efficient in public firms, limiting the need to use information that comes with great effort.

Consistent with the premises on which the theoretical frameworks adopted in this study rest, we found that the effect of CEO cognitive flexibility on organizational ambidexterity is fully mediated by search effort and search persistence in the full sample. This result allows us to provide a theoretically grounded and empirically validated explanation for how an individual-level construct, cognitive flexibility, may be linked to a key firm-level capability, organizational ambidexterity. It also allows us to go beyond the black box and inconsistent findings often associated with studies that attempt to use demographic proxies for CEO dispositions and/or directly link CEO characteristics to firm strategic outcomes (cf., Chatterjee & Hambrick, 2007; Hambrick, 2007) and provide a more nuanced and developed understanding of CEO antecedents for organizational ambidexterity.

Interestingly, we did not find support for the hypothesized impact of CEO search for outside information on organizational ambidexterity in our full sample, although we found a modest effect in our public firm subsample. In addition to differences in organizational structure, common to public and private firms, this result may also be attributed to several other factors. First, the additional robustness tests conducted supported that search for outside information acts as a mediator of the cognitive flexibility-

organizational ambidexterity relationship when analyzed in isolation from information search effort and persistence. However, our *simultaneous* analysis of the mediating effects of several different information search activities suggests that persistent and effortful information search by CEOs are more important causal mechanisms in the CEO cognitive flexibility – organizational ambidexterity link than search for outside information, which may only play a minor, supporting role in the full sample. Second, although cognitively flexible CEOs engage in search for outside information, this type of information is often highly tacit and complex in nature, more difficult to interpret, and may need to be disseminated and processed at other levels in the organization before it impacts organizational ambidexterity. Prior research (e.g., Lubatkin *et al.*, 2006) suggests that TMTs that are behaviorally integrated may manage “internal processes that enable them to handle large amounts of information and decision alternatives and deal with conflict and ambiguity” (Tushman & O’Reilly, 1997, p. 23). Outside information is often ambiguous and hard to interpret, which may lead to conflicts and disagreements among TMT members such that behaviorally integrated TMTs that benefit from a rich CEO-TMT interface, are better able to deal with ambiguous and tacit information and improve organizational ambidexterity (Cao *et al.*, 2010; Jansen *et al.*, 2006; Lubatkin *et al.*, 2006). Third, our results may be driven by the empirical setting selected. Search for outside information may be an activity in which lower level employees in product development and marketing may be more heavily involved, especially in the software industry. Labor mobility among Indian software engineers and the high number of Indian employees with global interpersonal ties, are factors known to influence the innovative behaviors and global competitiveness of Indian SMEs (Rosenkopf & Nerkar, 2001; Saxenian, 2005) and may play a substantial role in how firms access external information and achieve organizational ambidexterity.

Contributions, limitations, and future research directions

Our study contributes to several different streams of work. First, we contribute to the organizational ambidexterity literature. Although prior research has focused on several contextual, structural, and TMT

level mechanisms that help explain how firms successfully pursue organizational ambidexterity, and has conceptually argued for the importance of unique cognitive aspects of the leaders directing this process (e.g. O'Reilly & Tushman, 2008; Smith & Tushman, 2005; Taylor & Helfat, 2009), it has focused comparatively less on elaborating and empirically testing the process underlying these relationships. We focus attention on, and provide empirical support for important links between CEO cognitive flexibility, information search activities, and organizational ambidexterity. As such, our work responds to calls to address an important gap in the organizational ambidexterity literature (cf., O'Reilly & Tushman, 2013) and to calls (e.g., Hodgkinson & Healey, 2011; Powell *et al.*, 2011) for complex microfoundational, cognitive perspectives on firm capability (i.e. organizational ambidexterity) development (e.g., Eisenhardt *et al.*, 2010; Gupta *et al.*, 2006; Helfat & Peteraf, 2015). Our findings add to the evidence that the development of firm dynamic capabilities and the implementation of an innovation-based strategy are influenced by human factors in the executive office (Chatterjee & Hambrick, 2007; Finkelstein, Hambrick, & Cannella, 2009; Raffaelli *et al.*, 2019).

We also contribute to work on information search activities (Greve & Taylor, 2000; Katila & Ahuja, 2002; Li *et al.*, 2013). Prior research has suggested that managerial decisions related to search (*how* and *where* to search for information) are arguably some of the most important decisions associated with firms' exploitative and/or innovative output. Yet our understanding of the heuristics and cognitive antecedents associated with information search activities remains limited. We suggest that incorporating the concept of cognitive flexibility in models that study information search activities brings us a step closer to understanding *why* managers and firms engage in certain information search activities and shed additional light on variability in firm strategic outcomes associated with such activities.

Third, our study extends work on strategic leadership (Chen & Nadkarni, 2017; Hambrick, 2007; Peterson *et al.*, 2012) by focusing attention on the construct of CEO cognitive flexibility, and highlighting its relevance for organizations that pursue ambidexterity. By linking CEO cognitive flexibility to leader's

information search activities, and organizational ambidexterity we contribute to a growing body of research that argues for the importance of intermediary mechanisms in the relationship between CEO cognitive characteristics and firm strategy and for a contextualized approach to selecting and studying leader characteristics that are directly relevant for the phenomena studied.

Finally, from an empirical perspective our study complements the incipient stream of conceptual and experimental work on managerial cognitive flexibility (e.g., Laureiro-Martinez & Brusoni, 2018; Laureiro-Martinez *et al.*, 2009; Raffaelli *et al.*, 2019) by focusing attention on how this concept plays out in an organizational context with a large sample of CEOs. Taken together these studies point to the importance of managerial cognitive flexibility not just for narrowly defined attentional tasks, but also for a manager's overall approach to information search and, implicitly, for how organizations engage in exploratory and exploitative innovation activities, and suggest that this is a fruitful area for future research.

Our study has a number of limitations that represent opportunities for future research. First, while we engaged in several non-mutually exclusive strategies ranging from theoretically derived controls, to establishing the theoretical and contextual boundaries of the study, employing procedural survey design steps, performing statistical tests, and conducting a validation survey, and an experiment to address the issues of common method bias and alternative explanations, we cannot completely eliminate them. We encourage future research on this topic to consider the influence of additional CEO and firm level characteristics, the development of mixed-research designs, and alternative measures for organizational ambidexterity that do not rely on subjective assessments.

Second, our results may be limited to the empirical setting (i.e. technology- intensive SMEs in India) selected. The nature of firms and industries selected, may be sufficiently different from those encountered in other contexts such that future studies using different (e.g., large and diversified) samples of firms competing in additional industries (e.g. low- tech) and countries, may be needed to test the validity of the uncovered relationships. Further, additional research using firms from other countries with more developed

IP protection systems that allows researchers to capture organizational ambidexterity through a mix of subjective and objective data (e.g., patents) is warranted. Third, our goal in this study was to provide the most plausible and theoretically grounded explanation linking CEO cognitive flexibility to organizational ambidexterity and thus, focused on SMEs with more centralized decision making competing in similar technology-intensive industry settings, to better isolate this explanation. However, research suggests that certain structural, contextual, and environmental factors may also play a role in the achievement of organizational ambidexterity, particularly in larger, more diversified organizations, and may moderate the mediated relationships uncovered in our study. Fourth, we focused on CEO antecedents to organizational ambidexterity and captured information search at the CEO level. However, information search also occurs at other levels in the organization. Further, the nature of the information collected also depends on the functional role played by employees. This opens up opportunities for future studies that capture information search at multiple levels in the organization.

To summarize, in this study we took an upper echelons approach and adopted a mediation model to investigate the influence of CEO cognitive flexibility on CEO information search related to organizational ambidexterity. We found support for most of our hypotheses, thereby providing evidence of the importance of a particular cognitive characteristic of top managers (CEOs) to the achievement of organizational ambidexterity, and underscoring the importance of intermediary factors to explain these effects.

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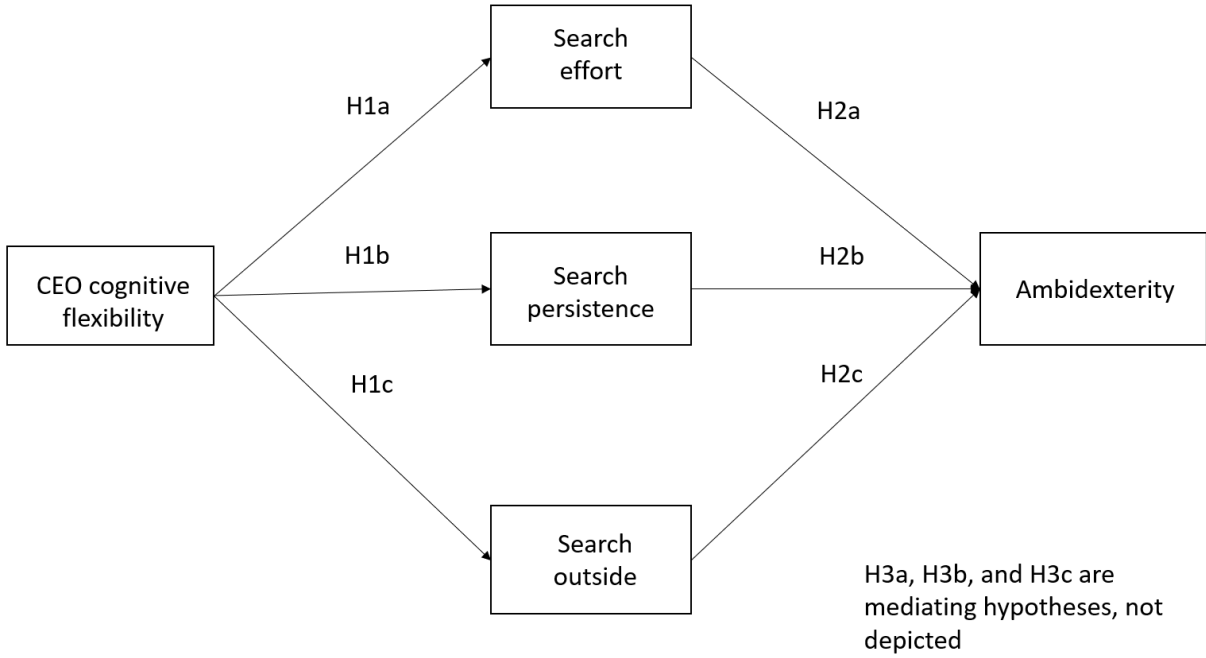


Figure 1
CEO cognitive flexibility, information search, and organizational ambidexterity

Table 1: Means, standard deviations, and correlations (N=202)

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.Firm age	25.31	14.93	1															
2.Firm size (log)	2.29	0.64	0.50	1														
3.Prior performance	297.43	1023	0.18	0.32	1													
4.R&D intensity	3.68	5.31	-0.35	-0.33	-0.05	1												
5.Financial slack	5.45	1.02	0.20	0.19	0.02	-0.17	1											
6.CEO experience	17.84	8.65	0.34	0.30	0.11	-0.28	0.11	1										
7.CEO tenure	16.33	10.02	0.40	0.32	0.11	-0.18	0.03	0.55	1									
8.TMT size	7.88	5.52	0.17	0.10	-0.01	-0.04	0.28	0.11	-0.01	1								
9.Male CEO	0.97	0.18	0.05	-0.07	0.04	0.02	0.02	0.06	0.14	0.05	1							
10.CEO age	47.84	9.06	0.35	0.34	0.12	-0.26	0.04	0.76	0.70	0.03	0.11	1						
11.CEO cognitive complexity	50.25	19.86	0.07	0.05	-0.02	-0.08	0.02	0.10	-0.02	0.03	0.00	0.03	1					
12.CEO Cognitive flexibility	4.84	0.47	-0.05	-0.17	-0.15	-0.04	0.01	-0.26	-0.10	-0.04	0.08	-0.17	-0.20	1				
13.Search effort	4.14	0.48	0.13	0.14	-0.04	-0.16	0.25	0.23	0.19	0.17	0.04	0.22	0.07	0.17	1			
14.Search persistence	4.16	0.49	0.03	0.04	-0.08	-0.17	0.24	0.17	0.10	0.07	0.04	0.13	0.11	0.16	0.64	1		
15.Search outside	5.53	1.05	0.14	0.27	0.06	-0.12	0.40	0.11	0.21	0.03	-0.03	0.16	-0.09	0.09	0.49	0.40	1	
16.Ambidexterity	11.40	1.11	0.06	0.05	-0.12	-0.04	0.37	0.15	0.01	0.15	0.01	-0.03	0.14	0.08	0.44	0.43	0.31	1

Table 2: CEO Cognitive Flexibility, Information Search, and Organizational Ambidexterity

	Model 1 Search effort	Model 2 Search effort	Model 3 Search persistence	Model 4 Search persistence	Model 5 Search outside	Model 6 Search outside	Model 7 Ambidexterity	Model 8 Ambidexterity	Model 9 Ambidexterity	Model 10 Ambidexterity
<i>Intercept</i>	3.106 (0.359)[0.000]	1.739 (0.519)[0.001]	3.398 (0.369)[0.000]	2.217 (0.539)[0.000]	2.908 (0.730)[0.000]	0.930 (1.149)[0.419]	9.852 (0.781)[0.000]	8.006 (1.151)[0.000]	6.549 (0.877)[0.000]	6.081 (1.109)[0.000]
Control variables:										
<i>Firm age</i>	-0.002 (0.003)[0.505]	-0.003 (0.003)[0.353]	-0.003 (0.003)[0.265]	-0.004 (0.003)[0.181]	-0.005 (0.006)[0.393]	-0.005 (0.006)[0.330]	-0.002 (0.006)[0.720]	-0.003 (0.006)[0.611]	0.000 (0.005)[0.930]	0.000 (0.006)[0.979]
<i>Firm size (log)</i>	0.036 (0.064)[0.578]	0.063 (0.063)[0.316]	-0.029 (0.066)[0.656]	-0.006 (0.065)[0.929]	0.309 (0.130)[0.019]	0.336 (0.130)[0.011]	0.065 (0.139)[0.638]	0.102 (0.139)[0.462]	0.042 (0.129)[0.744]	0.054 (0.130)[0.680]
<i>Prior performance</i>	0.000 (0.000)[0.269]	0.000 (0.000)[0.447]	0.000 (0.000)[0.287]	0.000 (0.000)[0.441]	0.000 (0.000)[0.845]	0.000 (0.000)[0.988]	0.000 (0.000)[0.054]	0.000 (0.000)[0.088]	0.000 (0.000)[0.118]	0.000 (0.000)[0.135]
<i>R&D intensity</i>	-0.006 (0.007)[0.377]	-0.003 (0.007)[0.682]	-0.012 (0.007)[0.081]	-0.009 (0.007)[0.175]	0.000 (0.014)[0.987]	0.004 (0.014)[0.800]	0.009 (0.015)[0.546]	0.013 (0.015)[0.366]	0.018 (0.014)[0.199]	0.019 (0.014)[0.175]
<i>Financial slack</i>	0.095 (0.034)[0.006]	0.091 (0.033)[0.007]	0.108 (0.035)[0.002]	0.105 (0.034)[0.003]	0.413 (0.069)[0.000]	0.408 (0.069)[0.000]	0.377 (0.074)[0.000]	0.371 (0.074)[0.000]	0.256 (0.074)[0.001]	0.257 (0.074)[0.001]
<i>CEO experience</i>	0.004 (0.006)[0.488]	0.008 (0.006)[0.161]	0.006 (0.006)[0.315]	0.010 (0.006)[0.113]	-0.009 (0.012)[0.475]	-0.005 (0.012)[0.715]	0.043 (0.013)[0.001]	0.049 (0.013)[0.000]	0.039 (0.012)[0.001]	0.041 (0.012)[0.001]
<i>CEO tenure</i>	0.005 (0.005)[0.337]	0.004 (0.005)[0.347]	0.003 (0.005)[0.593]	0.002 (0.005)[0.613]	0.018 (0.010)[0.061]	0.018 (0.010)[0.063]	0.008 (0.010)[0.457]	0.007 (0.010)[0.470]	0.003 (0.010)[0.743]	0.003 (0.010)[0.741]
<i>TMT size</i>	0.009 (0.006)[0.164]	0.009 (0.006)[0.128]	0.000 (0.006)[0.948]	0.001 (0.006)[0.887]	-0.014 (0.013)[0.279]	-0.013 (0.013)[0.297]	0.004 (0.014)[0.761]	0.005 (0.014)[0.718]	0.000 (0.013)[0.998]	0.000 (0.013)[0.973]
<i>Male CEO</i>	0.043 (0.182)[0.812]	-0.009 (0.178)[0.960]	0.064 (0.187)[0.732]	0.019 (0.184)[0.918]	-0.249 (0.370)[0.502]	0.302 (0.369)[0.415]	0.130 (0.396)[0.744]	0.059 (0.394)[0.882]	0.092 (0.361)[0.799]	0.072 (0.363)[0.843]
<i>CEO age</i>	0.004 (0.007)[0.550]	0.003 (0.006)[0.589]	0.001 (0.007)[0.905]	0.000 (0.007)[0.953]	0.005 (0.013)[0.708]	0.005 (0.013)[0.734]	-0.041 (0.014)[0.005]	-0.042 (0.014)[0.004]	-0.044 (0.013)[0.001]	-0.044 (0.013)[0.001]
<i>CEO cognitive complexity</i>	0.001 (0.002)[0.465]	0.002 (0.002)[0.152]	0.002 (0.002)[0.165]	0.003 (0.002)[0.050]	-0.005 (0.003)[0.169]	-0.004 (0.003)[0.307]	0.006 (0.004)[0.089]	0.008 (0.004)[0.036]	0.005 (0.003)[0.158]	0.005 (0.003)[0.127]
Independent variable:										
<i>CEO Cognitive flexibility</i>		0.262 (H1a) (0.074)[0.001]		0.227 (H1b) (0.077)[0.004]		0.264 (H1c) (0.154)[0.088]		0.354 (0.164)[0.032]		0.108 (0.156)[0.490]
Mediator variables:										
<i>Search effort</i>									0.536 (H2a) (0.189)[0.005]	0.516 (H3a) (0.191)[0.008]
<i>Search persistence</i>									0.435 (H2b) (0.177)[0.015]	0.426 (H3b) (0.178)[0.018]
<i>Search outside</i>									0.055 (H2c) (0.080)[0.491]	0.055 (H3c) (0.080)[0.493]
F	2.72	3.69	2.26	2.89	5.51	5.35	4.94	5.01	7.76	7.25
R2	0.14	0.19	0.12	0.15	0.24	0.25	0.22	0.24	0.37	0.37
Adjusted R2	0.09	0.14	0.06	0.10	0.20	0.21	0.18	0.19	0.32	0.32

N=202. Unstandardized regression coefficients are reported. Standard errors are in parentheses. P-values are between square brackets. Two-tailed tests