



## MANAGERIAL COGNITIVE CAPABILITIES AND THE MICROFOUNDATIONS OF DYNAMIC CAPABILITIES

CONSTANCE E. HELFAT\* and MARGARET A. PETERAF

Tuck School of Business at Dartmouth, Hanover, New Hampshire, U.S.A.

*The microfoundations of dynamic capabilities have assumed greater importance in the search for factors that facilitate strategic change. Here, we focus on microfoundations at the level of the individual manager. We introduce the concept of “managerial cognitive capability,” which highlights the fact that capabilities involve the capacity to perform not only physical but also mental activities. We identify specific types of cognitive capabilities that are likely to underpin dynamic managerial capabilities for sensing, seizing, and reconfiguring, and explain their potential impact on strategic change of organizations. In addition, we discuss how heterogeneity of these cognitive capabilities may produce heterogeneity of dynamic managerial capabilities among top executives, which may contribute to differential performance of organizations under conditions of change. Finally, we propose possible directions for future research. Copyright © 2014 John Wiley & Sons, Ltd.*

### INTRODUCTION

Over 50 years ago, Penrose (1959) identified the supply of managerial services, especially at the top of the organization, as a fundamental constraint on the ability of firms to grow and diversify. Today we might say the same about strategic change more generally. Not surprisingly, the role of individual managers has begun to assume greater importance in an emerging literature on the microfoundations of dynamic capabilities for organizational adaptation and change. Adner and Helfat (2003) recognized early on that some managers may have “dynamic managerial capabilities” with which to build, integrate, reconfigure, and competitively reposition organizational resources and capabilities. Adner and Helfat (2003) also observed that dynamic managerial capabilities depend in part

on managerial cognition. To date, the cognitive underpinnings of dynamic managerial capabilities remain largely unexplored (Eggers and Kaplan, 2013). Here, we focus on how cognition may help to explain why some top managers have more effective capabilities than others for anticipating, interpreting, and responding to the demands of an evolving environment.

To analyze the cognitive underpinnings of the dynamic capabilities of managers, we build on Teece's (2007) analysis of the microfoundations of dynamic capabilities.<sup>1</sup> In laying out the microfoundations of dynamic capabilities in tripartite form, Teece (2007) suggests a role for cognition in the “sensing,” “seizing,” and “reconfiguring” components of dynamic capabilities. Although Teece's (2007: 1319) primary concern is with “*enterprise level sensing, seizing, and reconfiguring capacities*” [italics added], he acknowledges that the cognition of top executives contributes to the microfoundations of dynamic capabilities. Building on both

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\*Correspondence to: Constance E. Helfat, Tuck School of Business at Dartmouth, 100 Tuck Hall, Hanover, NH 03755, U.S.A. E-mail: constance.helfat@dartmouth.edu

<sup>1</sup> Teece's (2007) article extends the analysis of dynamic capabilities by Teece *et al.* (1997) to consider specific mechanisms through which dynamic capabilities operate.

Teece (2007) and Adner and Helfat (2003), we show how dynamic managerial capabilities can be disaggregated, for analytical purposes, into sensing, seizing, and reconfiguring components that have important cognitive underpinnings.<sup>2</sup>

In analyzing the cognitive underpinnings of dynamic managerial capabilities, we draw on research in cognitive psychology, cognitive science, social psychology, cognitive neuroscience, and behavioral decision theory. Scholars often differ (sometimes strongly) across these fields in their views on cognition, even for very specific elements of cognition such as attention (see Ocasio, 2011). Here, we rely on definitions of terms in well-regarded dictionaries of psychology and textbooks, and on empirical findings reported in scholarly articles and books.

Research in strategic management has most commonly analyzed cognition, including heterogeneity of cognition among managers, in terms of information structures and mental maps (Gary and Wood, 2011). In psychological research, mental activities (also termed “mental processes” or “mental operations”) that utilize and alter information structures also comprise an important part of cognition. We bring together this aspect of cognition with strategic management research on capabilities (Amit and Schoemaker, 1993; Helfat and Peteraf, 2003). More specifically, we introduce the concept of “managerial cognitive capability,” which refers to the capacity of individual managers to perform mental activities. We then analyze the ways in which managerial cognitive capabilities underpin dynamic managerial capabilities.

In what follows, we first review evidence documenting the impact of top executives in general, and their cognition in particular, on firm performance and strategic change. We then discuss the role that mental activities play in cognition. Building on this discussion, we explain how the capability concept in strategic management relates to the mental activities of managers, and define the term “managerial cognitive capability.” We also discuss general characteristics of cognitive capability, including heterogeneity among individuals. Then, we explain how the concept of managerial cognitive capability substantially expands Teece’s (2007) sensing-seizing-reconfiguring framework, and discuss ways in which specific cognitive

capabilities may underpin sensing, seizing, and reconfiguring. We further explain how heterogeneity of cognitive capabilities among managers may lead to differential firm performance under conditions of change. In these respects, the paper contributes by enriching the dynamic capabilities framework and deepening our understanding of its micromechanisms and the role of top managers. The analysis concludes with avenues for future research.

## TOP MANAGEMENT, FIRM PERFORMANCE, AND STRATEGIC CHANGE

In strategic management, the study of managers in the upper echelon (Hambrick and Mason, 1984) and their impact on the organization has a long history, going back at least to *The Functions of the Executive* by Chester Barnard (1938). More recently, the resource-based view has highlighted the importance of managerial skills, particularly at the top of the organization (Castanias and Helfat, 1991; Maritan, 2001). Variance decomposition studies have provided empirical support for this focus on top management, showing that differences between CEOs account for a nontrivial portion of the variance of firm performance, termed a “CEO effect.” Early studies such as Lieberman and O’Connor (1972), Weiner (1978), and Thomas (1988) documented this relationship (for a review, see Bowman and Helfat, 2001). Recent variance decomposition studies have produced even stronger evidence. For example, using multiple measures of firm performance, Quigley and Hambrick (2011) found large CEO effects that increased over time from an average of 12.7 percent of the variance of firm performance during the years 1950–1969 to an average of 25 percent of the variance during the years 1990–2009.

These studies have documented that CEO heterogeneity contributes to the variance of firm performance, but have not examined the relationship between top management, strategic change, and firm performance. To address this issue, Adner and Helfat (2003) used variance decomposition to examine the impact of CEO decisions directed toward change. Using an estimation technique that produces conservative estimates of a CEO effect, Adner and Helfat (2003) found that heterogeneity in whether and when top management initiated

<sup>2</sup> For a discussion of the cognitive underpinnings of enterprise level dynamic capabilities, see Hodgkinson and Healy (2011).

a single strategic change in the U.S. oil industry accounted for 4.5 percent of the total variance of firm performance. Because Adner and Helfat (2003) estimated the effect of a single strategic decision, their estimate captures only a portion of the full CEO effect. Using a different methodology involving a matched-pair design, Bertrand and Schoar (2003) also found a significant impact of top managers on firm policies and performance. Manager-level fixed effects were important determinants of corporate investment policies, cost-cutting policies, R&D expenditures, diversification, and acquisitions—factors directed toward strategic change—and manager fixed effects were significant determinants of firm performance. Two additional studies have found that CEO age, tenure, and educational level affect the extent of strategic change (Datta, Rajagopalan, and Zhang, 2003; Zhang and Rajagopalan, 2010).

Case studies have also provided evidence of CEO impact in the face of change. For example, Holbrook *et al.* (2000) documented that, during the early years of the semiconductor industry, performance differentials between firms stemmed in part from differences in the approaches taken by top management. In another study, Rosenbloom (2000) showed that top management contributions to strategic change at NCR differed substantially over time. In attempting to make the transition to mainframe computing, NCR initially had great difficulty due to inertia of top managers. Subsequently, a new CEO, who came from NCR Japan with different prior experience than top management at company headquarters, was instrumental in the company's late but successful entry into computing.

The contributions of top management under conditions of change may be positive or negative, and as the foregoing studies indicate, the impact of CEOs varies. Rosenbloom (2000) argues that some CEOs have dynamic capabilities that can aid strategic change. Even among managers with dynamic capabilities, however, the benefits conferred by these capabilities are likely to differ, in part due to differences in managerial cognition (Adner and Helfat, 2003). Zott and Huy (2013) have investigated the affective microfoundations of dynamic capabilities through an examination of the emotion regulation behavior of the founders of entrepreneurial companies. To complement this approach, we investigate how cognition with respect to knowledge

and information underpins the dynamic capabilities of managers, and the implications for firm performance.

Management research has long regarded cognition as an important attribute of managers at the top of the organization (for a review, see Finkelstein, Hambrick, and Cannella, 2009). More recently, research on top management cognition specifically related to strategic change has accelerated. Smith and Tushman (2005), for example, have suggested that top managers need to build a “paradoxical cognition” that enables them to pursue exploration and exploitation simultaneously. Miller and Ireland (2005) have cautioned, however, that when firms explore for new technologies and strategies, intuition and hunches can be detrimental, due to the automatic and often inappropriate reliance on prior expertise. Subsequently, Gavetti (2012) has argued that strategic leaders with superior associative mental processes may avoid this trap and have greater success in identifying promising strategic opportunities.

Empirical evidence has documented the effects of managerial cognition on efforts directed toward strategic change. In his study of NCR, Rosenbloom (2000) demonstrated that managerial cognition, specifically the ways in which top management conceived of NCR's business, had a critical impact on both NCR's difficulty in transitioning to mainframe computers and its eventual success in doing so. Taylor and Helfat (2009) also found that the cognition of top management helped IBM in its successful transition to mainframe computing. In contrast, Tripsas and Gavetti (2000) documented that top management cognition, in terms of how executives conceived of their business, prevented Polaroid from successfully adapting as the camera industry shifted to digital imaging technology. Similarly, Helfat *et al.* (2007) documented the way in which the mindset of Rubbermaid's CEO contributed to the company's difficulty in adjusting to a changing marketplace. Additionally, in a study of the typewriter company Smith-Corona, Danneels (2011) showed that top management's misunderstanding of which company resources had value, and of the potential application of company resources to new markets, contributed to the company's demise.

Quantitative studies have also documented the impact of CEO cognition on strategic change. For example, Kaplan, Murray, and Henderson (2003) showed that the mental models of top management

affected the actions of pharmaceutical companies in response to the emerging biotechnology sector. Eggers and Kaplan (2009) further showed that in the communications technology industry, CEOs that paid greater attention to emerging technologies entered new product markets more quickly. Other studies have found that managerial demographic characteristics, as indicators of cognition, affected the initiation of strategic change by CEOs (Boeker, 1997) and top management teams (Wiersema and Bantel, 1992). In addition, in the first empirical analysis of the impact of CEO personality on strategic change, Hermann and Nadkarni (2013) found that in small and medium-sized Ecuadorian firms, CEO personality affected how many strategic changes a company undertook, as well as the implementation and outcomes of these changes.

The foregoing studies document that heterogeneity of top management cognition is associated with heterogeneity of strategic change efforts and outcomes. However, relatively little of this research has focused directly on the mental activities (or mental processes) aspect of cognition. (Exceptions include Eggers and Kaplan, 2009 and Gavetti, 2012.) Here, we focus on the mental activities involved in acquiring, organizing, and processing information. We introduce the concept of managerial cognitive capabilities that enable mental activities, elaborate on the heterogeneity of these capabilities, explain how they underpin dynamic managerial capabilities, and assess their potential impact on strategic change and long-term performance.

## MENTAL ACTIVITIES AND COGNITION

Although “cognition” is a broad term, dictionaries of psychology provide very consistent definitions of the term.<sup>3</sup> The American Psychological Association *Glossary of Psychological Terms* (2009) provides this definition of “cognition”: “processes of knowing, including attending, remembering, and reasoning; also, the content of the processes, such as concepts or memories.”

<sup>3</sup> As in many fields, one can find a variety of different, often closely related, definitions for a single term. Because our analysis rests on concepts in psychology that are not used as frequently in the strategy literature on dynamic capabilities, we provide representative definitions for the psychological terms that we employ.

Similarly, *A Dictionary of Psychology* (Colman, 2006), published by Oxford University Press, defines “cognition” as (1) “the mental activities involved in acquiring and processing information,” and (2) “an item of knowledge or belief.” In cognitive science, a multidisciplinary field that includes artificial intelligence as well as cognitive psychology (Luger, 1994), the term “cognition” applies to any kind of mental operation or mental “structure”; the latter refers not to physical structures in the brain but to representations of information by the mind (Schneider and Angelmar, 1993).

As the foregoing definitions indicate, the term “cognition” encompasses two meanings: (1) mental activities (also termed “mental processes” or “mental operations”), and (2) mental structures (or representations). Management research has focused heavily on the second understanding of cognition, also known as knowledge structures. Rajagopalan and Spreitzer (1997) define cognition explicitly in these terms, although its meaning is more often implicit. In management research, a wide variety of terms have been used to denote knowledge structures, including cognitive maps (e.g., Barr, Stimpert, and Huff, 1992); mental models (e.g., Glynn, Lant, and Mezias, 1991; Prahalad and Bettis, 1986); frames (e.g., Hodgkinson *et al.*, 1999; Kaplan, 2008); and schema, schemata, or interpretive schemes (e.g., Bartunek, 1984; Dougherty, 1992). They are hypothesized to play a role in an individual’s cognitive representation of an external reality. Walsh’s (1995) landmark paper provides a thoughtful review of the application of knowledge structures to strategic management and organization theory.

The relationship between mental representations and mental activities (or processes) is complex. When individuals carry out mental activities, they may retrieve, generate, or modify mental representations. For example, Ericsson and Lehmann (1996: 285) note that research on computer programmers engaged in problem solving (a mental activity) found that, for familiar tasks, programmers “often rapidly retrieved or constructed an accurate mental model.” Ericsson and Lehmann (1996: 285) also discuss evidence of problem solving by expert computer programmers who “were found to generate an initial ... representation of their design (mental model) and to modify it.” In addition to mental models, when performing mental activities, individuals rely on their beliefs, values,

motivation, and similar factors known as “mental states” in the field of cognitive science (Rokeach, 1970).

## COGNITIVE CAPABILITIES OF MANAGERS

In strategic management, the term “capability” refers to the capacity to perform a function or activity in a generally reliable manner when called upon to do so (Amit and Schoemaker, 1993; Helfat and Winter, 2011). The capacity to reliably perform an activity of some type implies only that a capability meets a minimum standard of acceptable functionality (Helfat *et al.*, 2007). As Winter (2000: 981) notes, how well a capability performs its intended function is “a matter of degree.” Capabilities develop in part through practice. As an individual or an organization gains experience performing an activity, the capacity to perform this activity again in the future tends to improve, particularly early in the development of a capability (Zollo and Winter, 2002).

This definition of a capability in terms of the capacity to perform an activity accords with standard dictionary definitions of the word “capability.” For example, Merriam Webster (2009) defines a capability as “the quality or state of being capable,” where the word “capable” is defined as “having attributes (as physical or mental power) required for performance or accomplishment.” As this definition indicates, capabilities and their associated activities can be mental as well as physical.

Both the dictionary definition of “capability” and its definition in the strategic management literature indicate that the capacity of individuals to perform mental activities is a type of capability.<sup>4</sup> In order to make the link explicit between managerial capabilities and mental activities, we define the concept of “managerial cognitive capability” as follows:

*Managerial cognitive capability is the capacity of an individual manager to perform one or more of the mental activities that comprise cognition.*

This definition of cognitive capability directs attention to the activities or functions that cognition performs.<sup>5</sup> The human brain performs many different mental activities, such as those involving attention, perception, and problem solving. Although these mental activities interact with one another, they are separable; cognitive psychologists have documented that they perform different functions, and brain imaging studies have shown that different mental activities are associated with different parts of the brain (for a review, see Smith and Kosslyn, 2008).

Research in psychology and related fields distinguishes between two modes of mental processing of information, denoted by a variety of terms (see Stanovich and West (2000: 659) for a partial list).<sup>6</sup> One is mostly automatic, termed System 1 mental processing by Stanovich and West (2000: 658) (see also Kahneman, 2011). Automatic mental activities enable quick responses to external stimuli and data (Schneider and Shiffrin, 1977). The other mode of processing is often referred to as “controlled” or “deliberative” mental processing or as “executive function,” termed System 2 processing by Stanovich and West (2000: 658) (see also Kahneman, 2011). Mental activities of this type are slower and support a more deliberate response to circumstances (Schneider and Shiffrin, 1977). The *INS Dictionary of Neuropsychology* (Loring, 1999) defines “executive function” as “cognitive processes that organize and order behavior, including (but not limited to) logic and reasoning, abstract thinking, problem solving, planning, and carrying out goal-directed behavior.” Similarly, the *APA Dictionary of Psychology* (VandenBos, 2007), states that “executive function includes the ability to plan and anticipate outcomes (cognitive flexibility) and to direct attentional resources to meet the demands of non-routine events.” There is debate about precisely how executive

<sup>4</sup> In psychology, one can find similar sounding terms, including “cognitive ability,” a term that often denotes general intelligence (Colman, 2006). Horn and Noll (1994) use the term “cognitive capabilities” to refer to intelligence. In strategic management, capability differs from intelligence, so using the psychological term “cognitive ability” would be misleading. A closer term in psychology is “cognitive capacity,” defined in terms of *potential* cognitive ability (Corsini, 1999). The term “capacity” in our definition of cognitive capability similarly connotes “potential ability.”

<sup>5</sup> Hodgkinson and Sparrow’s (2002) use of the term “cognitive competence” is similar in spirit, although less directly related to the capabilities literature on which we focus here.

<sup>6</sup> Stanovich and West (2000: 658) note that, although different research has emphasized different aspects of each processing mode, “there are clear family resemblances.”

function (or controlled or System 2 processing) operates, including the extent to which it confers conscious control over actions.<sup>7</sup> Nevertheless, there is overall agreement that this mode of mental processing supports deliberation and goal-directed behavior.

Cognitive capabilities can improve through practice, a phenomenon that similarly characterizes the development of capabilities studied in strategic management. For example, Ericsson and Lehmann (1996: 290) note that observational and laboratory studies show that memory performance improves through practice and training. Neuroimaging studies also reveal that brain structure depends on experience. Posner *et al.* (1997: 267), for example, find that “practice may change the size or number of brain areas involved and alter pathways used” in the performance of “cognitive skills” (e.g., reading) requiring attention. Findings such as these suggest that if some individuals practice a particular mental activity more frequently than other individuals (e.g., frequent use of short-term memory by waiters), they are likely to develop better cognitive capabilities of this sort, which further practice is likely to reinforce. In this way, path dependence in the development of cognitive capabilities may contribute to heterogeneity in both potential and actual performance of mental activities.

Research also suggests that cognitive capabilities have an important context- or domain-specific aspect that may further contribute to their heterogeneity. In a review of relevant literature, Ericsson and Lehmann (1996) cite evidence that performance of a variety of mental activities depends on prior experience in the particular domain of application (e.g., reasoning in medical diagnosis, memory in the game of chess). These differences in the context in which practice and training occur are likely to lead to heterogeneity of cognitive capabilities as well.

Such heterogeneity of cognitive capabilities appears to involve both controlled and automatic mental processes. Weber and Johnson (2009: 72) note that research has shown that individuals differ in their reliance on different types of automatic versus controlled processes. These differences may derive in part from differences between

individuals in the extent of prior experience in a domain of application. For example, Larrick and Feiler (unpublished: 9) note that studies suggest that the development of expertise initially relies on controlled (System 2) mental processing, but that mental processing becomes automatic with practice. In particular, practice changes the nature of “cognitive operations” by improving the speed and smoothness of mental processing, and reducing the demands that these operations place on brain capacity (Ericsson, 2006: 53). The finding that practice in a particular domain can lead to automaticity in mental processing suggests that differences between individuals in the extent of prior experience within a domain may lead to heterogeneity in the reliance on automatic versus controlled processing.

Greater reliance on automatic processes has both pros and cons. As just noted, automatic processes improve the speed of mental processes and place fewer demands on brain capacity. However, automatic mental processes can also lead to biases in decision making (for a review, see Kahneman, 2011; Kahneman, Slovic, and Tversky, 1982). Although research suggests that controlled mental processes may have the potential to intervene and override such biases (Stanovich and West, 2000: 662), individuals appear to differ in their capacity to do so (see, e.g., Weber and Johnson, 2009: 73), providing yet another source of heterogeneity in cognitive capabilities.

## DYNAMIC MANAGERIAL CAPABILITIES

Building on the foregoing discussion, we next explain how specific cognitive capabilities underpin the three classes of dynamic managerial capabilities set forth in Teece (2007). We also discuss heterogeneity in these cognitive capabilities, and implications for differential firm performance. Because space constraints preclude discussion of all cognitive capabilities relevant to each class of dynamic managerial capabilities, we focus on illustrative sets of cognitive capabilities in each case. In addition, the cognitive capabilities identified here as critical underpinnings for one class of dynamic managerial capability are likely to play a role in other classes of dynamic managerial capabilities as well; due to space constraints, we do not elaborate on

<sup>7</sup> The APA dictionary also notes that the location of executive function in the brain “remains elusive and controversial,” and goes on to state that “regions of the pre-frontal cortex may play a special role in recruiting other brain areas in a series of distributed networks that handle different components of executive functions.”

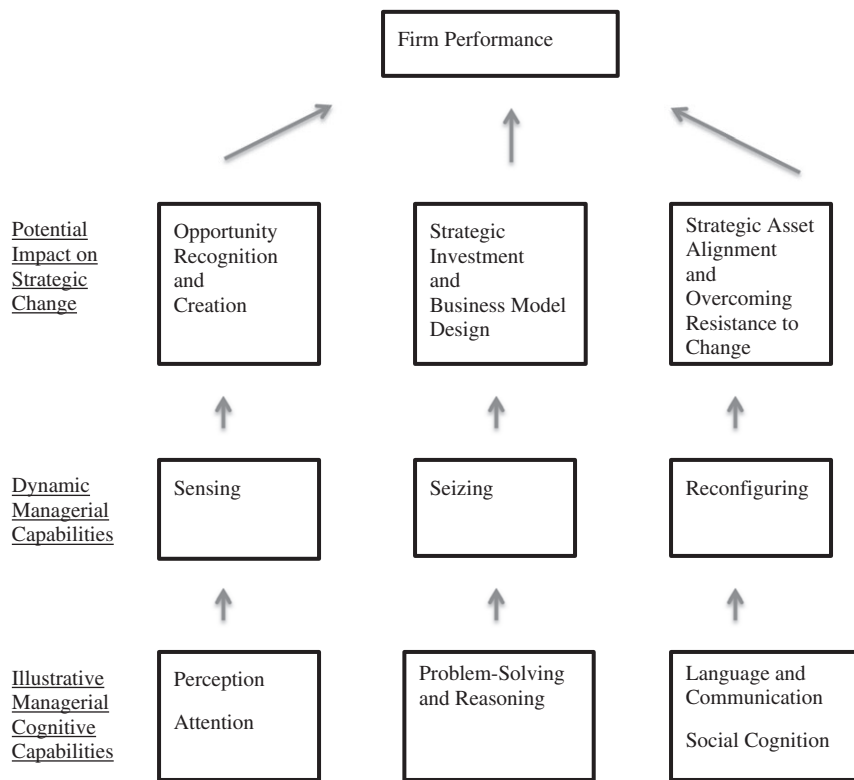


Figure 1. Managerial cognitive capabilities, dynamic managerial capabilities, and strategic change

these interrelationships here.<sup>8</sup> Figure 1 summarizes the relationships between managerial cognitive capabilities, dynamic managerial capabilities, strategic change, and firm performance analyzed below.

### The role of cognitive capabilities in sensing opportunities

*[T]he only way we could compete effectively was to take advantage of opportunities before they became obvious. Ted Turner (Turner and Burke, 2008: 161)*

Ted Turner, the founder of cable TV channels such as CNN, TNT, and TBS, is the epitome of the “entrepreneurial” manager to which Teece (2007) refers. Turner built his empire from its beginnings as a moderate-sized billboard business into

a company with global reach, under conditions of high uncertainty and complexity in the emerging cable television business.<sup>9</sup> Although Turner’s statement above may reflect some *ex post* rationalization, it encapsulates the logic that in an uncertain and complex environment, the capacity to sense opportunities before they fully materialize (Denrell, Fang, and Winter, 2003) is a critical component of dynamic capabilities and entrepreneurial activity. Environmental scanning is an important part of this, both with respect to recognizing opportunities as they arise and anticipating competitive threats (Kaplan *et al.*, 2003; Peteraf and Bergen, 2003). Entrepreneurial managers may also create new opportunities (Alvarez and Barney, 2007) through sense-making activities in an uncertain environment (Hill and Levenhagen, 1995; Weick, 1995). Because dynamic capabilities encompass creating change as

<sup>8</sup> For example, attention, which we discuss below with respect to sensing capabilities, is also required for reasoning and problem solving (Ocasio, 2011), which we discuss below with respect to seizing capabilities.

<sup>9</sup> All managers make mistakes, and Turner is hardly an exception, but his repeated successes in pioneering businesses and entering new markets produced an unusually good track record. Turner even argued against the Time Warner–AOL merger after his company became part of Time Warner. Although he was overruled by the Time Warner board at the time, he turned out to be correct.

well as reacting to it (Eisenhardt and Martin, 2000), its sensing component includes alertness and a discovery process (Gaglio and Katz, 2001; Kirzner, 1997).

These sorts of sensing activities are likely to draw on at least two cognitive capabilities—perception and attention—as next explained.

### Perception

The APA *Glossary of Psychological Terms* defines perception as the mental activities or processes “that organize information (in the sensory image) and interpret it as having been produced by properties of (objects or) events in the external (three-dimensional) world” (American Psychological Association, 2009). A closely related mental activity is that of attention, which entails the selection of relevant information. We discuss attention and its relationship to perception in the next section.<sup>10</sup>

In psychology, perception is generally distinguished from sensation, which refers to the subjective experience or feeling that occurs when sensory receptors are activated. Gazzaniga, Heatherton, and Halpern (2010: 180) note that “whereas the essence of sensation is detection, the essence of perception is the construction of useful and meaningful information about a particular environment.” Perception involves a range of mental functions, including those related to pattern recognition (Basic Behavioral Task Force of the NAMHC, 1996) and interpretation of data (American Psychological Association, 2009).

Prior knowledge, expectation, and belief guide perceptual mental activity. A summary report of the Basic Behavioral Task Force of the NAMHC (1996: 133) states that the human brain combines perceptual data from the environment with “knowledge, beliefs, and expectations to make reasonably informed guesses” about what is present in the environment. The report goes on to state that, with regard to pattern recognition, experts differ from novices (those without specialized knowledge or experience) “largely in terms of how many patterns they can recognize quickly and respond to appropriately” (Basic Behavioral Task Force of the NAMHC, 1996: 133).

In a classic study of pattern recognition by experts versus novices, Chase and Simon (1973a: 57) asked chess players to perform a “perception task” that required reconstruction of a chess position displayed in full view of the players. The study found that stronger chess players perceived larger chunks—“familiar or meaningful constellations of pieces that are already structured ... in long-term memory” (Chase and Simon, 1973b: 217)—enabling more rapid pattern recognition. As Chase and Simon (1973a: 56) noted, this rapid pattern recognition relies on automatic mental processing “amassed through years of constant practice.” Subsequent studies have replicated this phenomenon not only in chess, but also in other applications such as games of bridge and electronics (Ericsson, 2006: 59).

These studies suggest that, although subjective prior beliefs may distort perceptions, particularly when information is ambiguous (Powell, Lovallo, and Caringal, 2006), context-specific knowledge and experience in pattern recognition may provide a mitigating factor. In addition, the fact that knowledge gained from prior experience shapes the perception of new experiences suggests path dependency: prior experiences shape new perceptions, which then become part of the experience base for subsequent perceptual activity.

The cognitive capability of perception affects the sensing of opportunities in multiple ways. Recognizing emerging patterns in the environment, for example, is essential for sensing opportunities (Baron, 2006). Interpreting these data correctly is critical as well, both for accurate opportunity recognition and for opportunity creation that depends on feedback from the environment as entrepreneurs enact new business ideas. Quick recognition or creation of new opportunities also matters, particularly if firms can obtain long-term advantages from early entry into a market (Lieberman and Montgomery, 1988). In similar fashion, pattern recognition can also facilitate early recognition of environmental threats and enable more effective and timely responses.

### Attention

The APA glossary defines attention as “a state of focused awareness on a subset of available perceptual information” (American Psychological Association, 2009). Attention is critical for perception. Attention determines which stimuli are recognized

<sup>10</sup> In his highly cited article, Ocasio (1997) uses the term “attention” to include both of what we refer to here as “attention” and “perception.”

and identified, through the act of focusing on particular information (Kosslyn and Rosenberg, 2006).

Posner and Petersen (1990: 26) point to “three major functions that have been prominent in cognitive accounts of attention ... (a) orienting to sensory events, (b) detecting signals for focal (conscious) processing, and (c) maintaining a vigilant or alert state.” To some extent, the brain can attend to information contained in sensory stimuli through automatic mental activities. Automatic mental processes help to conserve the use of the brain’s limited capacity for attention (see Weber and Johnson, 2009: 56–57). For example, a phenomenon called “pop-out” occurs when a stimulus differs sufficiently from the ones around it that it grabs our attention automatically (Kosslyn and Rosenberg, 2006: 157). In contrast, during active search for a particular characteristic, object, or event, the brain relies on controlled processing to focus attention (Posner and Fernandez-Duque, 1999). Posner and Petersen (1990) have proposed the existence of an “executive attentional system” that may play a role in orchestrating various parts of an attentional system within the brain (Rueda, Posner, and Rothbart, 2005).

Practice and training can improve capabilities for attention, providing a source of path dependence. For example, Rueda *et al.* (2005) cite a number of studies showing that training programs have improved performance of specific executive attention tasks in brain-injured patients, attentional abilities in children with attention deficit hyperactivity disorder, and visual attention tasks in adults.

Sensing opportunities and threats in an uncertain, complex, and often fast-paced environment calls for acute cognitive capabilities with respect to attention. By focusing on relevant stimuli, attention can facilitate environmental scanning. In addition, the alertness component of attention can facilitate the detection and creation of new opportunities, while the orienting capacity turns attention to relevant information. In these ways, the cognitive capability of attention provides an underpinning for dynamic managerial sensing capabilities.

### *Heterogeneity of cognitive capabilities for sensing opportunities*

Research suggests that cognitive capabilities for attention and perception are distributed heterogeneously across individuals. Posner and Rothbart (2007: 9) state with reference to studies of attention

that “it is clear that normal individuals differ in their ability to attend to sensory events, and it is even clearer that they differ in their ability to concentrate for long periods on internal trains of thought.” The phenomenon of “inattention blindness”—which refers to the failure to attend to an event that occurs during the performance of another task—provides one example of heterogeneity in attention. In a classic experiment, Simons and Chabris (1999) found that only 33 percent of people noticed a gorilla walking across a basketball court while viewing a film of a basketball game. Individuals also differ in the performance of other types of tasks requiring divided attention (see, e.g., Han and Humphreys, 2002, and Rodriguez, Valdes-Sosa, and Freiwald, 2002). In addition, individuals differ in how well they filter out irrelevant information. For example, individuals differ in their performance on a Stroop test, in which a person is asked to name the colors of printed words, where the word for a color (e.g., “blue”) differs from the ink color in which the word is printed (Stroop, 1935).

The capacity for perception also varies across individuals. As noted previously, experts can perceive information within the domain of their expertise more accurately and quickly than non-experts. Perception varies along other dimensions as well. For example, in a study by Stanislaw and Todorov (1999), individuals varied in their “response bias” (a general tendency) in reporting perception of an ambiguous signal.<sup>11</sup> Moreover, because perception depends in part on attention, heterogeneity in attention contributes to heterogeneity in perception. In addition, heterogeneity in both perception and attention is likely to be reinforced by the path-dependent nature of these capabilities noted above; not only may differing prior experiences lead to heterogeneity among individuals in the capacity to perform these mental processes, but also this heterogeneity may be associated with differences among individuals in the reliance on automatic versus controlled mental processes.

Differences between managers in the cognitive capability of attention can affect which managers more accurately sense new opportunities and threats. Eggers and Kaplan (2009), for example, found that firms whose top managers paid greater

<sup>11</sup> A positive bias to report perception of a signal leads to a greater number of correctly identified signals as well as a greater number of false alarms; a negative bias causes individuals to miss relevant information more frequently.

attention to emerging telecommunications technology were more likely to correctly and quickly identify the promise of this market. Differences in the cognitive capability of perception can further affect whether or not managers correctly recognize patterns in the external environment, and interpret this information correctly. In addition, since practice can improve cognitive capabilities, managers that regularly attend to and perceive opportunities and threats in the environment may improve their ability to do so in the future. Such path-dependent heterogeneity in managerial cognitive capabilities and their associated sensing capabilities in turn may contribute to heterogeneity in long-term organizational performance, due to the potential for early mover advantages from superior sensing of new opportunities and emerging threats.

### The role of cognitive capabilities in seizing opportunities

*If we had enough cash [for CNN] to get on the air and could somehow get through our first year of operation, people would see that this was a viable and valuable service. Once the concept was proven, we would have easier access to capital. Even in the worst case, I figured that if we ran out of money after launching the channel and getting some distribution, we would have created a valuable asset that we could sell to a competitor. The key was to get started. Ted Turner (Turner and Burke, 2008:183)*

A second arena in which cognitive capabilities provide a foundation for dynamic managerial capabilities is with respect to seizing opportunities and responding to emerging threats. This can entail making large and sometimes irreversible investments in tangible and intangible assets. Strategic investments often require that senior management commit substantial funds and organizational effort under conditions of complexity and uncertainty. Maritan (2001), for example, has documented the critical role of senior management in making investments to develop new capabilities in an organization. In addition, seizing an opportunity may require design of a business model for a new venture (Teece, 2007). As we next explain, cognitive capabilities for problem solving and reasoning are likely to underpin business model design as well as the capacity for making sound strategic investments.

### Problem solving and reasoning

The APA glossary defines “problem solving” as “thinking that is directed toward solving specific problems and that moves from an initial state to a goal state by means of mental operations” (American Psychological Association, 2009). Similarly, Gazzaniga *et al.* (2010) define problem solving as “finding a way around an obstacle to reach a goal,” where an obstacle denotes a problem. Reasoning refers to “evaluating information, arguments, and beliefs to draw a conclusion” or “using information to determine if a conclusion is valid or reasonable” (Gazzaniga *et al.*, 2010: 342). The Oxford *Dictionary of Psychology* (Colman, 2006) provides a somewhat narrower definition of “reasoning” as mental activities “directed at finding solutions to problems by applying formal rules of logic or some other rational procedure” (Colman, 2006). Given the close relationship between problem solving and reasoning, we discuss them together.

Controlled mental processing comes into play in the application of formal rules of logic or other rational approaches to solving problems, and is associated with factors such as “fluid intelligence” and “rational thinking dispositions” (also termed “cognitive styles”) (Stanovich, 2009: 28–40). Fluid intelligence relies on short-term (working) memory, and “involves the ability to reason without relying heavily on previously learned knowledge or procedures” (Kosslyn and Rosenberg, 2006: 387). In contrast, thinking dispositions have to do with a person’s “cognitive propensities,” such as tendencies to “think extensively about a problem before responding ... calibrate the strength of one’s opinion according to the amount of evidence available ... think about future consequences before taking action ... [and] explicitly weigh pluses and minuses of a situation” (Stanovich, 2009: 31–32). These factors are involved in the ability to regulate our thinking and to override automatic responses (Stanovich, 2009: 32).

In addition to reliance on controlled processing, problem solving may utilize more automatic “heuristic processing,” “designed to get you into the right ballpark when solving a problem or making a decision” (Stanovich, 2009: 23). Rather than rely on extensive analysis of multiple possibilities, this approach relies on short cuts such as guessing at a solution and working backwards (Kosslyn and Rosenberg, 2006: 358). The brain may rely on heuristics in working through ill-defined problems

(Kosslyn and Rosenberg, 2006: 358) or in solving some well-defined but complex problems such as those encountered in chess (Kosslyn and Rosenberg, 2006: 364).

Frederick (2005: 26) has proposed a “cognitive reflection test” to measure the extent to which an individual uses automatic versus controlled processing in decision making. Using this test, Frederick (2005: 30–31, 33) found that individuals who relied more heavily on controlled mental processing (i.e., demonstrated greater cognitive reflection) were more willing to defer monetary rewards when doing so provided a substantially larger gain and were less subject to biases with regard to risk taking for gains versus losses. These results suggest the benefits of controlled mental processing in counteracting potential biases in decision making (for a comprehensive review of such biases, see Kahneman, 2011). In a different study, however, Payne, Bettman, and Johnson (1988: 539, 542–543) investigated decision making when individuals faced time constraints and had to choose the highest valued outcome among sets of monetary rewards with different probabilities of occurrence. They found that some heuristics led to outcomes that were as or more accurate than those obtained using controlled mental processing in the same situation, while requiring substantially less mental effort (Payne *et al.*, 1988: 539–540, 546). These results suggest that the efficacy of automatic versus controlled processing in problem solving may depend in part on characteristics of the situation such as time pressure.<sup>12</sup>

Decisions to seize opportunities through strategic investments likely call for reasoning and problem-solving capabilities in order to develop investment options and assess their profit potential. Business model design may also call for problem-solving capabilities, in that successful business models have an underlying logic to them (Zott and Amit, 2007). Successful design and execution of business models requires that various

elements of the design fit together, involving strategic fit and complementarities among activities (Peteraf and Reed, 2007; Porter, 1996). Here again, a cognitive capability for problem solving may aid managers in fitting together the numerous features of a business model. The reasoning capacity of fluid intelligence can aid problem solving related to both strategic investments and business model design. Thinking dispositions that foster careful consideration of alternative options may aid seizing of opportunities as well. Moreover, although the use of controlled mental processing may help managers to guard against cognitive biases in evaluating investment options, heuristics may prove particularly effective in some situations, such as when managers face stringent time pressures to make decisions or when problems are complex or ill-defined.

#### *Heterogeneity of cognitive capabilities for seizing opportunities*

The effectiveness of managers in seizing opportunities depends in part on the effectiveness of their underlying cognitive capabilities. Like other cognitive capabilities, problem solving and reasoning are heterogeneous, particularly with respect to the thought processes involved. In a review of psychometric assessment tests, Athanasiou (2000) documented heterogeneity among individuals in measurements of fluid intelligence. Thinking dispositions also appear to exhibit performance heterogeneity. For example, Stanovich and West (1997) found that differences in the ability to avoid bias in evaluating the quality of an argument, an essential aspect of critical thought, can be predicted by thinking dispositions even after statistically controlling for intelligence. In related work, Frederick (2005: 28–29) found substantial heterogeneity in the reliance on controlled versus automatic processing.<sup>13</sup>

Managers with superior reasoning and problem-solving capabilities are likely to have greater potential to design more effective business models, and to make more astute investment decisions. Business models are difficult to alter once implemented; many investment decisions are difficult to reverse as well. As a result, managerial decisions that entail

<sup>12</sup> Payne *et al.* (1988: 550) also found that individual decision makers adapted the heuristics that they used as the task and context changed, and argued the individuals “will choose strategies that are relatively efficient in terms of effort and accuracy as task and context demands are varied.” In contrast, Frederick’s (2005) study did not vary the context and time constraints under which an individual made decisions. Other scholars have argued that in most situations the use of heuristics produces outcomes as accurate as those produced by controlled mental processes (see, e.g., Gigerenzer, 2007), but this is a subject of much dispute (see, e.g., Kahneman, 2011).

<sup>13</sup> Frederick’s (2005) sample included students from a variety of colleges. He argued that a more diverse sample of the population would likely reveal even greater heterogeneity.

commitments to investments and business models may have repercussions for long-term organizational performance (Ghemawat, 1991). Thus, heterogeneity in cognitive capabilities for reasoning and problem solving may lead to heterogeneity in long-lived investments and business models, which in turn may lead to persistent performance differentials between organizations.

### The role of cognitive capabilities in reconfiguring and orchestrating assets

*I was learning very quickly that in television it was better to be big than to be small. The business was a lot like Monopoly, and to be the winner you had to own multiple properties around the board. Ted Turner (Turner and Burke, 2008:233)*

Sensing and seizing new opportunities, if successful, can lead to firm growth and profitability. The third leg of the dynamic capabilities triad involves sustaining that growth and profitability, by enhancing, combining, and reconfiguring the firm's organizational assets—its resources and capabilities. Teece's (2007) discussion of this third leg, which he refers to using the short-hand term "reconfiguration," focuses heavily on organizational level phenomena. The role of executive management, however, is no less important, as Helfat *et al.* (2007) make clear in their discussion of "asset orchestration" by top executives.

Asset orchestration refers to the selection, configuration, alignment, and modification of tangible and intangible assets (Helfat *et al.*, 2007). Adaptation to change in the external environment often requires the enhancement or alteration of strategic assets through innovation and organizational learning (Zollo and Winter, 2002), as well as acquisition of new assets (Capron and Mitchell, 2009). In addition, adaptation of strategic assets throughout an organization entails integration, recombination, and reconfiguration of these assets (Helfat *et al.*, 2007). This coordinated adaptation is necessary in order to maintain strategic fit among organizational assets as conditions change, which may be a factor in sustaining competitive advantage (Peteraf and Reed, 2007; Zajac, Kraatz, and Bresser, 2000).

Coordinated adaptation of strategic assets involves managerial choice and action (Child, 1972; Whittington, 1992). It is difficult to envision

company-wide coordination of adaptive changes in strategic assets without some involvement of managers at the top of the organization. Moreover, as strategic adaptation proceeds, top managers may need to play a role in overcoming organizational resistance to change. Resistance to change is a well-known management problem that can come from a variety of quarters, including rigid cognitive frames within the organization (Barr *et al.*, 1992; Kaplan and Henderson, 2005).

Coordinated adaptation of assets and overcoming resistance to change can benefit from dynamic managerial capabilities for reconfiguration. As next explained, these dynamic capabilities are likely to depend on managers' cognitive capabilities for language and communication, and on social cognitive capabilities.

### Language and communication

There is no universally accepted definition of "language" in psychology. The term is sometimes used broadly to indicate "any system for representing and communicating ideas" (Kolb and Whishaw, 2009: 526). Dictionaries of psychology, however, sometimes differentiate between "language" and "non-verbal communication," and we take this approach here. The Oxford *Dictionary of Psychology* (Colman, 2006) defines "language" as "a conventional system of communicative sounds and sometimes (although not necessarily) written symbols" capable of fulfilling four specific functions: "expressing a communicator's physical, emotional, or cognitive state; issuing signals that can elicit responses from other individuals; describing a concept, idea, or external state of affairs; and commenting on a previous communication." In contrast, "nonverbal communication" is "any form of communication other than language, including paralanguage (non-verbal aspects of speech), facial expressions, communicative gaze and eye contact, kinesics (gestures and other communicative bodily movements) and proxemics (communicative use of personal space)" (Colman, 2006).

Cognitive capability in the domain of language is closely related to other cognitive capabilities. Nevertheless, based on tests, measurements, and observational studies of language skills, Carroll (1993: 145) argues that "language abilities tend to cohere, separately from other abilities." Based on a factor analysis of data from psychoeducational assessment tests and other sources, Carroll (1993, Chapter

5) provides evidence that in most cases the language domain factor is differentiated from other factors such as those associated with reasoning, memory, and perceptual speed. The domain of language encompasses a number of cognitive capabilities. Carroll (1993: 146–47) differentiates between oral language (listening and speaking) and written and printed language (reading and writing), and between language reception (listening and reading) and language production (speaking and writing). Based on a review and synthesis of research on language skills, Bialystok and Ryan (1985) argue that the extent of controlled processing in language usage varies by type of language skill. Writing, for example, appears to rely more on controlled mental processing than speaking (Bialystok and Ryan, 1985: 218).

Nonverbal behavior such as facial expressions and gestures also can convey a range of information, including that regarding opinions, values, cognitive states such as comprehension or confusion, physical states such as fatigue, and emotions (DePaulo, 1992: 205). People can use nonverbal behavior in place of verbal communication or to supplement verbal communication (DePaulo, 1992: 207). In a review of the evidence, DePaulo (1992: 207) argues that nonverbal behaviors vary along a “continuum of controllability.” That is, some nonverbal behaviors are largely automatic, whereas others have the potential for deliberate self-control (termed “self-regulation”). DePaulo (1992: 209) also points to research suggesting that, with practice, deliberate nonverbal behaviors can become automatic.

Asset reconfiguration may depend critically on the ability of entrepreneurial top executives to persuade others in their organization to undertake new initiatives. Language can be used to communicate broad, overarching goals so as to foster alignment among disparate parts of an organization (Barnard, 1938). The communication style of top managers in general, and the way in which they communicate a vision for the organization in particular, can inspire workers, encourage initiative, and drive entrepreneurial growth (Baum, Locke, and Kirkpatrick, 1998; Wesley and Mintzberg, 1989). Managerial skill in using language, such as through impromptu talks, flow of words, and articulation in conversation, may affect worker response to change initiatives. Nonverbal communication, such as through facial expressions and gestures, can further affect worker response. Moreover, the metaphorical use of language by CEOs

and entrepreneurs can facilitate strategic change within organizations and drive alignment by orienting members toward common goals (Hill and Levenhagen, 1995). Thus, drawing on research in cognitive science, Shaw, Brown, and Bromiley (1998) advise managers to hone their storytelling skills as a means of motivating and mobilizing an organization around a new strategic plan. Others have noted the importance of managerial storytelling in transferring knowledge (Swap *et al.*, 2001), driving innovation, and persuading others to follow their lead (Conger, 1998).

### *Social cognition*

Asset reconfiguration can also benefit from managerial skills in inducing cooperation among members of an organization. Achieving asset alignment under changing conditions often requires cooperative activity across the organization (Teece and Pisano, 1994). Gaining that cooperation depends upon a manager’s social skills, supported by social cognitive capabilities.

Cognitive capabilities and mental activities related to social cognition are those for “perceiving, attending to, remembering, thinking about, and making sense of the people in our social world” (Moskowitz, 2005: 3). These mental activities influence social behavior involving relationships and interactions between people (Fiske and Taylor, 1991: 369; Pennington, 2000: 2–3). Social cognition is a complex phenomenon, encompassing many types of mental activities such as attention and memory (Fiske and Taylor, 1991: Chapters 7–8), with close links to emotion and the affective system of the brain (Fiske and Taylor, 1991: Chapter 11). Based on evidence from developmental science, social psychology, and neuroscience, Decety and Sommerville (2003) argue that the processing of socially relevant information takes place in specific areas of the brain, suggesting that social cognitive capabilities perform a distinctive cognitive function. That is, mental activities involved in social cognition, such as those for attention, perception, and reasoning, appear to relate specifically to social aspects of an individual’s external environment. The mental activity of social perception, for example, has to do with impression formation (Pennington, 2000: 62).

Social cognitive capabilities appear to entail automatic as well as controlled mental processing. For example, the attribution of intentions to others

appears to be automatic (Kolb and Whishaw, 2009: 582). Bargh and Chartrand (1999: 465) note that research suggests more generally that social perception is largely automatic. In contrast, controlled processing comes into play in setting goals for social behavior and self-monitoring of progress toward attaining these goals (Moskowitz, 2005: 98–99).<sup>14</sup>

Social cognitive capability includes the capacity to understand the point of view of others, and therefore provides the potential to influence the behavior of others as well. The social cognitive capabilities of top executives may enable them to influence organizational members to promote asset reconfiguration in at least two ways. First, these capabilities may help managers to foster cooperation. Cooperation is often associated with trust among organization members; trust also may serve to lower the costs of coordination (Gulati, 1995; Zaheer and Venkatraman, 1995). The capacity of top executives to trust and foster trust is likely to depend in part on their social cognitive capabilities, since trust requires mutual understandings.<sup>15</sup>

Top executives may also utilize social cognitive capabilities when seeking to overcome organizational resistance to change. These capabilities may provide insight into how members of the organization view change, which in turn may enable top managers to provide better incentives for change or frame their communications regarding change more effectively. Social cognitive capabilities may also be important for managing power relations among members of the organization (Krackhardt, 1990), which is important for overcoming organizational inertia and barriers to change (Macmillan and Guth, 1985).

### *Heterogeneity of cognitive capabilities for reconfiguration*

Like other cognitive capabilities, those involving language and communication and social cognitive capabilities differ across individuals. Research

shows that individuals differ in the general level of language development by age, and within groups of the same age (Carroll, 1993: 146). In addition, individuals differ in their capability in specialized language skills, such as those connected with speaking, reading, or writing (Carroll, 1993: 146). Various sorts of reading disorders (e.g., dyslexia), for example, are differentially distributed in the population. Individuals also appear to differ in their non-verbal communication skills. For example, a review by DePaulo (1992: 221–224) found that individuals differ with respect to factors such as age and sex in the deliberate use of nonverbal behavior for self-presentation (to convey an image or impression of oneself)—which has social cognitive purposes as well.

Other evidence also suggests that individuals differ in their social cognitive capabilities. For example, Fletcher *et al.* (1995) have found that people differ in the speed with which they attribute mental states to others. As another example, a number of studies indicate that individuals differ in their capabilities to discern the meaning of nonverbal behavior and their sensitivity to social norms (for a summary, see Snyder, 1979). Additionally, Galinsky *et al.* (2006: 1068) found individual differences in the extent to which an individual took the knowledge and perspective of another individual into account; individuals with greater power (defined as the capacity to influence others) were less likely to take a friend's perspective rather than their own when interpreting a message (Galinsky *et al.*, 2006: 1070–1071). These results suggest the possibility that top managers who have greater checks on their ability to wield power, such as through a strong board of directors, may have greater capacity for perspective taking that in turn can facilitate persuasion.

Because cognitive capabilities for social cognition and language and communication undergird a dynamic managerial capability of asset reconfiguration, heterogeneity in these cognitive capabilities contributes to heterogeneity in the associated reconfiguration capabilities. Due to heterogeneity in language and social cognitive capabilities, top executives are likely to differ in their capacity to facilitate strategic change through communication, inducing cooperation, and reducing resistance to change. As a result, the effectiveness of asset reconfiguration is likely to differ among firms. Asset reconfigurations of the type described by Teece (2007) are also likely to be difficult to

<sup>14</sup> Bargh and Chartrand (1999: 468–469), however, argue that goals such as for impression formation can also be activated automatically, and that practice in goal formation in the same circumstances can lead to automaticity. More generally, based on an analysis of brain imaging studies related to social cognition, Lieberman (2007) argues that a number of social cognitive capabilities may involve both automatic and controlled processes.

<sup>15</sup> Brain imaging has shown that trust is associated with specific neural mechanisms and associated mental activities that enable people to assign credit or blame for shared outcomes (Tomlin *et al.*, 2006).

reverse, because they involve coordinated adaptation and change throughout the organization. This irreversibility, in combination with heterogeneity of asset reconfiguration capabilities, is likely to result in persistent performance differences across firms.

## DISCUSSION AND CONCLUSION

Our analysis of the microfoundations of dynamic capabilities has focused at the level of the individual, delving into the cognitive underpinnings of dynamic managerial capabilities. We introduced the concept of “managerial cognitive capability,” which highlights the fact that capabilities in general encompass the capacity to perform not only physical but also mental activities. For managers faced with the need to develop and implement strategic change, the latter are likely to hold particular importance.

In our analysis, we identified specific types of cognitive capabilities that underpin dynamic managerial capabilities for sensing, seizing, and reconfiguring, and explained their potential impact on strategic change of organizations. We examined the role of attention and perception in relation to sensing, the role of problem solving and reasoning in relation to seizing, and the role of language and communication as well as social cognition in relation to reconfiguring. Although we have highlighted particular cognitive capabilities associated with each type of dynamic capability, many other cognitive capabilities are involved.

These cognitive capabilities involve both automatic and controlled mental processing. Our analysis documented that both types of mental processing are likely to play an important role in all three classes of dynamic managerial capabilities. For example, the brain may use heuristics, which are invoked automatically, in solving problems under conditions of high uncertainty and complexity. Thus, Bingham, Eisenhardt, and Furr (2007) argue that in highly complex and uncertain environments, cognitive heuristics may provide superior underpinnings for dynamic capabilities at the organizational level. Controlled mental processing also plays a role in problem solving, and may help to counteract potential biases that may arise in using heuristics. In addition, both automatic and controlled processing underpin cognitive capabilities of attention and perception, as well as social cognitive capabilities and language and communication.

Our analysis also showed how heterogeneity and associated path dependence of cognitive capabilities is likely to produce heterogeneity of dynamic managerial capabilities among top executives, which in turn may lead to differential performance of organizations. Although some managers are likely to have more effective cognitive capabilities than others, this does not imply simply that some managers are smarter than others. What constitutes intelligence is an ongoing subject of debate. Moreover, other factors such as thinking dispositions are distinct from intelligence, but are particularly important for problem solving and reasoning capabilities.

In addition, individual managers may not be equally skilled at all types of mental activities. If some types of cognitive capabilities are more important for certain dynamic capabilities than for others and are heterogeneously distributed among managers, then managers with superior capabilities for sensing, for example, may not necessarily have superior capabilities for reconfiguring. Related research suggests that entrepreneurs, who are involved in sensing, and managers of mature enterprises, who may need to undertake reconfiguring, differ in their cognition (specifically, their decision-making heuristics and biases) (e.g., Barney and Busenitz, 1997). Our analysis suggests that it would also be useful to investigate how cognitive capabilities contribute to heterogeneity of dynamic managerial capabilities in different types of firms.

With respect to dynamic managerial capabilities for seizing and reconfiguring in particular, we have emphasized ways in which top management can shape aspects of the organizational context, such as by encouraging cooperation, lowering resistance to change, designing a business model for a new venture, and investing in new skills and assets. This suggests that managerial cognitive capabilities may function as mediators of the relationship between changes in organizational context and strategic change, which in turn can affect firm performance.<sup>16</sup> Although we can point to prominent examples of CEOs that have successfully reshaped their organizations, such as Lou Gerstner at IBM (Harrell, O'Reilly, and Tushman, 2007) and Steve Jobs at Apple (Isaacson, 2011), other CEOs have had less success—such as the parade of CEOs at Kodak that culminated in the company's recent

<sup>16</sup> We thank Rahul Kapoor for suggesting that cognitive capabilities may serve as mediators in this way.

declaration of bankruptcy. This sad ending to an iconic company raises the question of whether the CEOs at Kodak lacked the necessary cognitive and other dynamic managerial capabilities, or whether the organizational context would have bedeviled even the most skilled CEO. That is, even executives with superior cognitive capabilities may face limits to what they can accomplish in some settings. Such limits might arise from disagreements between entrenched political coalitions within a company, rigid organizational identity, or insufficient financial resources, to name but a few possibilities. Obtaining a better understanding of the limits that some organizational contexts may place on dynamic managerial capabilities, and the sources of these limits, would be a fruitful endeavor.

Our analysis also suggests empirically testable propositions. For example, firms that have CEOs with superior cognitive capabilities for sensing and seizing may be more likely to obtain early mover advantages. CEOs that pay more attention to, and more accurately perceive, emerging shifts in technology and customer demand are more likely to sense new opportunities, and therefore may move more quickly. In seizing new opportunities, CEOs that have superior problem-solving and reasoning capabilities are likely to make more astute investments and design better business models, increasing the probability that their firms can obtain longer-lived advantages from moving early. Additionally, when conditions change sufficiently to warrant reconfiguration of strategic assets, firms may accomplish these reconfigurations more quickly and with less disruption when CEOs have superior language and communication and social cognitive capabilities.

We have focused on the cognitive capabilities of the individual at the top of an organization. Other individuals can and do affect strategic change in organizations, including members of the top management team, business unit general managers (Martin, 2011), and middle managers (Maritan, 2001; Taylor and Helfat, 2009). Analyzing the cognitive capabilities of managers below the top executive level would further enrich our understanding of strategic change. For example, in a study of dynamic managerial capabilities at the general manager level in multibusiness software companies, Martin (2011) documented that these managers worked episodically as teams to sense and seize opportunities, but did not investigate the role of cognition. Additionally, in an analysis of

IBM's transition to mainframe computing, Taylor and Helfat (2009) documented ways in which groups of middle managers helped to transform shared organizational cognition (i.e., shared understandings). Repeated communication with others in the organization, an aspect of cognitive capabilities for reconfiguration, was critical in promoting this shift—suggesting that explicit consideration of cognitive capabilities at the middle manager level could yield additional insights regarding the process of strategic change.

We also know relatively little about how the interaction of cognitive capabilities of individuals in the top management team affects team decision making, particularly with regard to strategic change. Research has often used demographic diversity of top management teams as a proxy for cognitive diversity, and has produced mixed results regarding the impact of such diversity on organizational performance (Finkelstein *et al.*, 2009: 132).<sup>17</sup> Future research could investigate whether diversity of managerial cognitive capabilities within a team helps or hinders strategic change. More generally, investigation of managerial cognitive capabilities and their impact within and across different levels of the organization, as well as investigation of the limits that organizational context may place on the impact of managerial cognitive capabilities, may lead to a richer and deeper understanding of dynamic capabilities and strategic change.

Finally, our analysis suggests an opportunity for research on the relationship between dynamic managerial capabilities and organizational dynamic capabilities, and their joint contributions to strategic change and organizational performance. For example, dynamic managerial capabilities and the underlying managerial cognitive capabilities may help to create, extend, or modify organizational capabilities (including dynamic ones) that in turn affect organizational performance. In addition, organizational dynamic capabilities and their underlying routines may involve managerial input and decisions (e.g., choice of research and development projects), such that dynamic managerial capabilities and their associated cognitive capabilities become intertwined with dynamic

<sup>17</sup> Miller, Burke, and Glick (1998) directly measure diversity of managerial beliefs, rather than using demographic diversity, and find a negative effect of belief diversity on the comprehensiveness and extensiveness of top management team strategic decision processes.

organizational capabilities. Untangling the relationships between managerial and organizational capabilities both theoretically and empirically remains a largely unexplored but important terrain for future research.

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