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## Cognition and Capabilities: A Multi-Level Perspective

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# Cognition and Capabilities:
## A Multi-Level Perspective

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### Abstract

Research on managerial cognition and on organizational capabilities has essentially developed in two parallel tracks. We know much from the resource-based view about the relationship between capabilities and organizational performance. Separately, managerial cognition scholars have shown how interpretations of the environment shape organizational responses. Only recently have scholars begun to link the two sets of insights. These new links suggest that routines and capabilities are based in particular understandings about how things should be done, that the value of these capabilities is subject to interpretation, and that even the presence of capabilities may be useless without managerial interpretations of their match to the environment. This review organizes these emerging insights in a multi-level cognitive model of capability development and deployment. The model focuses on the

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recursive processes of constructing routines (capability building blocks), assembling routines into capabilities, and matching capabilities to perceived opportunities. To date, scholars have focused most attention on the organizational-level process of matching. Emerging research on the microfoundations of routines contributes to the micro-level of analysis. The lack of research on capability assembly leaves the field without a bridge connecting the macro and micro levels. The model offers suggestions for research directions to address these challenges.

## Introduction

Research on the impact of organizational capabilities on firm performance has been a centerpiece of strategic management theory in the 1990s and 2000s. But through much of this research, the role of managers has been conspicuously absent from the conversation (see such seminal work as Barney, 1991; Collis, 1994). This has begun to change. Adner and Helfat (2003) and King and Tucci (2002) have more recently argued that capabilities (and resources) must be properly utilized by managers in order to be effective at driving firm performance. Similarly, in Teece's evolving discussion of dynamic capabilities, the focus is particularly organizational in the early articles (Teece & Pisano, 1994; Teece, Pisano, & Shuen, 1997) and decidedly more managerial later on (Augier & Teece, 2009; Teece, 2007).

Recognizing that strategies for the deployment of capabilities are conceived of and implemented by managers, researchers have begun to devote more attention to the cognition of managers and the interpretive processes in which they engage (Benner & Tripsas, 2012; Eggers & Kaplan, 2009; Gavetti, 2005; Kunc & Morecroft, 2010). Their initial insights suggest that managerial cognition plays a central role in capability development and deployment. While these studies are intriguing, they remain fragmented. We sense that they are examining different parts of the elephant without an appreciation of the whole animal. This article seeks to draw together the different bits and pieces in order to provide a sketch of the elephant. In doing so, we offer a detailed review, a dynamic model, and a roadmap for future research on the interconnections between cognition and capabilities.

### Intellectual History of Cognition and Capabilities

Starting with Lawrence and Lorsch's (1967) seminal work on organizations' responses to their environments and Learned, Christensen, Andrews, and Guth's (1965) introduction of the SWOT (strengths, weaknesses, opportunities, and threats) framework, research in strategic management focused primarily on the match that organizations made with exogenously given parameters established by the environment in which they operated.

Since that time, two streams of research emerged—one examining organizational capabilities and the other managerial cognition. The capabilities approach (and the resource-based view) problematized the organization by showing that heterogeneous capability endowments across organizations could lead to differential performance even in the same environment (Barney, 1991; Henderson & Clark, 1990; Henderson & Cockburn, 1994; Nelson & Winter, 1982; Prahalad & Hamel, 1990; Wernerfelt, 1984). Managerial cognition scholars problematized the environment by suggesting that it is not purely exogenous; instead, managerial interpretations of the environment shape how organizations respond to it (Barr, Stimpert, & Huff, 1992; Daft & Weick, 1984; Lant, Milliken, & Batra, 1992; Ocasio, 1997; Porac, Thomas, & Baden-Fuller, 1989; Reger & Palmer, 1996).

Both of these approaches—capabilities and cognition—were useful correctives to the then-prevailing assumptions in strategic management. And, they each spawned tremendously rich streams of research that continue to this day. However, they have essentially developed along parallel but separate paths (Laamanen & Wallin, 2009).[1] That is, the cognition scholars have for the most part foregrounded managerial interpretations of the environment while black boxing or at least backgrounding the routines, skills and capabilities of the organization. And, the capabilities scholars have focused on capabilities as a source of inertia or adaptation to the environment without considering how the interpretation of the possibilities presented by the environment might matter for outcomes.

It is only recently that scholars have begun to link the two sets of insights. This has come primarily in the form of studies that examine organizational response to change in the operating environment. These studies highlight, for example, how the match between capabilities and the market cannot be made if managerial beliefs are not aligned with the opportunity (Eggers & Kaplan, 2009; Tripsas & Gavetti, 2000) or how forward-looking managerial attention to new opportunities can even compensate for a lack of needed capabilities in spurring the organization to take action (Gavetti, 2005). While most of the work has focused on the match made between the organization and its environment, other research has shifted the focus to the microfoundations of capabilities in order to shed light on how they are developed. Here, scholars have suggested that routines and capabilities emerge from particular understandings about how things should be done (Coriat & Dosi, 1998; Kaplan & Henderson, 2005) and that the nature and usefulness of these capabilities is subject to interpretation over time (Danneels, 2011).

### A Plan for this Study

To reflect on these recent developments and build a tighter link between research on capabilities and that on cognition, this paper explores the possible

interconnections at various levels of analysis—from routines to capabilities to organizations.[2] It blends previously unconnected or only partially connected literatures that together shed light on important questions about how cognition and capabilities are reciprocally intertwined.

The literature points to three processes by which cognition and capabilities recursively interact. First, the process of "construction" addresses the ways in which cognition is implicated in the development and maintenance of routines, which are the building blocks of capabilities. Second, the process of "assembly" addresses how these building blocks are assembled based on managerial interpretations of the potential value of the resulting capabilities. Third, the process of "matching" addresses how choices about the application of capabilities to the environment are shaped by managers' interpretations of the match between them. A variety of literatures offers glimpses into these three processes and, collectively suggest a model of capability development and deployment that considers the role of cognition across the levels of routines, capabilities, and organizations.

This review first discusses why incorporating cognition should be valuable in updating a basic model of capability development and deployment. The review then analyzes existing studies that inform each of the three cognitive processes that generate a more complete model of the relationship between capabilities and performance, and reflects on the recursive links that identify the interdependencies in these processes. The model helps classify the literature into meaningful categories and also identify gaps and open questions that should be useful in guiding future research.

## Cognition and Capabilities: A Baseline Model

A central argument of many streams within strategic management is that capabilities and resources are built through experience, and that these capabilities and resources in turn drive organizational performance. The latter is the central contribution of the resource-based view of the firm, which views heterogeneity in organizational resources as an explanatory factor for heterogeneity in performance (Barney, 1991; Wernerfelt, 1984). The concept that these capabilities and resources are accumulated through experience builds on concurrent work in organizational learning (Argote, Beckman, & Epple, 1990) and asset accumulation (Dierickx & Cool, 1989). From an empirical perspective, experience-based measurements are often used as a proxy for the resources and capabilities possessed by the organization (Klepper & Simons, 2000; Zollo, Reuer, & Singh, 2002). A few studies (exemplified by King & Tucci, 2002) highlight that the managerial choice of a strategy moderates the link between capabilities and performance, but in the majority of studies managerial choice is not explicitly modeled or measured. Managers are seen as seamless and rational conduits in the deployment of capabilities. The implied model
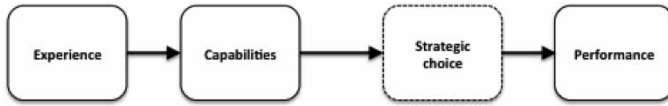
Figure 1    Capabilities and Performance—The Standard Model.

of capability development and deployment therefore looks like Figure 1—organizations accumulate experience that leads to the creation of capabilities, and those capabilities are deployed (implicitly through managerial choices) to generate organizational outcomes.

Yet, such a model connecting experience to organizational performance makes three assumptions that elide important processes. The first assumption is that the origins and emergence of capabilities are unproblematic—experience consistently and predictably leads to capability development. Organizational capabilities are seen as given from initial endowments of the organization, are fixed at any one point in time, and evolve based on a path dependent process of local search (Barney, 1991; Peteraf, 1993; Wernerfelt, 1984).

A return to the original evolutionary theories that inform the resource-based view (Nelson & Winter, 1982; and, more recently, Winter, 2000; Zollo & Winter, 2002) emphasizes the cognitive underpinnings of capabilities. These theories conceptualize routines as building blocks of capabilities and the source of routines as organizational "truces" around understandings of how things are done and what motivates people to act (Cohendet & Llerena, 2003; Coriat & Dosi, 1998; Kaplan & Henderson, 2005; Zbaracki & Bergen, 2010). This literature proposes that routines (capability building blocks) emerge through a collective process of developing beliefs about what is in peoples' interests and what activities should be done. Thus, an understanding of the cognitive aspects affecting the translation of experience into routines that are ultimately assembled into capabilities would improve the model of capability development and deployment. Therefore, *constructing* routines is the first additional process that is useful to update Figure 1.

Second, the model represented in Figure 1 assumes that managers are fully aware of their organization's existing and potential capabilities. In reality, however, we know very little about how managers understand what the organization is capable of and how the capability building blocks are assembled into capabilities to be deployed in particular contexts. Evolutionary theories are silent about how these building blocks are transformed into capabilities (Abell, Felin, & Foss, 2008), but an implication of the idea of routines as building blocks is that "some assembly is required". Research suggests that cognition could play a role in the assessment and assembly of capabilities through two potential paths. One comes from a signal-plus-noise perspective (Swets & Pickett, 1982) in which the organization possesses underlying capabilities

that could be used to create value, but managers develop only noisy perceptions of those capabilities. These perceptions are subject to classic biases of interpretation (Garbuio, King, & Lovallo, 2011). By this logic, the "best" managers would be the ones with the most accurate mental representations of their organization's capabilities. As Alchian and Demsetz (1972, p. 793) state, "efficient production with heterogeneous resources is a result not of having better resources but in knowing more accurately the relative productive performances of those resources".

An alternate view emerges from Helfat and Winter's (2011, p. 1244) definition of a capability as having a "specific and intended purpose": as an example, "the capability to 'manufacture a car' has the specific and intended purpose to produce a functioning automobile" (see also Amit & Schoemaker, 1993; Dosi, Nelson, & Winter, 2001; Helfat et al., 2007; Winter, 2003). In this case, the development of an understanding or interpretation of that purpose must be central to the assembly of the capability. This argument implies that "capabilities" exist in part as managers interpret them (Daft & Weick, 1984; Weick, 1969). Until there is an interpretation of a capability's purpose, the organization possesses only a set of routines, knowledge, and assets and not capabilities per se. Cognition is a mechanism by which routines are transformed into capabilities. By this logic, there is no difference between the organization's capabilities and the manager's interpretations of those capabilities. Under either assumption—signal-plus-noise or intended purpose—an articulation of capability *assembly* is a second process needed to update Figure 1. This would provide a better understanding of how cognition affects the assembly of capabilities from the building blocks of routines.

The third assumption in the basic model of capability development and deployment is that the path from capabilities to performance is unproblematic. As Barney and Arikan (2001, p. 174) state, "resource-based theory has a very simple view about how resources are connected to the strategies that a firm pursues". The matching between capabilities and the opportunities created by the environment is often seen as a set of implicit—though "rational" —strategic choices (King & Tucci, 2002; Klepper & Simons, 2000; Lambkin, 1988). Yet, recent work on the resource-based view points out that "what a firm does with its resources is at least as important as which resources it possesses" (Hansen, Perry, & Reese, 2004, p. 1280). The implication is that the mere possession of capabilities does not affect performance—outcomes are contingent on what managers decide to do with their organizations' capabilities.

Managers, of course, do not always make perfectly rational decisions and deploy capabilities optimally to maximize performance. Further, even if managers "rationally" deployed capabilities, this might lead to resource allocation that is ex post inadequate for the opportunity or threat at hand (Henderson, 1993). Research has shown that managers possess incomplete views of the external competitive landscape (Porac et al., 1989) and are subject to a
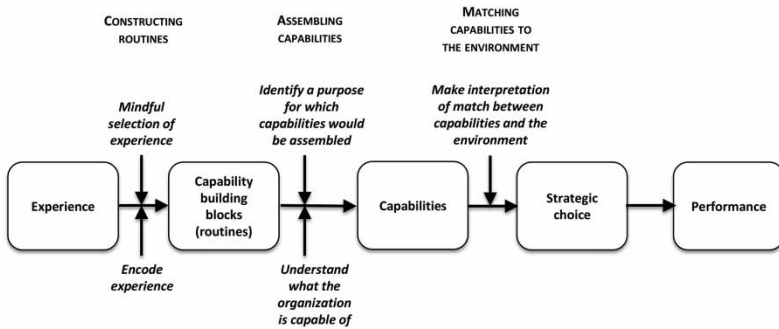
Figure 2    Cognition and Capabilities—A Linear Model.

number of biases that affect decision making (March, 1994; March & Shapira, 1987; Miller & Shapira, 2004). A focus on managerial choices as a process linking capabilities and performance pushes us to recognize that managerial choices will be made based on the opportunities created in the environment only as perceived by organizational participants. Thus, *matching* (when managers assess matches between perceived capabilities and perceived opportunities) is the third process needed to update Figure 1.

   This study seeks to uncover and investigate these hidden assumptions underpinning Figure 1, and builds from existing work to explore what we currently know or need to know about these three processes that implicate cognition in the relationship between capabilities and performance. The articulation of these three processes—constructing, assembling, and matching—helps us to develop a revised model that both sheds light on these typically implicit or ignored cognitive processes and serves as roadmap for a review of the literature. This revised model (Figure 2) provides a first revision to the standard model of the capability–performance relationship. It is important to note that Figure 2 as drawn here is linear, suggesting that experience flows through to performance in one direction only. This, of course, is also an oversimplification that will be corrected after reviewing the literature and identifying the core recursive processes that further complicate this model.

## Constructing Capability Building Blocks: The Microfoundations of Routines

How do capabilities emerge? The literature in strategic management has suggested that prior experience forms the basis of organizational capabilities (Helfat & Lieberman, 2002). The "pre-histories" of organizations create potential capabilities that can be leveraged in new sets of activities (such as entry into new markets) (Eggers, 2012a; Holbrook, Cohen, Hounshell, & Klepper, 2000; King & Tucci, 2002; Klepper & Simons, 2000). Even startups possess historical roots through the experiences that founders and early members bring to the

organization (Burton, Sorensen, & Beckman, 2002; Gong, Baker, & Miner, 2005; Klepper, 2002; Klepper & Sleeper, 2005; Shane & Khurana, 2003). How exactly these experiences are transformed into capabilities is a more difficult question, and most proposed answers center on the concept of routines.

Routines are important because they form "the building blocks of capabilities" (Dosi et al., 2001, p. 4; see also Nelson & Winter, 1982; Teece et al., 1997; Winter, 2000). Routines are patterns of actions that constitute organizational skills: *organizational* because they require coordination and cooperation across multiple actors, and *skills* because they can be repeated reliably over time (Cohen & Bacdayan, 1994; Feldman & Pentland, 2003; Miner, 1991; Nelson & Winter, 2002; Parmigiani & Howard-Grenville, 2011). As such, routines are conceptualized as "truces" amongst the conflicting interests of these actors, which embody understandings about how things are done as well as motivations based in what actors believe to be their interests (Cohendet & Llerena, 2003; Dosi, Levinthal, & Marengo, 2003; Gibbons, 2006; Kaplan & Henderson, 2005; Nelson & Winter, 2002; Zbaracki & Bergen, 2010).

Gavetti (2005) suggests that any consideration of the encoding of routines requires attention to their cognitive microfoundations. This view suggests that human cognition plays a major role in sensing, interpreting, encoding, and retrieving prior experiences to use in the construction of organizational routines. As Kogut and Zander (1996, p. 515) argue:

> Firms differ in what they can do. Some produce cars by highly flexible production lines; others mass-produce. The capabilities to do one or the other is not the choice variable of classic decision theory. The limitations are not simply that incentives are too weak, or that people too selfish, to motivate changing capabilities. The roots of this inertia lie in the wiring of human cognition to acquire tacit procedural knowledge as the basis of interaction with other individuals.

Research at the individual level has identified procedural memory as the means by which actors form routines. In experiments, Cohen and Bacdayan (1994) found that paired players in a card game developed interlocked patterns for performing tasks (and continued to apply them even when the game changed). They argue that such procedural memory is the means for selecting and storing routines. Similarly, Chassang (2010) demonstrated that even without complete information, actors in a repeated game can learn routines to coordinate their actions simply through the accumulation of history together. Translated to the organizational level, according to Kogut and Zander (1996, p. 508), such procedural memory "provides the conceptual underpinning to understanding the generation of routines as arising out of sustained interactions". That which is retained in organizational memory can be deployed at a later time for the advantage of the organization (Garud & Nayyar, 1994; Hargadon & Sutton, 1997).

The question is, which experiences are encoded into routines for potential future use? Research on "pre-adaptive" capabilities (Cattani, 2005, p. 563) suggests that a "firm's prior experience . . . is accumulated without anticipation of subsequent uses". Similarly, from a real options perspective, organizations may develop and store routines without knowledge of their value nor their eventual deployment (Kogut & Kulatilaka, 2001; Miller, 2002). One risks assuming that the retention of routines in organizational memory is purely mechanical. However, given the plethora of experiences that organizations accumulate, and the compelling evidence of organizational "forgetting" (Argote & Epple, 1990; Engeström, Brown, Engeström, & Koistinen, 1990; Holan & Nelson, 2004), there is evidence to suggest that the selection of some experiences over others to encode into routines is not mechanical but rather a product of cognitive processes (Levitt & March, 1988).

We consider several different cognitive processes by which experiences are encoded into routines—first, processes with behavioral bases, and, second, the mindful generation and encoding of experiences (see Table 1 for a summary of the relevant research).

### Encoding Experience into Routines

Scholars have identified three behavioral mechanisms that are likely to affect the encoding of experiences into routines—the degree of success, familiarity, and regularity of experiences. First, Levitt and March (1988, p. 320) suggest that routines are based on "interpretations of the past", which for them means that actors in an organization select and adapt routines based on the perceived success of outcomes. This behavioral perspective emphasizes performance relative to aspiration levels as a source of cues that actors use to determine which experiences to encode into organizational memory. The implication is that successful experiences are more likely to be encoded than unsuccessful ones (Levinthal & March, 1993, p. 110), which is consistent with research on the difficulty of learning from failure (Baumard & Starbuck, 2005; Cannon & Edmondson, 2001; Eggers, 2012b; Shepherd et al., 2011).

Second, experiences that have links with existing routines, knowledge and capabilities are easier to encode and thus more likely to be stored. This is the premise of absorptive capacity (Cohen & Levinthal, 1990; Lewin et al., 2011; Zahra & George, 2002)—it is easier to learn new things that are similar to things already known. Cohen and Levinthal (1990, pp. 129–131) build this assertion based on the cognitive psychological insight that associative concepts facilitate learning activities. Gavetti et al. (2005) extend the idea of associative learning in explaining how analogies function to enable the recollection and reuse of past experience. Thus, experiences that are similar to existing knowledge are more likely to be encoded.

**Table 1**  Constructing Capability Building Blocks (routines)

| Topics | References | Key insights |
|---|---|---|
| Overall: cognition in microfoundations | Cohen and Bacdayan (1994), Kogut and Zander (1996); Kogut and Kulatilaka (2001), Miller (2002), Nelson and Winter (2002), Dosi et al. (2003), Cattani (2005), Gavetti (2005), Kaplan and Henderson (2005), Gibbons (2006), and Zbaracki and Bergen (2010) | Cognition plays a role in creation of routines |
| Encoding based on | | |
| . . . success | Levitt and March (1988), Levinthal and March (1993), Cannon and Edmondson (2001), Baumard and Starbuck (2005), Shepherd, Patzelt, and Wolfe (2011), and Eggers (2012b) | Successes are more likely to be encoded than failures |
| . . . similarity | Cohen and Levinthal (1990), Zahra and George (2002), Gavetti, Levinthal, and Rivkin (2005), and Lewin, Massini, and Peeters (2011) | Experiences similar to existing memories are easier to encode and retrieve |
| . . . repetition | Argote and Epple (1990), Argote (1999), Starbuck (2009), Rerup (2009), and Zollo and Reuer (2010) | Infrequent and unrepeated experiences are difficult to encode properly |
| . . . mindfulness | Helfat and Peteraf (2003), Levinthal and Rerup (2006), Gavetti and Rivkin (2007), Laamanen and Wallin (2009), Salvato (2009), and Knott, Gupta, and Hoopes (2011) | Experiences generated through mindful action are more likely to be encoded |

Third, experiences that are repeated are easier to encode and remember than rare events. The cognitive underpinnings of the learning curve suggest that repetition is an element to improvement in performance (Argote, 1999; Argote & Epple, 1990). By contrast, learning from rare or infrequent events is seen as difficult because these rare events provide uncertain (Starbuck, 2009) and difficult-to-interpret cues (Rerup, 2009). One exception to this generalization is rare events, such as the space shuttle disasters and nuclear power plant crises that have such a significant impact that managers cannot avoid

encoding learnings (Rerup, 2009; Starbuck, 2009), though they may struggle to draw useful inferences from such rare events. Thus, even if managers and organizations attempt to store and encode data from infrequent experiences, this information may be improperly encoded and rendered useless, or even harmful (Zollo & Reuer, 2010). As a result, experiences that are repeated are more likely to be encoded into routines.

### Mindfulness and the Intentional Creation of Routines

The three behavior factors affecting the encoding experience and creation of routines discussed above—success, similarity, and repetition—may occur without any conscious effort on the part of organizational participants. But there is evidence that managerial intention and volition may also have significant effects on the encoding of experience. As discussed later in this paper, managers may perceive the need for new routines to construct desired capabilities, and this process of intended routine creation may play an important role in altering the organization's stock of available routines. Salvato (2009) proposes that "mindfulness" to all sorts of cues from the internal and external organizational environment (not just performance signals) can shape how routines are formed and changed. Organizational actors "replicate past experiments by mindfully formalizing a selection of them into organizational routines" (Salvato, 2009: p. 400; see also Levinthal & Rerup, 2006). Such mindfulness suggests that managers, while having little direct control over experiences themselves, may have more control over which experiences become encoded, presumably targeting experiences that meet desired needs for the organization.

Thus, backward-looking attention to cues would appear to be complemented by forward-looking cognition in the selective encoding of experiences into routines (Gavetti & Levinthal, 2000). Actors' cognitive frames or schemata of interpretation influence their actions regarding which experiences to retain and which to discard (Gavetti & Rivkin, 2007). Laamanen and Wallin (2009, p. 965) describe this "instrumental cognition" as central to the process of capability development. Indeed, Helfat and Peteraf (2003, p. 1000) argue that having a "central objective" is the starting point for capability development. Frames shape the development of routines but as experience with these routines accumulates, the frames are refined into heuristics (Bingham, Eisenhardt, & Furr, 2007; Bingham & Haleblian, 2012), which then reciprocally shape which future experiences get incorporated into routines.

The development of routines as capability building blocks involves the interplay between actions to perform the routines and understandings of what those actions and experiences mean (Feldman & Pentland, 2003). In one study, Knott et al. (2011) identify the intentional process of modifying existing routines to perform new tasks that better suit organizational needs,

and outline this modification or "tricking" process as a means of intentionally changing the organization's routine structure. However, Pentland and Feldman (2008), in documenting failed attempts at routine creation, highlight that intentionally creating routines may be difficult at best, and impossible at worst.

At the extreme, routines and cognitive frames or schemata about routines are "coconstituted" (Rerup & Feldman, 2011, p. 578; see also Howard-Grenville, 2005), where interpretations of potential routine usage affect how managers encode new routines and alter existing ones. This co-constitution involves intentions of actors as well as performances of the routines that may lead to the retention of routines that deviate in some ways from intentions (Rerup & Feldman, 2011). That is, routines have performative and ostensive aspects where the intention shapes the performance but the improvisation of the performance may influence intention (Feldman & Pentland, 2003). Further, the degree to which mindfulness matters in encoding routines will vary by the type of routine (Becker, Lazaric, Nelson, & Winter, 2005).

The various perspectives on the microfoundations of capabilities suggest that experience is the source of organizational capability building blocks, but only as it is selected and encoded into organizational memory and then repeated in organizational routines. The process by which this happens is at least in part cognitive. That is, it involves procedural memory, attention to cues, and cognitive frames that shape the interpretations of the value and usefulness of experiences. Overall, the existing research in this area suggests that cognition—at various levels of the organization—will have a dynamic relationship with routine formation (which then affects which capabilities the organization possesses). That capability building blocks (i.e. routines) are based in cognitive processes has important implications for organizational inertia or adaptation in the face of change, as any organizational response will require the breaking and remaking of the "truces" that support organizational routines (Zbaracki & Bergen, 2010). We return to this insight in the discussion and conclusion.

## Assembling Capabilities from their Building Blocks

If routines are the building blocks of capabilities, how are they assembled? The literature is nearly silent on this process. We are missing an articulation of the connection between the micro foundations of routines and the macro-level organizational analysis of the match of capabilities to the environment. This missing link in the capabilities literature can be at least partly filled using cognitive explanations for the assembly of capabilities from their building blocks.

Helfat and Peteraf (2003) argue that the development of capabilities comes through an iterative process of trials and reflection by management. Tripsas

and Gavetti's (2000) and Laamanen and Wallin's (2009) longitudinal analyses of capability evolution are initial empirical efforts to unpack these dynamics. They show that in each of the organizations they studied, cognition affected how capabilities were built by shaping choices about what capability development actions to take. As an example, Laamanen and Wallin (2009) find that because the leaders of the software firm they studied paid most attention to client needs, they chose to develop programming capabilities and license external software to improve their offering. This set of actions in turn provoked efforts to establish a strong capability in branding that would allow them to position their increasingly standardized products in the market. At Polaroid, Tripsas and Gavetti (2000) found that attention to new technologies enabled the company to develop leading-edge skills in digital imaging, but the belief in the razor/razor blade business model meant that these skills were never combined effectively with capabilities in marketing and manufacturing to allow Polaroid to develop profitable products.

In tracing such capability development paths, these scholars powerfully demonstrate that capabilities are assembled from different sets of routines. Conversely, they also find that capabilities are not developed if assembly does not take place. Yet, they do not give us a sense for how the assembly from routines happens. Lavie's (2006) theoretical argument about capability reconfiguration highlights the role of managerial cognition in identifying the ideal capabilities given the environment in which the organization operates. From his standpoint, managerial cognition enables organizations to break apart capabilities into their constituent elements and then reconfigure them through substitution, evolution or transformation. Despite the lack of research on the assembly process itself, related clues emerge from diverse literatures. Prior studies suggests that the transformation of routines into capabilities could be supported by two interrelated sets of cognitive processes: identifying the purpose for which capabilities might be applied and making interpretations of what the organization can or might be able to do.

Helfat and Winter's (2011; see also Helfat & Peteraf, 2003) definition of a capability as having a specific purpose provides a useful anchor. An essential component of the assembly process would therefore be to identify that purpose. Seeing the identification of the purpose as somehow separate from the interpretation of what the organization can do is a potentially artificial separation of actions that occur concurrently or iteratively. Similarly, the assembly of capabilities also happens in the matching between them and the environment (the subject of the next section). However, because so little attention has been paid by scholars to the assembly process, and because the studies of "matching" have assumed capabilities to be somewhat fixed, it is worth drawing out some of the underlying processes (see Table 2 for a summary of the related literature). Given that few studies speak directly to the assembly of capabilities, this area is ripe for future research.

**Table 2**  Assembling Capabilities

| Topics | References | Key insights |
|---|---|---|
| Overall: cognition in assembly process | Helfat and Peteraf (2003) and Lavie (2006) | Cognition plays a role in the movement from routines to capabilities |
| Identifying a purpose | | |
| . . . via problem sensing | Kiesler and Sproull (1982), Lai and Grønhaug (1994), Haunschild and Sullivan (2002), and Greve (2003) | Poor performance can create awareness of a problem that needs to be addressed |
| . . . via opportunity awareness | Kirzner (1973), Shane and Venkataraman (2000), Gaglio and Katz (2001), Ardichvili, Cardozo, and Ray (2003), Baron and Ensley (2006), and Grégoire, Barr, and Shepherd (2010) | Individuals vary in their ability to perceive potentially unmet market needs that represent entrepreneurial opportunities |
| Understanding capabilities | | |
| . . . via experience | Liang, Moreland, and Argote (1995), Kogut and Zander (1996), Rulke, Zaheer, and Anderson (2000), Denrell, Arvidsson, and Zander (2004), Miner, Gong, Baker, and O'Toole (2011), Ren and Argote (2011), and Argote and Ren (2012) | Managers with greater experience with a capability have a more refined understanding of its potential (through transactive or procedural memory) |
| . . . via benchmarking competition | Greve and Taylor (2000), Greve (1998), Baum and Lant (2003), and Benner and Tripsas (2012) | Managers will imitate and benchmark themselves against firms that they view as similar and relevant to their firm |

*Identifying a Purpose*

As theorized by Helfat and Peteraf (2003), the identification of a purpose is the initial step in the capability life cycle. This is in line with Penrose's (1959/1995) foundational suggestion that capabilities (or "services" in her language) imply a designated purpose (p. 25). While the encoding of experiences into routines may occur without clear intentions, the value of introducing the idea of the "assembly" of routines into capabilities is precisely that it highlights the role of a defined purpose. Purposes typically arise because managers perceive

an organizational shortcoming or a strategic opportunity external to the organization. A substantial portion of the research on managerial cognition has focused on managers' interpretations of the environment (see Kaplan, 2011; Walsh, 1995, for reviews). The essential idea is that a manager's interpretations of the external landscape will affect how they see their own organization's abilities to respond to it (Milliken, 1987).

A good deal of this work examines whether managers see the environment as posing either threats or opportunities (Dutton & Jackson, 1987; Gilbert, 2006; Jackson & Dutton, 1988; Milliken, 1990), where perceived threats are more likely to anchor managers in their current understandings of internal capabilities (Bateman & Zeithaml, 1989; Thomas, Clark, & Gioia, 1993; Thomas & McDaniel, 1990) while perceived opportunities can relax the rigidity of routines (Gilbert, 2005). Relatedly, other scholars have shown that the direction of managerial attention (Ocasio, 1997), either toward new opportunities or instead toward existing markets or technologies, affects what capabilities are seen to be salient (Barr, 1998; Garud & Rappa, 1994; Kaplan, 2008a). This section concentrates on how managers become aware of these challenges or opportunities, and translate them into purposes that orient capability creation.

The learning literature on "problem sensing" (also called problem finding, problem identification, problem recognition, etc.) helps draw out the processes involved with identifying "threats". This research indicates that managers must be aware of a failure or gap in performance relative to aspirations in order to generate learning about the nature of a problem (Baumard & Starbuck, 2005; Cannon & Edmondson, 2001; Eggers, 2012b; Haunschild & Sullivan, 2002). Problem sensing is a starting point for creative action (Unsworth, 2001) and a central dynamic in learning and education (Hmelo-Silver, 2004). Kiesler and Sproull's (1982) model of problem sensing suggests a process by which managers attempt to infer causality behind perceived problems in order to interpret and categorize them. Further, they argue that analogical reasoning (the process of noting similarities between current problems and prior problems) is one means by which managers perceive and understand the problems they face. Their model does not, however, deal directly with how managers become aware of the existence of a problem in the first place—managers are presumed to receive negative (performance) stimuli that alert them to the existence of the problem.

Research in entrepreneurship has focused instead on opportunities (and not threats), seeking to understand how entrepreneurs identify which alternatives to pursue. Scholars have argued that the ability to find market imperfections that might lead to profitable new businesses is a core aspect of entrepreneurship (Shane & Venkataraman, 2000). This particular stream of research is useful in thinking about capability assembly because, as Klein (2008, p. 187) argues, entrepreneurship is about the "exercise of judgment over the arrangement of heterogeneous capital assets". Specifically, individuals that are more

"entrepreneurially alert" are said to have flexible schemas as the environment changes (Gaglio & Katz, 2001; Kirzner, 1973).

As articulated by Ardichvili et al. (2003), "entrepreneurial alertness" is seen as a multi-stage process: individuals first perceive an unmet market need, then discover a fit between the need and available resources, and finally create a new business concept to match the two. Individuals are heterogeneous in their abilities based on their "genetic makeup, background and experience, and/or . . . the amount and type of information they possess about a particular opportunity" (p. 110). Such alertness takes the form of pattern recognition, and the ability to recognize such patterns in the environment is a skill built through experience (Baron & Ensley, 2006). While these visions of entrepreneurial alertness are relatively passive—individuals either do or do not perceive opportunities (Shane, 2000)—they offer a starting point for an exploration of purposeful interpretive processes that the revised model of capability development and deployment would suggest are likely to be present.

Note that the theories behind opportunity identification and threat (or problem) sensing differ in their underlying assumptions. As Lai and Grønhaug (1994) suggest, problems may be seen to exist objectively, waiting to be discovered, or they can be seen to be constructed through managerial action (Agre, 1982; Nadler, 1983). Similarly most of the research on opportunities sees them as exogenously determined, though some scholars have portrayed opportunities as created through entrepreneurial action (Alvarez & Barney, 2007). Grégoire et al. (2010) offer just such a purposeful view in suggesting that awareness increases as managers build on prior knowledge to diagnose potential opportunities. In either case, the identification of the purpose for the deployment of capabilities should be central in the process by which capabilities are assembled from their building blocks. The process of identifying a purpose also provides inputs further downstream to the matching process (through the labeling and identification of a given capability) and upstream to the processes of intentional coding of new routines to fill gaps in the portfolio.

### Understanding what the Organization can do

The other cognitive aspect of capability assembly is in understanding what the building blocks are, or said differently, in finding out what the organization can do. While academics and practitioners both acknowledge the importance of managers' understanding of their organization's resources and capabilities (Danneels, 2011; Marino, 1996), it seems that doing so is not straightforward. Managers in the same organization can have very different views about the capabilities present within that organization (Birkinshaw & Arvidsson, 2004). For example, Denrell et al. (2004) found via a large scale empirical survey that the interrater reliability of respondents from the same organization

in their assessment of the organization's proficiency in "strategic" capabilities was only 0.28, suggesting significant internal disagreement about the presence of certain capabilities. This variance in perception implies that studying the differences in those interpretations is an important part of understanding how capabilities are assembled. The process by which managers recognize what the organization can do is neither straightforward nor linear—it is inherently iterative, building on feedback about efficacy and usefulness from attempts to use the capabilities being assembled.

The literature suggests two basic mechanisms by which actors learn about their own organizations' skills. The first is through their direct experience in the organization. Rulke et al. (2000) introduce the term "organizational self-knowledge" to capture the extent to which managers understand the strengths of their own organization, and show that such knowledge derives largely from direct personal interactions with people and activities within the organization. Denrell et al. (2004) found that when managers agreed about their organization's capabilities, it was in cases of the greatest familiarity with the activities and performance of the division or business unit where the capability was located. Similarly, Miner et al. (2011) argue that prior managerial experience with specific routines and capabilities increases the likelihood that they are both well understood and redeployed—consciously or unconsciously—to solve new problems.

The exact process by which direct managerial experience translates into understanding of their organization's capabilities, however, is still somewhat unclear. One potential explanation is based on transactive memory, which has been used to identify how individuals learn about the skills possessed by others, especially team members (Argote & Ren, 2012; Ren & Argote, 2011; Wegner, 1986). Transactive memory is built through interpersonal interactions and the observation of the skills and actions of other individuals (Liang et al., 1995). To the extent that the routines and knowledge that form the building blocks of capabilities reside in individuals within the organization, the transactive memory perspective may be applicable. A second perspective that may be helpful is based on procedural memory, which captures the way in which individuals build "learned skills or nondivisible cognitive operations" (Kogut & Zander, 1996). Such memory is build through sustained interaction, and represents a form of automatic, tacit knowledge about how to complete a task (Cohen & Bacdayan, 1994). Therefore, managers can come to know what an organization can do through their own experiences in executing routines. Transactive memory and procedural memory provide possible processes by which experience helps managers understand the capabilities of the organization.

Another mechanism for understanding capabilities is through comparison with other organizations (often, competitors). "Benchmarking" is a well-known procedure through which managers can interpret their own organizations strengths and weaknesses (Drew, 1997). Managerial cognition research points out that the selection of those competitors is itself an interpretive

process, where the relevant competitive strategic groups should be understood as cognitive strategic groups (Baum & Lant, 2003; Giaglis & Fouskas, 2011; Porac et al., 1989; Reger & Huff, 1993; Sutcliffe & Huber, 1998). Managers will notice and imitate those organizations that they perceive to be in their industry (Benner & Tripsas, 2012). Further, the identification of which aspects of these competitors' activities to copy is also cognitive (Greve, 1998; Greve & Taylor, 2000). The sources of a competitor's success (or failure) may not be obvious, and thus managers must sort through noisy signals or make interpretations about what might be worth copying (or worth avoiding).

The above studies on interpretations of the environment and interpretations of capabilities suggest that the assembly of capabilities from routines happens through the intersection of these two cognitive processes, where there is no strict temporal sequencing. Laamanen and Wallin's (2009, p. 977) conclusion from their analysis of capability development paths echoes this insight: "Managerial cognition and capability paths develop as distinct but mutually intertwined co-evolutionary processes that over time condition each other's evolution". The interpretation of the environment (as an opportunity to seize or a problem to be solved) should be seen as an essential part of the process by which managers interpret and assemble capabilities. This sense of purpose provides some structure to the process of understanding what an organization's capabilities are.

### Matching Capabilities to Opportunities

The final process in the updated model of capability development and deployment is the cognitive process by which managers *match* capabilities and opportunities. This matching process affects what managers actually do with the capabilities that organizations possess (Foss, 2011; Hansen et al., 2004). Penrose (1959/1995) argues that capabilities are bundles of resources that are deployed based on their match with perceived opportunities, where the environment is an "'image' in the entrepreneur's mind" (p. 42). While capability assembly has received little attention, studies of the match managers make between capabilities and opportunities have been more plentiful (see Table 3 for a summary of the relevant research).

The insight of managerial cognition scholars such as Barr et al. (1992), Tripsas and Gavetti (2000), and Gilbert (2006) is that it is not enough for managers to develop interpretive schema of their marketplace or to assemble a set of capabilities, they must mobilize those capabilities in taking strategic action. More specifically, cognitive frames are seen to have diagnostic and prognostic dimensions such that any strategic choice stems from interpretations about the environment as well as about what actions should be taken (Kaplan, 2008b). Frames, therefore, shape the organization's dedication of scarce resources to

**Table 3**  Interpreting the Match Between Capabilities and the Environment

| Topics | References | Key insights |
|---|---|---|
| Overall: matching | Penrose (1959/1995), Barr et al. (1992), and Tripsas and Gavetti (2000) | Capabilities are bundles of resources that are deployed based on a match with perceived opportunities |
| Interpretive schema | | |
| . . . Cognitive frames | Barr et al. (1992), Tripsas and Gavetti (2000), Gilbert (2006), Kaplan (2008b), and Laamanen and Wallin (2009) | Cognitive frames are both diagnostic of the environment and prognostic about what organizational capabilities should be deployed |
| . . . Dominant logic | Prahalad and Bettis (1986), Ginsberg (1990), Bettis and Prahalad (1995), Levy, Schon, Taylor, and Boyacigiller (2007), and West (2007) | Organizations create dominant logics that screen out potential opportunities that do not match with capabilities |
| . . . Identity | Milliken (1990), Dutton and Dukerich (1991), Gioia, Thomas, Clark, and Chittipeddi (1994), and Gioia and Thomas (1996) | Organizational identity is a lens through which potential matches are assessed |
| . . . Business models | Chesbrough and Rosenbloom (2002), Tikkanen, Lamberg, Parvinen, and Kallunki (2005), and Chesbrough (2010) | Organizational perception of business models for value creation affect which opportunities are seen as viable |
| Inertia | | |
| . . . Attention | Milliken and Lant (1991), Barr et al. (1992), Barr (1998), Osborne, Stubbart, and Ramaprasad (2001), Kaplan, Murray, and Henderson (2003), and Kaplan (2008a) | Managerial attention to new opportunities increases likelihood of organizational action |
| . . . Identity | Kogut and Zander (1996), Zucker and Darby (1997), Tripsas and Gavetti (2000), Nag, Corley, and Gioia (2007), Tripsas (2009), and Gioia, Patvardhan, Hamilton, and Corley (2013) | Potential opportunities that do not fit with the organization's identity are typically disregarded |
| Adaptation | | |
| . . . Exaptation | Cattani (2005), Dew (2007), and Marquis and Huang (2010) | Organizations will expand based on reusing and repurposing existing capabilities |

**Table 3** Interpreting the Match Between Capabilities and the Environment (Continued)

| Topics | References | Key insights |
| --- | --- | --- |
| . . . Fungibility | Regnér (2008), Taylor and Helfat (2009), and Danneels (2011) | Cognition about the applicability of existing capabilities to new environments affects growth patterns |
| Processes | | |
| . . . Attention | Kazanjian and Drazin (1987), Ginsberg (1989, 1990), D'Aveni and MacMillan (1990), Milliken (1990), Milliken and Lant (1991), Wiersema and Bantel (1992), Ocasio (1997), Cho and Hambrick (2006), Eggers and Kaplan (2009), and Joseph and Ocasio (2012) | The focus of managerial attention affects strategic action and adaptation. Senior managers tend to be inert in their frames and must be replaced in order for the organization to shift attention |
| . . . Search | Tripsas and Gavetti (2000), Gavetti (2005), Gavetti et al. (2005), and Gavetti (2012) | Conscious efforts to build new capabilities will lead to exploratory action. Managers reason and search for new opportunities based on analogies with existing knowledge |

one capability or another (Laamanen & Wallin, 2009). This resource allocation process is the central task of strategic management (Bower, 1970).

There are many disparate streams of research that make this point—interpretive schema shape resource allocation and capability deployment. For example, Prahalad and Bettis (1986) have suggested that resource allocation is cognitive in that it is based in a "dominant logic". They define dominant logic as the "way in which managers conceptualize the business and make critical resource allocation decisions" (p. 500). The essential point is that the dominant logic represents a collective cognition about the strategy and objectives of the organization, and that this shared cognition affects what opportunities the organization will choose to pursue. As summarized by Bettis and Prahalad (1995) in their ten year retrospective, dominant logic has been used to explain a large number of observed patterns of organizational change, including diversification and learning (Ginsberg, 1990) and adaptation and inertia (Prahalad & Hamel, 1994). Subsequent research has focused on extending the effects of dominant logics to other corporate activities, including the strategy creation of new ventures (West, 2007) and on the international expansion patterns of large organizations (Levy et al., 2007). The common thread has been that initial choices create a dominant logic that then dictates the perceived suitability of future options in a path dependent fashion.

Relatedly, scholars examining organizational identity describe it as the "perceptual lens" through which strategic choices are made (Dutton & Dukerich, 1991; Gioia & Thomas, 1996; Gioia et al., 2013; Milliken, 1990). Researchers studying business models describe them as the "heuristic logic that connects technical potential with the realization of economic value" (Chesbrough & Rosenbloom, 2002, p. 529) and thus shape the degree to which organizations can mobilize their resources to pursue new opportunities (Chesbrough, 2010; Chesbrough & Rosenbloom, 2002; Tikkanen et al., 2005).

## *Observing Matching: Inertia and Adaptation, Diversification and Growth*

The phenomena most amenable to observing the matching process have been in studies of organizational inertia and adaptation to change and in studies of diversification and growth. It is such moments of change that reveal cognitive dynamics that might otherwise be indistinguishable from the standard operating procedures of the organization.

A central focus of the research on managerial cognition has been in understanding why organizations tend to do a poor job of adapting to change in the environment (Milliken & Lant, 1991). As Barr et al. (1992, p. 16) suggest, "managers' mental models both facilitate and limit attention to and encoding of salient information about changes in organizational environments" and "may lead managers to overlook important environmental changes so that appropriate action at the organizational level is not taken". Their early study in this area compared two railway companies and showed that it was not enough for the managers to see changes in the environment, it was the ability to translate those insights into changes in the organization that made the difference in eventual performance.

A series of studies have followed this approach, each establishing a link between managers' interpretations of the environment, their choices about strategic action and the performance of their organizations. For example, Barr's (1998) study of pharmaceutical firms showed that managers' interpretations of an external shock (increases in regulation) varied across organizations and changed over time. The insight here was that these interpretations did not lead to a shift in resource deployment until the environmental shift was seen to have a meaningful impact on performance (see also Nadkarni & Barr, 2008). Osborne et al. (2001) found that pharmaceutical firms fell into different cognitive strategic groups depending on their views of various themes (such as "overseas expansion"). Affiliation with these groups was associated both with differences in such strategic actions as facilities expansion or introduction of new products and with reports about the performance impact of those activities. Kaplan et al. (2003) found that pharmaceutical firms' efforts to build new capabilities in the emerging field of biotechnology (as evidenced by patenting

and scientific publication) were preceded by shifts in managerial attention toward this new market.

Related studies on organizational identity find that persistent and strong identities can restrict the ability to adapt organizational capabilities to new environmental conditions and new opportunities (Gioia et al., 1994, 2013; Kogut & Zander, 1996; Zucker & Darby, 1997). That is, even if some capabilities are present, they may not be leveraged to address a market threat or opportunity if it is inconsistent with the organization's identity. Tripsas' (2009) study of a flash memory company demonstrated how identity shaped managers interpretations of external events. As a result, they filtered out changes that might challenge their organizational identity. Further, because the organization's identity was an underpinning of their routines and capabilities, the company could not change the organization without changing the identity—and vice versa: it was difficult to change the identity without changing the organizational capabilities (see also, Nag et al., 2007 on this last point).

The message of much of this research is that organizations will fail to adapt when they cannot adequately match their capabilities to the opportunities or threats seen in the market. Often the source of inertia is not a lack of capabilities, but rather managers' failures to connect these capabilities to the possibilities created in the environment (Eggers & Kaplan, 2009; Tripsas & Gavetti, 2000). Their cognitive frames are stuck in an old understanding of the environment. As Lavie (2006, p. 160) says,

> A timely recognition of technological change, an accurate evaluation of its implications for incumbent capabilities, and, in particular, an estimation of the value-maximizing capability configuration require significant monitoring, information accumulation, and evaluation costs. Decision makers need to possess sufficient managerial insight and cognitive abilities in order to analyze changes in the firm's external environment.

Thus, possession of the requisite capabilities but without appropriate managerial awareness may be insurmountable for the firm. The opposite, however, appears not to be true—when firms lack the needed capabilities but managers are attuned to the threat or opportunity, the cognitive framing can actually compensate for missing capabilities in spurring action. Managerial attention can direct the organization (through the mindful processes discussed earlier) to build up new capabilities that would be better suited to the evolving market (Kaplan, 2008a; Rosenbloom, 2000).

A second research stream where the matching of capabilities to the environment is salient is in studies of diversification and growth. The focus of most research on capabilities has been on how capabilities, resources, and assets might be profitably redeployed toward new opportunities (Penrose, 1959; Prahalad & Hamel, 1990; Teece, 1982). The implication is that the purpose for

which a capability is ultimately used need not always be the one for which it was initially encoded. Resources and capabilities are "fungible" in that they are amenable to use in a diverse set of applications (Danneels, 2007, p. 516). For organizations that are able to grow (and adapt to change), managers find ways to create new capabilities or recombine old capabilities in new ways. Managers can renew, redeploy, reapply, recombine, retrench, or retire capabilities over the course of the capability life cycle (Helfat & Peteraf, 2003). This reuse or recombination has been described as "exaptation" (or sometimes "pre-adaptation") (Cattani, 2005; Dew, 2007; Marquis & Huang, 2010). Borrowed from evolutionary theory (Gould & Vrba, 1982), the concept of exaptation highlights the fact that traits that evolved for one purpose could be used later for another (new) purpose. As adopted by management theory, it focuses attention on how capabilities developed for one product market could be used in another.

While most of this research views fungibility as an inherent aspect of the capability itself, some scholars have suggested that exaptation is a cognitive process. Most notable is Danneels (2011), who introduces the concept of "resource cognition" to describe how managers understand the organization's existing resources and their potential to be deployed in new tasks. The implication is that managers with different perspectives on the possible applications of their existing capabilities will look to recombine them in different ways. Similarly, Taylor and Helfat (2009) focus on the process by which managerial cognition affects the ability to use existing complementary assets in support of a new technological opportunity. They argue that such redeployment is evidence of organizational ambidexterity (see also O'Reilly & Tushman, 2004; Smith & Tushman, 2005), stating that, "articulation by top management of a common vision and values that bridge dual contexts increases the likelihood of ambidexterity" (p. 725). Additionally, Regnér's (2008) analysis of the relationship between strategy process research and dynamic capabilities argues that managerial cognition and action affect organizational development of new capabilities and capability redeployment in new contexts. The cognitive context—the lens through which existing capabilities and potential opportunities are interpreted—in which managers conceive of and craft strategies has implications for what new capabilities will be developed.

Capabilities may be fungible, but their (re)deployment depends on managers' cognitive frames. What has been perceived in the past as core rigidities (Leonard-Barton, 1992; Levinthal & March, 1993; Tushman & Anderson, 1986) may rest to a certain extent in managerial cognition rather than in the organizational capabilities themselves. While this relationship between capabilities and cognition is certainly interesting and provocative, more work is needed, particularly on the boundary conditions under which managerial cognition can compensate for a lack of capabilities and encourage organizational change and growth.

*Identifying Matching Processes*

If the prior section focused on the extent to which matching between capabilities and opportunities occurs, comparatively less is known about the processes by which such matching between capabilities and perceived opportunities takes place. We can infer some mechanisms, however, from research on individual and social cognition. These can be grouped loosely into the categories of attention and search.

Attention-based theories suggest that decisions about resource allocation are shaped by how organizations channel managers' attention (Ocasio, 1997, p. 188), "What decision makers do depends on what issues and answers they focus their attention on". Attention signals the manager's willingness to pursue a course of action, serving as a sign-post for the organization's employees and stakeholders about the focus and orientation of the organization (Eggers & Kaplan, 2009; Ocasio, 1997). D'Aveni and MacMillan's (1990, p. 650) study of managerial attention in organizations that subsequently fail highlights the role of "crisis-induced perceptual shifts among top managers" in influencing turnaround success. Joseph and Ocasio's (2012) study of General Electric show how the channels of attention influenced the degree to which the organization pursued adaptive moves such as commercializing products in new markets, establishing distribution partnerships, or acquisitions of organizations. In each case, the potential adaptation involved shedding old capabilities or building new ones, therefore implying that channeling attention can shape how capabilities are developed and which potential matches are uncovered.

Studies of top management teams have suggested that attention is shaped by team demographics and collaborative processes. Researchers have found, for example, that top teams with greater tenure resist change because they get wedded to the organization's traditional way of doing business (Finkelstein & Hambrick, 1990; Hambrick, Geletkanycz, & Fredrickson, 1993). The degree of consensus amongst top team members affects what opportunities they perceive as salient and which are not attractive or feasible (Ginsberg, 1989, 1990; Kazanjian & Drazin, 1987). When top teams fail to recognize change (Barr et al., 1992; Cho & Hambrick, 2006; Kaplan et al., 2003; Milliken, 1990; Wiersema & Bantel, 1992), their organizations exhibit inertia.

Cho and Hambrick (2006) explicitly address the links between top team demographics and direct measures of attention. In their study of deregulation in the airline industry, they showed first that the industry tenure, the functional experiences and the heterogeneity of the team were all associated with strategic change and adaptation. Second, they found that shifts in the top team's attention from an "engineering" to an "entrepreneurial" orientation were also associated with subsequent changes in strategic actions and these attention shifts partially mediated the effects of the top team characteristics. These results suggest a top

team's knowledge and interactions work in part to channel attention toward some matches between opportunities and capabilities and not others.

A second category of cognitive matching processes is that of search. Tripsas and Gavetti (2000, p. 1157), in their detailed study of Polaroid's failure to adapt to the new digital photography technologies, state that "search processes in a new learning environment are deeply interconnected to the way managers model the new problem space and develop strategic prescriptions premised on this view of the world". They show in their map of the evolution of capabilities and beliefs over several time periods that Polaroid did not have difficulties in developing new digital technological capabilities. They failed, instead, to make the match between those capabilities to the changing environment. The set of beliefs of top management—in the primacy of technology and in the "razor and blade" business model in which hardware was not seen as a source of profits—shaped the degree and direction of their search activities.

Analogical reasoning is another search process by which matching of opportunities and capabilities occurs. With roots in cognitive psychology (Gick & Holyoak, 1980), studies of organizational analogical reasoning suggest that it is key to strategic decision making (Gavetti, 2012; Gavetti et al., 2005). First, managers assess the similarity between a focal new option and prior opportunities pursued by the organization. If the new opportunity is perceived as a close match, and the prior decision was successful, then the new opportunity is more likely to be seen as a match. If, conversely, the new opportunity is perceived as closely matching a prior action that was unsuccessful, the likelihood of perceiving a match decreases. Comparative analogues between current and past opportunities act as a means by which search is conducted and filtered.

We suspect that there is more going on in the matching process than only attention and search. Prior research says very little about whether, for example, managers might evaluate potential matches through experimentation (akin to the "online search" discussed by Gavetti & Levinthal, 2000), either through adopting potentially reversible courses of action or testing possible matches in beta or pilot form. Given recent interest in "crowdsourcing" (Surowiecki, 2004), do (and should) managers turn to polling or voting by managers, employees, or shareholders to evaluate potential matches? Future research might explore these and other processes.

## A Recursive Model

This review uncovered three dynamics by which cognition is implicated in capability development and deployment: constructing (forming the microfoundations of routines), assembling (shaping how managers assemble and understand the organization's capabilities), and matching (driving how managers see a fit between internal capabilities and external opportunities).

Adding these cognitive processes to the model of capability development and deployment (as in Figure 2) enriches the standard view in the capabilities literature. However, research suggests that these processes are not as linear as presented in Figure 2. Indeed, scholars have highlighted several ways that the relationships are recursive. Figure 3 documents these recursive relationships and represents a more comprehensive cognitive model of capability development and deployment. Having already discussed the three central cognitive processes included in Figure 2, this next section identifies the recursive relationships included in Figure 3. We also highlight different perspectives on the temporal ordering of these relationships.

*Five Iterative Processes*

To start, experience is often portrayed as the initial input to the development of routines while performance is shown to be the central outcome of interest. However, this outcome is also a potential contribution to experience, as organizational performance in the current period becomes prior experience that drives capability development in a future period (recursive link 1 in Figure 3). This highlights an iterative pattern of feedback-based learning as actions and outcomes are (given the limitations discussed above) encoded into future routines. This circular pattern plays out in two ways. First, positive performance is more likely to result in knowledge that managers are willing and able to encode into routines for future reuse (Levinthal & March, 1993). Failed experiences, therefore, are less likely to result in the development of new routines than successful ones (Cannon & Edmondson, 2001; Eggers, 2012b; Starbuck & Hedberg, 2001). Second, prior organizational performance provides one set of aspiration levels that affect the likelihood of managers engaging in active search processes to develop new routines and capabilities (Gavetti & Rivkin, 2007; Greve, 2003). This relationship is not necessarily linear—performance below aspirations may increase search activities, but
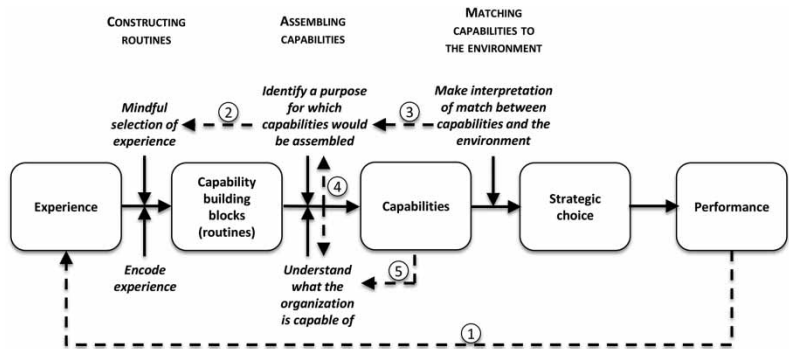


Figure 3   Cognition and Capabilities—A Recursive Model.

poor performance that increases the risk of bankruptcy (March & Shapira, 1992; Miller & Chen, 2004) or occurs in unfamiliar domains (Denrell & March, 2001; Eggers, 2012b; Eggers & Suh, 2012) may dampen search activities. Thus, experience that is transformed into routines does not only come from "learning by doing" (Levitt & March, 1988), but also from learning that is triggered by prior performance.

The next two feedback loops shape the encoding of experience into routines. As Huff, Huff, and Barr (2000) suggest in their cognitively anchored model of strategic change, feedback may initiate in the assembly process (recursive link 2 in Figure 3), as managers realize that they lack the building blocks to assemble the desired capability, or in the matching process (recursive link 3 in Figure 3), as managers perceive external opportunities that require the creation of new capabilities. Thus, it may be the very matching process that triggers or enables the assembly of capabilities from their building blocks, and the resulting revised goals also instigate the construction of new routines.

Such triggers lead to the intentional absorption of new experiences to augment the knowledge stock of the organization. Experiences can also result from intentional actions to augment the knowledge stock of the organization. Such intentional processes include internal search and development (Gavetti, 2005), learning from others (Haunschild & Miner, 1997), learning through hiring (Rosenkopf & Almeida, 2003; Song, Almeida, & Wu, 2003), or learning through alliances and mergers (Khanna, Gulati, & Nohria, 1998; Koza & Lewin, 1998). Such new knowledge and skills can then be encoded into organizational memory, repeated and retained as new routines. Gavetti and Levinthal (2000), in their simulation work, applied this general insight to show that cognitive representations guide organizational search and experiential learning. Assembly and matching are therefore iterative processes that shape the organization's portfolio of routines. Managers may become aware of an opportunity, but if the organization lacks the capabilities to take full advantage of it, managers might instigate search processes to build or acquire the necessary capabilities.

With regard to assembly itself, the distinction between the identification of a purpose and the diagnosing of organizational routines is analytically useful but likely unrealistic in practice. Helfat and Peteraf (2003) make a temporal distinction between identifying a purpose and the process of actually building a new capability, but are silent about diagnosing the existing capability building blocks beyond suggesting that "the endowments present at founding set the stage for further capability development by preconditioning the emergence of a capability" (p. 1001). From this, one could infer that managers must understand the existing routine base before developing a plan for a new capability. Conversely, the identification of a purpose has been argued to precede the intentional creation of new routines (in order to know which routines to create), but even this process is muddied by the potential that the results of any intentional routine creation processes may not perfectly match the

intended outcome (Howard-Grenville, 2005; Rerup & Feldman, 2001). This might necessitate further updates to the purpose of the capability.

As a result, the two parts of the assembly process (identification of a purpose and diagnosing existing routines) should be seen as interacting (recursive link 4 in Figure 3) as managers use their perceptions of an organization's goals to shape their understanding of the potential value of the routines that the organization possesses. Thus, there likely is not a strict temporal sequencing in aggregating routines into capabilities. Routines are building blocks that can be taken apart and assembled in new ways based on new interpretations. That said, there is so little existing research on the assembly process that future research specifically on the interplay between these two activities would be useful in providing more detail and context.

Just as cognition has been shown to shape the development of capabilities, capabilities can influence the interpretations that managers apply (recursive link 5 in Figure 3). This is the underpinning of the concept of organizational "myopia" (Levinthal & March, 1993) in which routines and capabilities cannot be changed to respond to changes in the environment. Capabilities can be codified in manuals or guidelines (Zollo & Winter, 2002) or transformed into shorthand "rules of thumb" (Eisenhardt & Martin, 2000) which become the schema through which subsequent interpretations are made. As Verona (1999, p. 139) argues, "capabilities contribute to structuring the attention of each agent shaping organizational behavior and, therefore, affect his or her performance over time". As capabilities get refined in their use, they become part of well-oiled systems that involve not just day-to-day operations but also managers' understanding of markets and technologies. The smooth functioning of this system maybe useful in stable contexts, but may block adaptation when the environment changes (Kaplan, 2008b; Siggelkow, 2001).

This view of capabilities affecting interpretive schema is also related to the idea of situated attention. According to Ocasio (1997, p. 188), "what issues and answers decision-makers focus on, and what they do, depends on the particular context of situation they find themselves in" (see also Ocasio, 2011). Under this perspective, organizational capabilities provide an important context that affects how managers perceive and interpret the complex array of routines that the organization possesses. This filtered interpretation process implies that differences in context may alter the way two different managers perceive the same foundational building blocks.

Thus, the presence of these recursive dynamics offers an explanation for sources of organizational stability and change. If capabilities become tightly intertwined with schema, the organization can get locked into an existing way of doing business and become unable to shift their capabilities when such a move might be required. On the other hand, changes in interpretations, perhaps provoked by performance feedback or by poor matches between the environment and existing capabilities, can lead to the development of new capabilities over time.

*Inside-Out Versus Outside-in?*

The temporal sequencing and underlying logic of the recursive processes identified in Figure 3 may occur from the inside-out or from the outside-in. The views of organizational growth espoused by Penrose (1959) and Barney (1986), as well as Danneels' concept of resource cognition (2011), focus on understanding the firm's existing routines and capabilities first before considering external opportunities. Under this logic, managers would be likely to engage in the assembly of routines into potentially useful capabilities before seeking to match those capabilities to the set of perceived opportunities. This process functions "inside-out", with the initial focus being on the existing capabilities (the "inside") before turning to consider the external ("outside") opportunities.

A contrasting perspective of the process builds on cognitive mechanisms such as identity (Tripsas, 2009) and dominant logic (Prahalad & Bettis, 1986). In this perspective, these mechanisms are seen as filters that affect how senior managers view specific opportunities. The presumption is that managers are actively searching for external opportunities, and then engaging in a matching process (driven by the understanding of the firm's routines and capabilities) that assesses the feasibility of building new capabilities to address the perceived opportunities. This process is "outside-in", where the perception of a potentially attractive external opportunity (the "outside") encourages managers to look within the firm ("inside") to assess whether resources and capabilities can be cost-effectively marshaled to exploit the opportunity.

Relatedly, Stevenson and Gumpert (1985) contrast "typical" and "entrepreneurial" strategy processes. The "typical" process (of the large, established organization) begins with an understanding of the resources controlled by the organization in order to decide where to apply them. The "entrepreneurial" process begins with the identification of an opportunity before considering what resources the firm has and (more importantly) where to acquire the resources that the firm lacks. Both of these two temporal sequences (inside-out or typical and outside-in or entrepreneurial) are "ideal types" —the reality of organizational behavior and managerial action will be a complex of both. But, to the extent that (for example) large incumbent organizations may follow the inside-out method, while entrepreneurs may be more prone to follow an outside-in approach, taking a cognitive perspective on capability development and deployment may create a useful meeting point for entrepreneurship and strategic management research.

## A Research Agenda on Cognition and Capabilities

This review allowed us to build a conceptual model that highlights the importance of cognition in capability development and deployment. The first part of the multi-level model articulated the cognitive microfoundations of routines

that are the building blocks of organizational capabilities, namely by exploring what is known about the encoding of experience as routines are constructed. The second part of the model addressed the cognitive processes by which managers assemble routines into capabilities in response to interpretations of the environment. The third part of the model detailed the matching process by which managers make strategic choices about whether and when to deploy organizational capabilities toward potential opportunities. This model extends the existing framework by which capabilities are presumed to lead to organizational performance and identifies how cognition about experience, capabilities, and opportunities affects the capability–performance relationship. By highlighting the recursive relationships amongst these processes, we also emphasize the dynamic, iterative relationship of cognition and capabilities. Cognition shapes capabilities just as capabilities shape cognition.

In integrating across several previously unconnected literatures, this study has fleshed out many aspects of a cognitive model of capability development and deployment while at the same time identifying lacunae to be filled. The recursive model is necessarily complex: no individual research project could or should endeavor to analyze the entire process. The most fruitful way forward will continue to be to examine parts of the whole elephant. But the model sensitizes the scholar to the complexity of the full system and helps make explicit what is being "black boxed" while other dynamics are being explored. In using the multi-level model as a foil for analyzing the existing literature, this review identifies a number of avenues for future research on the role of cognition—in the emergence and assembly of capabilities, in organizational change and growth, and in dynamic (managerial) capabilities.

### The Emergence and Assembly of Capabilities

Recent inquiries into the microfoundations of strategy have dramatically increased understanding of the origins of capabilities. Despite this work, how experiences are encoded into routines and then assembled into capabilities is less understood. Prior research offered a number of suggestions about which types of experience are more likely to be encoded into routines and capabilities (much of which has been based on laboratory experiments), but few studies have tested these ideas within real-world organizations.

There is ample opportunity to develop a more comprehensive and organizationally situated approach to questions about which experiences are actually encoded, stored, and retrieved. In addition, it would be helpful to investigate how managerial action can affect this process. Scholars could study whether managers, through purposeful action, can increase the volume, direction or efficiency of experience encoding—potentially through mechanisms such as knowledge management systems and managerial rotations. Alternatively, it may be that there is a limit to how much organizations can process and

store. Recent work has begun to explore these questions (Laamanen & Wallin, 2009; Rerup & Feldman, 2011; Salvato, 2009), but the field is in the early stages of understanding these dynamics.

In addition, we need to know more about how managers become aware of and understand their organizations' capabilities (existing and potential). We know that managers disagree about organizational capabilities (Denrell et al., 2004; Rulke et al., 2000), but the processes underlying this effect are not well understood. Without such a perspective, it is hard to diagnose the exact role played by managers in the creation of organizational capabilities. What actions can managers take to increase awareness and agreement, and to what extent does this lack of agreement lead either to costly infighting over a single organizational frame or the inefficient allocation of resources as different managers pull capabilities in different directions?

Most importantly, the process of "capability assembly" remains a nearly unexplored topic. If routines are the building blocks of capabilities, what are the actions that managers (at any level of the organization) take to assemble routines into capabilities? To the extent that capabilities are assembled from routines to address a particular opportunity, this question relates to work on strategic implementation. Recent research on resource orchestration suggests that managerial decisions about the deployment of assets plays a role in creating competitive advantage (Sirmon, Hitt, Ireland, & Gilbert, 2011), but neglects the cognitive dynamics that the revised model would suggest are important. This question is a space where scholars of routines and scholars of capabilities can, and should, meet. We suggest that cognition is the bridge between these two hitherto poorly connected domains.

### Organizational Change and Growth

Of all of the topics discussed in this review, scholars know the most about the role of managerial cognition (and related concepts) in affecting strategic change and inertia. In part this is because organizational actions and outcomes at this level are relatively observable, facilitating empirical research and case study identification. At the most general level, there is an already sizable stream of research about the relationship between cognition and strategic change. Prior research has investigated how managers perceive and become aware of threats brought about by technological change (Kaplan, 2008b), and how entrepreneurs identify potential opportunities (Gaglio & Katz, 2001). Less is known, however, about the cognitive aspects of how organizations identify and pursue opportunities for expansion in situations other than those brought about by radical environmental change.

There is room for additional work on the matching process itself, where managers consider potential alternatives and weigh uncertainty and organizational risk as they evaluate matches. While existing research has shown that

matching occurs, our understanding of exactly what managers do during this matching process is limited. Attention and search are two candidates, but as suggested above, other possible processes such as experimentation or crowd-sourcing should be explored in order for the field to have a better sense of the mechanisms at play. Moreover, recent research has pointed out that cognition may be able to substitute for a lack of capabilities in spurring organizational action (Eggers & Kaplan, 2009; Gavetti, 2005; Kaplan, 2008a), but less is known about how this works in practice.

Research on exaptation (Cattani, 2006; Dew, 2007; Marquis & Huang, 2010) has begun to explore how resources and capabilities may be redeployed to serve new purposes, but most (with the notable exception of Danneels, 2011) give little consideration to the cognitive processes that underlie this matching process. Given recent work highlight the importance of pre-entry experience as potential driver of organizational performance (Eggers, 2013; Helfat & Lieberman, 2002; Sosa, 2013), understanding how managers perceive and (re)deploy existing capabilities toward new potential uses would seem to be an extremely promising direction for future research. Further, exaptation must surely be recursive with the process of assembling the capabilities themselves. Research, likely in-depth field studies, to unpack the iterations between these two processes might be particularly useful.

### Cognition as a Capability: Dynamic Managerial Capabilities

The model offered in this paper has implications for thinking about cognition *as a* capability, which may inform the ongoing puzzle about how dynamic capabilities operate (Eisenhardt & Martin, 2000; Lavie, 2006; Peteraf, Di Stefano, & Verona, 2013; Teece et al., 1997). Consistent with the work of prior scholars in situating dynamic capabilities in managers' abilities to "build, integrate and reconfigure organizational resources and competences" (Adner & Helfat, 2003, p. 1012), managerial cognition can be seen as a dynamic *managerial* capability (see also, Eggers & Kaplan, 2009). This highlights the potential for the purposeful action of managers to interpret the environment in new ways, reconfigure organizational capabilities to match those opportunities (Bingham et al., 2007; Gavetti & Levinthal, 2000), and build organizational flexibility (Zollo & Winter, 2002). Such a view is also aligned with recent research on organizational ambidexterity (O'Reilly & Tushman, 2004; Smith & Tushman, 2005). There are three ways the discussion of dynamic managerial capabilities may be advanced by a cognitive model of capability development and deployment.

First, bringing in the perspective of cognition as a pillar in the microfoundation of routines (Dosi et al., 2001; Gavetti & Rivkin, 2007; Kaplan & Henderson, 2005) helps to identify what efforts might be involved in reconfiguring capabilities. The implication is that the cognitive and motivational truce

(Nelson & Winter, 1982) that is represented in a routine would have to be broken and remade in another form (Zbaracki & Bergen, 2010). Future research could investigate how purposeful action—including the initiation of search to accumulate new and useful routines—affects the availability of potential capability building blocks and thus improves chances for adaptation. This is one place where attention to the cognition of people at different levels of the organizational hierarchy might matter most. Routines are executed by the front line in many cases, but changes in routines might be initiated by either those workers through their everyday practice (Howard-Grenville, 2005; Rerup & Feldman, 2011) or perhaps by the top management team in a deliberate attempt to create new truces (Zbaracki & Bergen, 2010). To date, research on deliberate managerial action in relation to the creation of routines is underdeveloped.

Second, by focusing on the role of cognition in the assembly of capabilities and opportunities, we argue that managerial awareness—both internally and externally—shapes how organizations pursue new opportunities. Managerial cognition has a significant impact on how building blocks are assembled into capabilities, on the comprehension of the potential value of those capabilities (Danneels, 2011; Rulke et al., 2000), and on the breadth of opportunities considered (Barr, 1998; Jackson & Dutton, 1988). Future research could explore how managers experiment with potential building blocks in order to create new capabilities. Scholars could also investigate at a more granular level how managers familiarize themselves with the organization's existing capabilities and the opportunity set.

Third, by showing that the process of matching capabilities to the environment is cognitive, this study highlights the degree to which perceived matches result in positive outcomes for the organization (Eggers & Kaplan, 2009; Taylor & Helfat, 2009). It also brings into relief the opportunities that are missed due to perceived lack of fit (Tripsas & Gavetti, 2000). The iterative nature of the matching process also drives managerial decisions to explore less understood opportunities and to build or reconfigure capabilities.

A cognitive model of capability development and deployment therefore offers specific ideas for future empirical research to explore the operation of dynamic capabilities and organizational ambidexterity. Further, it suggests that such capabilities are resident in managerial cognition and thus are perhaps best characterized as dynamic *managerial* capabilities.

*Conclusion*

The purpose of this article has been to review the various literatures that link capabilities and cognition in organizations. The model that emerged proposed three central processes in capability development and deployment: the construction of routines, the assembly of routines into capabilities, and the

matching of (perceived) capabilities to (perceived) opportunities. While the role of cognition in the matching process and (to a lesser extent) the role of cognition in the microfoundational development of routines have both been studied through various empirical and theoretical approaches, the processes by which managers assemble routines into capabilities have been largely over-looked. As such, the connection between the microfoundations work and organizational performance is tenuous. Attention to the assembly process should help build the macro–micro bridge in strategic management. Further, our mapping of the whole elephant—in a cognitive model of capability development and deployment—enables future researchers to focus on individual aspects while remaining sensitive to the entire animal.

## Acknowledgements

## Endnotes

1. Laamanen and Wallin's (2009) search of 20 years of the top 10 management journals in the ISI Web of Knowledge identified 426 research articles referring to cognition and 586 to capabilities, but only 30 that addressed both, of which only 10 focused on the relationships between them.

2. It is not within purview of this study, nor would it be feasible, to provide comprehensive reviews of each of the separate domains of cognition and capabilities. For deeper considerations of these areas, see Walsh (1995) and Kaplan (2011) on managerial cognition, and Becker (2004), Felin and Foss (2009), Parmagiani and Howard-Grenville (2011), and Gavetti, Greve, Levinthal, and Ocasio (2012) on routines and/or capabilities.

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