

**ORGANIZATIONAL STRUCTURE, INFORMATION PROCESSING, AND
DECISION MAKING: A RETROSPECTIVE AND ROADMAP FOR RESEARCH**

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Abstract

Beginning with Simon (1947)—and motivated by an interest in the effect of formal organizational structure on decision making—a large body of research has examined how organizations process information. Yet, research in this area is extremely diverse and fragmented. We offer a retrospective of past research to summarize our collective knowledge, as well as identify and advance new concerns and questions. In doing so, we identify three critical issues: a division between an aggregation perspective and a constraint perspective of structure; little focus on informational sources of conflict; and uneven treatment of the various stages of decision making. We then offer a roadmap for future research that elaborates the role of organizational structure in decision making. In this endeavor, we offer an ecological perspective of information processing that addresses the issues and provides opportunities to expand research in new directions.

INTRODUCTION

Scholars have long been interested in the effects of organizational structure and its influence on decision making. As remarked by Simon (1997: 240), “[i]n a post-industrial society, the key problem in research related to organizational structure is how to organize to make decisions—that is, to process information.” Hence the literature addressing these aspects of organization have traditionally relied on some form of information processing: the gathering, interpretation, and synthesis of information (Tushman & Nadler, 1978: 614; see also Galbraith, 1974; Obel & Burton, 1984; Puranam, Raveendran & Knudsen, 2012; Van Kippenberg, Dahlander, Haas & George, 2015).

Research on organizational structure, information processing, and decision making has spanned over seven decades. The areas of organization theory, strategy, and organizational economics (among others) have concerned themselves with this subject and have used different theories and methods to examine a variety of structural features, causal mechanisms, and outcomes. There is a considerable amount of recent work that addresses the decision-making and performance implications of organizational structure, which reflects the organization design research agenda pursued by an increasing number of researchers (Gulati, Puranam & Tushman, 2012; Burton, Obel & Håkonsson, 2015, Joseph, Baumann, Burton & Srikanth, 2018; Puranam, 2018).

The growth in scholarly attention, along with advances in adjacent fields, has led to multiple streams of research on this topic. Each of these streams uses different ways to link organizational structure—which we define as the ways in which an organization divides its labor and integrates their efforts (Mintzberg, 1979)¹—to decision making. Although this trend stems,

¹ We recognize that there are many definitions of organizational structure. Each of these definitions emphasizes different aspects of structure including interactions (Purnam, 2018), configurations (Burton, Obel, and DeSanctis,

in part, from different methodological approaches (e.g., mathematical models, agent-based models, empirical studies), the research reflects a more fundamental division with regard to its overall focus and to the theoretical treatment of information processing. The downside of such divergence is that further development will be hindered to the extent that research retreats into a regress into respective domains.

Notably absent is a concerted effort to review and assess the literature. Although a few papers have acknowledged the growing interest in this subject (e.g., Puranam, 2012; Joseph et al., 2018) and some articles include structure within their remit (Gavetti, Levinthal & Ocasio, 2007; Posen, Keil, Kim & Meissner, 2018), none have either directly surveyed and identified key issues in this research stream or crafted a research agenda for the decision-making implications of organizational structure and information processing.

Therefore, the goal of this paper is to review the extant literature and summarize our collective knowledge, as well as identify and advance new concerns and questions about organizational structure and decision making. In this process, we revisit some of Simon's original ideas and assess how they are reflected in contemporary research. We analyze the different perspectives of how an organization's structure affects decision making and, in so doing, identify some of the literature's key issues. We then offer a roadmap for future research that addresses these issues and a point of view that could bring these perspectives closer together and expand research in new directions.

This endeavor should yield a fresh perspective on the design of organizations. It is useful given the proliferation of new organizational forms and supra-firm architectures (Burton, 2013). A better understanding of the decision-making implications of these new organizational forms

2011), networks (Krackhardt and Hanson, 1993), and hybrids (Soda and Zaheer, 2012). We purposely draw on a foundational and general definition of formal organizational structure.

may depend on a more refined understanding of the information processing properties associated with them. Finally, in terms of practical implications, organization structure provides a powerful set of levers that are directly accessible to top management. Hence a more informed view of information processing may improve the ability of top management to use these levers effectively.

Our review of the literature identified four major streams of research: *problem-skill matching, screening, adaptation, and cognition*. In concert with our categorizing efforts, we also identified three critical issues. First, existing research is divided in its treatment of the role of structure in information processing. Although some of the literature concerns itself with how individual decisions come together (i.e., on how structure aggregates), other streams focus on how the organizational context affects individual decision making (i.e., on how structure constrains). Since the both views typically neglect shared cognition and since the constraint view routinely neglects interactions, neither approach adequately links the socio-cultural properties of organizational structure to particular contexts of joint decision making.

Second, the literature largely overlooks the potential for conflict in decision making. This shortcoming reflects, inter alia, the belief that conflict results from divergent interests and poor incentive design (Gibbons, 2010). Because so much research intentionally abstracts from incentives, discussions about the source and consequences of intra-organizational tensions have been avoided. This lack of conflict stems also from a lack of focus on the organization's system of meaning making and attention. Structure's impact on the variation (and hence differences) in the interpretation of information is incidental to the theory, and hence, omits the possibility that informational sources of conflict may arise. Also, without a solid understanding of the

relationship between formal structure and attentional processes, we are unable to fully establish the conditions for when conflict is beneficial for decision making.

Third, the treatment of the various stages of decision making is uneven. Simon (1947) articulated four steps in the decision-making process: agenda setting, problem representation, search, and evaluation. Most studies focus on search and (to a lesser degree) evaluation. The effects of structural variation on agenda setting and problem representation remain relatively unexplored. This omission is consequential in that it ignores the potential impact of setting an agenda and representing problems on search, and for a recursive relationship between alternatives selected and subsequent agendas and problems.

In addressing these issues, we offer a view which moves away from the literature's emphasis on individual cognition, and brings back Simons' notion of common maps or shared representations (Simon, 1952) to enable a more complete view of the role of structure on decision making. In doing so, we incorporate the concepts of embedded and situated interactions to better capture the information processing properties of structure, and specifically how shared representations are made accessible and activated. We offer an ecological perspective which not only bridges the aggregation and constraint views, but also explains how conflict arises in the process, and how agendas and problem representations are affected.

We place several boundary conditions on the scope of this paper, a necessary restriction given the vast literature that references information processing. First, we consider only formal organizational structure. Thus we ignore informal organizational structures and social networks except when considered in conjunction with formal structure. Second, we mostly examine information processing in relation to problem solving and choice; that is, we are interested in how organizational structure affects decision making but *not* vice versa. Hence, we leave aside

those studies that examine: (i) the effect of decomposability on organizational structure (Zhou, 2012) and product architecture (e.g., Baldwin & Clark, 2000; Yayavaram & Ahuja 2008); (ii) the effects of formal structure on the informal organization (Kleinmbaum, Stuart & Tushman, 2013; Clement & Puranam, 2017); or (iii) governance decisions, firm boundaries (Foss and Weber, 2016), or interfirm relationships (Aggarwal, Siggelkow & Singh, 2011) as dependent variables. Neither do we consider studies in which structure is merely a moderator or second-order boundary condition of the primary theoretical argument. Thus our review maintains, as its primary focus, organization structure and its implications for decision making.

Finally, since we are interested in conflict that arises from misunderstandings rather than from misaligned incentives, we keep incentive issues in the background. Understanding the role of incentives in coordination is an important area of inquiry, and incentives are widely considered as a credible alternative explanation in studies of organizational structure and decision making (Gibbons, 1998; Kreschmer & Puranam, 2008). Even so, organizational economists and strategy scholars acknowledge that incentives and information processing involve different sets of causal mechanisms; hence we will address the former only in terms of their role in information processing accounts.

Most of our review is limited to papers published within the last 20 years (2000–2019). Although we discuss the literature's foundational papers, we are mainly interested in the trends that have become evident over these past two decades. By classifying the extant research and highlighting the major information processing perspectives, we lay the groundwork—and devise a roadmap—for a renewed and fruitful program of research into the relationship between organizational structure and decision making.

FOUNDATIONAL LITERATURE ON INFORMATION PROCESSING

The models of information processing proposed by Herbert Simon have provided, directly or indirectly, the conceptual scaffolding for much of the literature that addresses the relationship between organizational structure and decision making. We therefore begin our review by examining these contributions, after which we detail the more current research. In this latter task, we categorize previous work into four areas. The thematic complementarities and differences across these four areas drive the specifics of our proposed research agenda.

Herbert Simon and the origins of information processing

In the field of organization research, information processing in relation to decision making traces its lineage back to Herbert Simon—a scholar who was mainly concerned with understanding how people solve problems and make decisions. Through his intellectual efforts, Simon brought psychological research into economics and established a more behavioral approach to the study of human decision making (Augier, 2001).

Simon's ideas on information processing were initially and most fully developed within two streams of work. The first stream dealt with administrative theory, which identified hierarchically ordered decision making as the key concept underlying “the superstructure of the theory of bounded rationality”—a notion that was central to his research for the duration of his career (Simon, 1991; see also Augier, 2001: 86). Although Simon did not use the term “information processing” in the original *Administrative Behavior* (1948) book, the idea itself and its central components were clearly present. Both March and Simon's (1958) *Organizations* and Cyert and March's (1963) *A Behavioral Theory of the Firm* were explicit in their view of the organization as an information processing and decision-rendering system. According to Cyert and March, “we need more reliable information on where and how organizations secure

information, how that information is communicated through the organization, and how authoritative decisions are reached, and finally how such decisions are implemented in the organization” (1963: 20). Similarly, March and Simon discuss the communication requirements and processes for effective coordination. According to them, “the capacity of an organization to maintain a complex interdependent pattern of activity is limited in part by its capacity to handle the communication required for coordination” (1958: 183). It was during this period that Simon’s Nobel prize–winning work was conducted, research that established a behavioral approach to rational choice (Simon, 1955, 1956).

A second stream of Simon’s research, which included his collaboration with Alan Newell, concerned human problem solving, symbol processing, and heuristic search. Newell and Simon (1956) identified the individual decision-making process as a key unit of analysis. In this theory, there is an important distinction between the actual task environment and “the way a particular subject represents the task in order to work on it” (Simon & Newell, 1971: 151). Simon argued that “simplifications of the real world for purposes of choice introduce discrepancies between the simplified model and the reality; and these discrepancies, in turn, explain many of the phenomena of organizational behavior” (1995: 114).

It is worth noting that even though Simon’s work reflects two distinct information processing fields (which focused respectively on organizations and individual psychology), these two streams were interconnected. Simon’s research dealing with organizational structure did not neglect individual decision making, and key concepts of his work on individual cognition appeared in the framework of his work on organizations (Koumakhov, 2009). Although the former category did not always explicitly consider organizational structure (e.g., hierarchy), it was implicit in the idea that structural boundaries and the division of labor reflect how the

organization represents its problems and affect how individuals filter information.² Simon suggested that, for organizational members, their corresponding subgroup or organizational participation influences their common maps and selective perception (Dearborn & Simon, 1958). Common maps or shared representations³ (i.e., perceptual mechanisms) arise in social contexts and supply interacting individuals with the “social definition of a situation” (Simon, 1995: 299), which is constructed via a firm’s formal organizational structure (March & Simon, 1958). For Simon, then, the socio-cognitive properties of organizational structure establish a link—between individual cognition and collective decision making. As we will discuss, this aspect of Simon’s work has been mostly overlooked in recent research.

Information processing perspective

An information processing perspective that was largely separate from Simon’s work emerged in the field of management during the 1970s, and it reflected a growing interest by organization theorists and in the question of how organizations are affected by their external environment. The most notable and influential proponents of this perspective were Jay Galbraith, David Nadler, and Michael Tushman, who built on the work of Thompson (1967) and Lawrence and Lorsch (1967). Within this stream, information processing was a molar concept related primarily (though not entirely) to knowledge acquisition and communication among decision makers. According to these scholars, the role of structure is to increase the organization’s information processing capacity to deal with internal complexity and environmental uncertainty (Galbraith, 1977; Tushman & Nadler, 1978; Gulati, Lawrence & Puranam, 2005).

² We thank Phil Bromiley and Rouslan Koumakhov for many of these insights into Herbert Simon’s work.

³ The terminology “common maps” and “shared representations” are used interchangeably throughout the paper.

Among these scholars, there was general agreement that no single template for an optimal formal organizational structure exists; in other words, the “best” structural solution depends on a variety of contingencies. So rather than prescribe an ideal universal type of organization design, scholars postulate that the relationship among strategy, structure, and performance depends on multiple factors (e.g., Donaldson, 2001). This perspective, which is known as *contingency theory*, holds that an organization cannot be effective unless there is “fit” between its environment and its structure. Fit is achieved by mutually reinforcing internal activities and by matching an organization’s structural characteristics to its information processing demands (Burton & Obel, 2004).

Although contingency theory lost much of its potency in the 1980s and 1990s, interest in information processing continued to grow and became more sophisticated. Scholars in the field of organization and strategy sought to model more complex organizations, and agent-based computer modeling techniques led to research that could account for multiple design choices (Siggelkow, 2011). This literature re-discovered Simon’s interest in individual information processing and the notion of nearly decomposable systems (Simon, 1964). These foundational ideas, when expressed with new modeling tools, made it possible to explore systematically the trade-offs involved with—and the decision-making implications of—interacting agents across a greater number and variety of information processing structures. Researchers adopted these methodologies, which led to a rebirth of organization design in strategy and organization theory.

MAJOR THEMES IN RECENT RESEARCH

Our initial scan of the literature involved identifying key foundational works and review articles. To build our set of representative papers, we accessed the Google Scholar and Social

Science Citation Index and used a Boolean search string to retrieve articles whose titles, abstracts, or keywords contained the terms “organization* structure” (or “organization* design”, “organization* form”, “organization* architecture”, “multi-business”, “structure”, “corporat*”, “hierarch*”, “subunit”), and “information processing”, or “decision making” (or “adapt*”, “search”, “explore”, “evaluat*”). To ensure that our analysis would encompass mainly papers of more recent vintage, we limited our search to those published—over the last 20 years—in the field’s nine leading journals: *Academy of Management Journal*, *Academy of Management Review*, *Administrative Science Quarterly*, *Journal of Management*, *Journal of Management Studies*, *Management Science*, *Organization Science*, *Organization Studies*, and *Strategic Management Journal*. We then narrowed our results based on the boundary conditions described in the introduction section. This effort yielded 281 articles.

After eliminating those papers that contained only brief usage of the terms and topics in question, we were left with a total of 70. We then read these papers and coded the central focus of the study in terms of its overall conceptualization of the role of structure in decision making. We found that these papers addressed four major categories of research: *problem-skill matching*, *screening*, *adaptation*, and *cognition*. These four categories of the literature all echo foundational work in viewing organizational structure as a solution to the problems associated with information processing and a means for coordination in decision making. We reviewed the initial papers from each of the streams, as well as identified some of their major similarities and differences. We sorted the 70 articles according to the number of Google Scholar citations they had received. We proceeded to examine the backward and forward citations of the most influential articles in the list. This exercise led us to both papers outside of the initial sample that may have not used verbatim one of the original search terms, as well as relevant papers in

journals in adjacent fields. We continued with the exercise until we felt confident that we had identified the relevant and representative papers in each of the four categories published in the last 20 years.

See Tables 1 and 2, respectively, for illustrative citations and comparison across streams.

Insert Tables 1 and 2 about Here

Problem-skill matching

Problem-skill matching studies are grounded in organizational economics. The research in this stream takes a decision-theoretic approach that focuses on representations of efficient allocation of tasks among the members of a multi-agent team. The central problem addressed by such models is that, although organizational members need to coordinate, the tasks and skills used to make decisions varies from one member to the next (Garicano, 2000). Hierarchy affects organizational decision making by ensuring that people see problems that uniquely require their particular level of skill.

This stream originates from the same tradition as team theory, which was an early economic model of decision making in organizations, and examines the costs and benefits of decentralized information processing (Marshak & Radner, 1972; Radner, 1993). In these models, the objective is to compute a set of decision rules or programs, for each individual of the “team” (i.e., organization), that maximizes the expected payoff in a stochastic environment.

Organizational members process different information and communicate their conclusions up the vertical hierarchy, with the top of the hierarchy making the final decisions (Van Zandt, 1999).

This theory of teams ultimately served as the foundation for a variety of subsequent models, including those that elaborate on the optimal grouping of functions (Cremer, 1980), diversity of information (Cremer, 1983), and allocation of decision rights (Sah & Stiglitz, 1986). Studies

addressing the last of these have been useful in strategy research that seeks to build and test theories of centralization and decentralization in organizational design, which we shall describe in detail (cf. Csaszar, 2012).

Among the efforts by economists to model organizational decision making, the work by Garicano and colleagues is notable for management scholars (Garicano, 2000; Garicano and Wu, 2012; Bloom et al., 2014). The goal of such studies is to devise an optimal organizational structure given the costs of communication and information acquisition. The hierarchy's rank ordering of knowledge serves to manage exceptions and to match problems with solutions. More difficult or complex problems are referred up the hierarchy to be handled by specialized (i.e., more highly skilled) problem solvers.

Garicano (2000) developed a formal model in which the division of labor increases specialization and thus allows lower-level specialists to solve simple problems; harder or more complex problems are elevated up the hierarchy. The costs of workers acquiring knowledge to solve problems (delegation) are weighed against the costs of elevating those problems to the management level. Garicano's model indicates that hierarchy minimizes the cost of knowledge acquisition and increases the specialized use of knowledge—especially when knowledge is tacit and/or when problems are difficult to identify *ex ante*.

Bloom, Garicano, Sadun, and Van Reenen (2014) found empirical evidence consistent with Garicano's (2000) theory. Using plant-level data on information technology investment and a survey to elicit the structural features of firms, they found that lowering the costs of acquiring and communicating knowledge affects the extent of decentralization within a firm. These authors showed that investment in "enterprise resource planning" systems, increases the autonomy of plant managers and also of workers; in contrast, investment in intranet technology—which

lowers communication costs—*reduces* both manager and worker autonomy. Wu (2014) extended Bloom et al.’s work by modeling the choice of organizational structure and products. He found that the greater span of control (flatter organization with more intensive vertical interactions) lends itself to producing higher value products, and is enhanced with greater communication of knowledge.

Bridging organizational economics and strategy perspectives, Garicano and Wu (2012) argue that to support coordination, the choice of an organizational structure is driven by the complexity of tasks faced by the firm and by the “modifiability” of knowledge required to perform those tasks. Here variation in costs, which necessarily follows from limited attention, is a function both of the firm’s specialization in activities and of its capacity for vertical information processing when matching problems with solutions. They also highlight the benefit of shared codes for coordination when information is at least partially tacit.

Synthesis. Although the work in this stream models the actions of economic agents, it deviates from foundational work on team theory. In particular, team theory is concerned with the aggregation of information. These models articulate vertical information processing in a decentralized organization as a concern of both the amount of information, the timeliness of processing that information, and of course the associated costs (e.g., costs of delay).

However, the task assignment models proposed by Garicano and colleagues do not aggregate information in this sense that that multiple organizational members collectively contribute to an overall final decision (Gibbons, 2003). Instead, the focus is on how structure constrains decision making. Organizational structure is modeled as a hierarchy of knowledge (or skill) rather than a hierarchy of authority.⁴ The central information processing problem is an

⁴ The two are rarely isomorphic; imagine a division manager being tasked with solving a production process problem that the shop floor engineer cannot.

optimal task allocation problem, given the costs of knowledge acquisition and communication. The hierarchy is a tool for exception management where problems of increasing complexity are elevated within the organization. Lower level individuals are thus limited or constrained by their specialized knowledge and handle problems that match their skill level.

Importantly, the models all assume that member interests do not differ. Decision making reflects implications of different individuals who hold different information, have different skills, and control different decisions, but are working toward the same end. This crucial assumption allows researchers to avoid the incentive problem and to focus instead on the information problem. Even so, frictions that might arise from specialized knowledge and/or information sharing in coordinated decision making are largely glossed over. Hence, the potential for conflict is not accounted for explicitly.

Also, Garicano and colleagues generally consider the differences in know-how between hierarchical levels to be infinitely “sticky.” But the specific facts to be processed are “mobile,” in that they can be readily transmitted and the only cost involved is from transmission and attention. However, as noted by Postrel (2002: 304, quoting Kogut and Zander, 1996), “this approach assumes away the real difficulties of communication among people, which have to do with such things as conflicting conceptual categories and semantic ambiguities.” Finally, while acknowledging the specialization of decision making at different levels of organization, the studies here do not explicitly articulate different steps (or types) in the decision-making process.

Screening

The literature here deals with the screening of information by individuals situated in different structures. It includes studies of how different decision rules affect quality of decision making and of how hierarchies affect the psychological biases in decision making. More practically, the

literature on screening sheds light on how an organization's structure can be modified to compensate for its member's fallibility. This is a diverse set of studies utilizing a variety of methods and approaches drawn from economics, social psychology, and organization theory.

Decision rules. The first set of studies largely draw from and build on the basic model proposed by Sah and Stiglitz (1985, 1986, 1988), which compares the screening properties of hierarchies and polyarchies; those studies reflect (respectively), centralized and decentralized decision-making structures in the economy. The basic premise underlying these models is that individuals are prone to errors of judgment and that those errors are affected by the aggregation, decision, or voting rules associated with different structures. The key insight is that, if decision makers are fallible, then hierarchical (resp., polyarchical) structures increase errors of omission (resp., errors of commission). Sah and Stiglitz (1991) also showed that, in structures that are relatively centralized, highly capable decision makers have more beneficial effects (than in a decentralized structure) on decision quality. This latter result amounts to a salient qualification on the implicit assumption that guides the problem-skill matching literature—namely structural position and skill level are equivalent.

In applying these insights to organizations and empirically testing their propositions, strategy and organization scholars have suggested some important extensions. For example, Christensen and Knudsen (2010) examined the reliability of different structures as a function of the organization's number of individual members. Their analytical model considers not only the extremes (hierarchy vs. polyarchy) but also the full range of organizational architectures, enabling the specification of structures that trade off Type I and Type II errors (i.e., those of omission and commission, respectively) as the relative degree of hierarchy and polyarchy shifts. Csaszar (2012) exploited the stock-picking decisions of mutual fund managers and found that

decentralized structures are associated with the acceptance of more projects—with fewer errors of omission and more errors of commission—than are centralized structures. In linking Sah and Stieglitz with signal detection theory, the work suggests that if errors of omission (resp., commission) are costlier, then the organization is best served by a decentralized (resp., centralized or hierarchical) structure.

Knudsen and Levinthal (2007) described how agents within different organizational structures perceive and search in an NK landscape and found that some structures are better than others at promoting exploration. Screening ability and organizational structure exhibit a high degree of complementarity. The less (resp. more) able are individual evaluators, the more attractive are organizational forms that tend toward hierarchy (resp. polyarchy). Thus a hierarchical structure compensates for the high error rates of less able individual evaluators whereas a polyarchy—or, more strictly, the variance that it induces—compensates for what can be the overly precise judgments of abler evaluators. Similarly, Csaszar (2013) looked at the relationship between the structure of an organization and its ability to explore and exploit; in that study, exploration and exploitation are viewed in terms of the errors of (respectively) omission and commission. He showed that “hybrid” structures not only can trade off one error against the other but also can achieve a smaller error overall. That is, hybrid structures allow for a simultaneously high degree of exploration *and* exploitation.

Csaszar and Eggers (2013) evaluated the robustness of various decision-making structures—delegation to experts, majority voting, and averaging of opinions—to environmental changes and to differences in the expertise of decision makers. They found that each structure’s performance depends on the breadth of knowledge within the firm and on changes in the

environment. Delegation is a common structure for organizations in relatively stable environments, whereas voting is more common under changing environments or memberships.

Research in this stream has also started to address how more distributed structures, such as communities and crowds use to access, process, and screen information (Van Knippenberg, Dahlander, Haas, & George, 2015). For example, Retelny et.al (2014) and Valentine et. al (2017) introduce the idea of “flash teams” and “flash organizations”– dynamically assembled online experts from the crowd – to manage complex and interdependent tasks. These computationally-represented structures rely on traditional notions of roles, teams and hierarchy and the roles encode interdependencies, and the nesting of roles encodes hierarchy and decision rights. The information flows to up the hierarchy as a worker submits a task in the system, who then reviews and accepts it or returns it with feedback for revision. At the same time, the structure adapts continuously by reconfiguring roles, teams, and hierarchy based on both top-down and bottom-up information flows.

Psychological mechanisms. The second set of studies introduces the idea that hierarchy may affect the behavioral tendencies of those sending proposals up the chain of command for approval. For example, in a study of commercial banks, McNamara, Moon, and Bromiley (2002) found that the propensity of managers to loan money to businesses despite a negative change in their credit worthiness was attenuated, when those managers faced hierarchical evaluation of their decisions. This de-escalation of commitment is attributable to the increased monitoring that comes with hierarchy.

In other cases, structure may exacerbate decision-making biases. Managers may feel threatened by top management or by the centralized provision of feedback, a dynamic that has implications for creativity and novel search (Kim & Kim, 2019). For example, Fang, Kim, and

Milliken (2014) reasoned that an organization's members may screen information in their reluctance to inform managers of bad news; hence lower-level staff may "sugarcoat" negative feedback and thus leave those managers with a distorted view of the organization's performance. Yet the authors found that there may actually be some positive consequences to a moderate amount of systematically distorted negative information: it may create a sense of well-being that is sufficient to prevent potentially valuable exploratory efforts from being prematurely abandoned.

Reitzig and Sorenson (2013) reported that the failure to adopt an idea or innovation can arise from in-group bias among employees of an organizational subunit; such bias would result in those individuals systematically undervaluing the ideas proposed by organization members outside their own subunit. Along similar lines, Reitzig and Maciejovsky (2015) used a data set of innovation ideas submitted by mid-level managers in a large European consumer goods firm. They found that a hierarchical structure reduced the number of ideas that these managers passed up to superiors. They offer two explanations this finding: (i) mid-level managers fear negative feedback from errors of commission, in which case structures that are more hierarchical induce more apprehension about evaluation; and (ii) these managers may view themselves as lacking control and hence would prefer to forgo the administrative burden of transmitting new ideas. These explanations notably run counter to those implicit in the Sah and Stiglitz model, under which mid-level managers should be less likely—given that ideas are screened also at higher levels—to exhibit conservative screening behavior and thus *more* likely to send ideas up the chain of command. Building on this empirical work, Keum and See (2017) adopted a mixed-method approach to examine both idea generation (search) and idea selection (evaluation). Combining an experiment with data on apparel launches by a multi-national fashion retailer, the

authors hypothesized and demonstrated that hierarchy may impede idea generation owing to the “evaluation apprehension” and lack of control experienced by those at lower levels. Hierarchy is beneficial in the selection phase, however, because it may reduce the bias of individual subunits that are prone to favor their own ideas and thus may encourage the promotion (and acceptance) of proposals made by other units.

Synthesis. Our analysis has identified two substreams of screening research: one which builds on the Sah and Stiglitz (1986) decision rules model, and the second which highlights the behavioral biases of managers. A key difference across these substreams is the role of the organizational structure. The decision rules models are about information aggregation. This literature documents that the search for and evaluation of alternatives are consequences of different structure types, which in turn affect how the information is screened and aggregated by boundedly rational individuals (Csaszar, 2012, 2013; Csaszar & Eggers, 2013; Knudsen & Christensen, 2010). The behavioral studies are less about aggregation and more about how the structural context affects individual decision-making biases. Although both streams recognize fallible decision makers, the decision rules models emphasize errors in judgment; whereas the behavioral models emphasize psychological biases. As we shall see below, this relates the screening literature to some of the adaptation literature which is our next section.

These two substreams are similar in that for both, hierarchy serves as a mechanism for proposal evaluation. In particular, hierarchy is a tool for *validating alternatives* generated at lower levels; thus proposals are either endorsed or rejected at higher levels after vetting at lower levels. However, the nature of the hierarchy also differs across the two substreams in that in decision rules models, the term hierarchy is used in a narrow sense; that is, the structures do not fully incorporate issues of authority or power. In the behavioral models, the role of hierarchical

authority is important (though usually implicit) in that it influences the behavior of lower-level people.

Much of the decision rules work also assumes that individual evaluators are homogeneous in terms of their interests and screening abilities.⁵ The focus is on who makes which decisions using what information, and on how those factors are related to the structure of communication (March & Simon, 1958/1993). Because it relies on the independence of individual judgments in support of *common* outcomes, this substream also neglects any motivational differences between decision makers. Moreover, the likely tension between information screening and motivational differences among decision makers is not yet fully explored.

Note that the studies largely focus on search and evaluation of alternatives, and the findings are broadly consistent. Both sets of studies suggest that the impact of hierarchy may vary with outcome and stage of decision making. Though the voting models focus on search, and much of the behavioral models focus on evaluation (Keum & See, 2017 is an exception). Hierarchy seems to be more detrimental for search than for evaluation (McNamara et al., 2002; Keum & See, 2017; Reitzig & Maciejovsky, 2015; Reitzig & Sorenson, 2013), consistent with the modeling work that suggests omission errors occur more in hierarchies than in decentralized structures owing to vetoing ideas as they are elevated (Christensen & Knudsen, 2010; Csaszar, 2012).

⁵ A notable exception is Csaszar and Eggers (2013) who, like the problem-skill matching literature, account for heterogeneity in terms of ability.

Adaptation

The third vein of research pertains to learning and adaptation. Much as in the problem-skill matching and screening literatures, information processing in the adaptation stream of research reflects Simon's notion of limited human cognition. When presented with problems, rather than search for optimal solutions, individuals *satisfice* and choose the first alternative that meets their aspiration levels. Scholars in this domain view organizations as adaptive systems (Denrell & March, 2001; Posen & Levinthal, 2012); thus firms adapt via experiential, trial-and-error, and/or reinforcement learning—as indicated by their updated actions in response to performance feedback.

Organizational structure plays several roles in this literature. A large share of the research in this domain focuses mainly (though not exclusively) on understanding how organizations enable their boundedly rational members to adapt collectively to their interdependencies (Aggarwal & Wu, 2015; Baumann, 2015; Puranam et al., 2015). A primary concern in this literature is how best to balance the interactions within and between individuals or units as a change in one aspect of a firm may, in turn, affect its other aspects (Siggelkow, 2001). Given the complexity of such interdependencies, it is hardly possible for a manager to be aware of—much less to comprehend—all these interactions. Some of these studies also share a common methodological approach: agent-based modeling. Such models—which include, inter alia, NK models, bandit models, and coupled learning models (Puranam et al., 2015)—often characterize decision sets as existing on a “performance landscape” where variations in the interactions between choices result in different performance levels or “peaks” (Levinthal, 1997). In real-world organizations, these combinations manifest as interconnected decisions between upstream

and downstream functional departments, collaborating business units, adjacent components of the value chain, or integrated product development activities (e.g., Sorenson, 2003; Sosa, Eppinger & Rowles, 2004). Next, we examine the structural variations that characterize the efforts of firms to deal with interdependencies and consider the impact of these efforts on decision making.

Modularity. Drawing on the notion of modularity featured in the literature on design (Sanchez & Mahoney, 1996; Baldwin & Clark 2000), several studies seek to determine the optimal degree of modularity considering the underlying internal interdependencies. For example, Ethiraj and Levinthal (2004) modeled the outcomes of managers under- and over-modularizing their organizational designs relative to the actual structure. They found that excessive modularization may obfuscate important interactions and create significant uncertainty about system complexity, resulting in poor performance. Along similar lines, Siggelkow (2002) explored the consequences of managers who do not fully comprehend the strength of interactions between activities. According to the results of that study, misperceptions involving complementary activities are costlier than those involving substitute activities because complements (resp. substitutes) tend to amplify (resp. attenuate) the performance consequences of misperception. In a mixed-method study including a theoretical model and a laboratory experiment, Billinger, Stieglitz, and Schumacher (2014) asked participants to design a new product in which multiple product features must be combined in a particular configuration. The authors established different levels of interdependencies among design elements in order to manipulate task complexity (i.e., by creating different landscapes). Study participants in the low-complexity landscape found the global optimum, whereas none of them found it in the high-

complexity landscape. In addition, deviations from local search were more strongly associated with complex tasks—especially in the advanced stages of search.

Aggarwal and Wu (2015) used a panel data set of firms in the US defense industry between 1996 and 2006 to examine the organization's interdependence structures—and its associated coordination needs—toward the end of explaining differences in how firms adapt to an industry-wide demand shock. The authors found that coordination across product areas creates greater adaptation challenges than does coordination within product areas. They also report that the negative effects of interproduct coordination are enhanced when the firm's products have a greater number of underlying interactions (i.e., higher product complementarity) yet are mitigated when interdependences are grouped by organizational unit.

Integration through hierarchy. In studies addressing this topic, hierarchy is a key integrating mechanism to limit suboptimal choices (due to unobserved interactions) and thereby improve overall decision quality. One group of studies test whether, in the presence of decision interdependencies or other boundary conditions, a centralized instead of decentralized structure yields more benefits. For example, Rivkin and Siggelkow (2003) found that a hierarchy tends to yield better outcomes when interactions among decisions are pervasive—but only if there is sufficient information flowing up the hierarchy. That is, centralized decision makers amid interdependencies are better (than decentralized ones) at vetting proposals but require a robust set of proposals to which they can respond. A later paper established environmental turbulence and complexity as important boundary conditions of such centralization and demonstrated lateral communication (between department heads) as an effective alternative (Siggelkow and Rivkin, 2005).

In a related paper, Siggelkow and Levinthal (2003) examined how decentralization affects the search for high-performing combinations of activities. They found, in accord with prior research, that decentralization allows for the sufficient exploration of new combinations; however, they found also that reintegration (i.e., centralization) is needed to ensure a complete accounting of all the interdependencies among activities. These benefits of temporal shifts in structure were likewise identified by Nickerson and Zenger (2002), who argued that regularly switching between efficient and flexible structures often places the organization in an intermediate stage that enhances its performance.

This interest in hierarchy and adaptive behavior has not been confined to modelers. In their empirical study of innovation in multi-technology firms, Eggers and Kaul (2018) found that managers responsible for a portfolio of technologies are more willing to take greater risks (to launch radical innovation projects), than are managers responsible for a single technology. Centralized control over a portfolio leads the former to be less concerned about the risk of any one technology and to seek expansion of the portfolio, an orientation whose effect is to reduce the portfolio's overall risk. Joseph, Klingebiel, and Wilson (2016) similarly reported that more centralized managers (i.e., those responsible for a portfolio of products) are less concerned about the fate of any particular product than are decentralized, single-product managers; hence centralized managers are more willing to pull unsuccessful products from the market and to reinvest those resources in the portfolio's other, potentially more successful products. In conglomerates with subsidiaries exposed to multi-market competition, centralized decision makers (i.e., corporate office) may be best off to limit the decision rights and resources of constituent subsidiaries—what Sengul and Gimeno, (2013) call imposing constrained discretion.

Constrained discretion limits subsidiaries' competitive actions, which is beneficial since aggressive responses can serve as strong basis for retaliation by rivals.

Finally, Seshadri, Shapira, and Tucci (2019) study the relationship between degree of hierarchy and the quality of R&D and find that there is an “optimal” level of hierarchy for the quality of R&D decisions (patenting), a finding that is consistent with other research that has identified the benefits of a moderate degree of structure (Davis, Eisenhardt, & Bingham, 2009).

Coupled search within hierarchies. A second series of studies examine the *coupled search process within multi-level hierarchies*. This dynamic is often reflected in efforts by senior managers to find superior combinations of policy choices and parallel efforts by lower-level managers to find superior combinations of activities that conform to those policy choices. For example, Siggelkow and Rivkin (2009) examined such a hierarchical coupled learning problem and established that such a search process can, at lower levels, obscure the true impact of higher-level choices. In particular, lower-level organizational members can (owing to “luck”, say) make good choices despite poor higher-level choices or can misattribute their good choices to good high-level choices that have been since discarded. Lee and Puranam (2016) extended this line of thinking to examine what happens when the organizational member who holds a belief or favors a related strategy (e.g., senior manager) is not the same person who undertakes action based on that strategy (e.g., lower level manager). In this case, imperfect implementation could be beneficial even if ex ante beliefs were imperfect, since the updating of imperfect models and strategy may benefit more from accurate performance feedback.

More recently, Levinthal and Workiewicz (2018) examined a hierarchical form commonly found in “matrix” organizations, where an individual member reports to two different managers. In their setup, multiple higher-level managers search for better *policies* while multiple

lower-level managers search for better *strategies*. Such dual authority may provide lower-level managers with more autonomy in decision making (i.e., because they have fewer constraints); multi-authority structures also make it possible for the manager to negotiate between superiors, who may in turn offer greater latitude in light of the dual demands. The Levinthal and Workiewicz results indicate that a dual reporting structure performs better when organizational demands likewise have a dual focus—in other words, when the organization needs to enable local adaptation by subunits but still must coordinate across those subunits. The matrix organization’s capacity for coordination and negotiation has similarly been demonstrated empirically in the context of alliances (Sytych, Wohlgezogen & Zajac, 2018).

Interdependencies within the multi-divisional firm. Another group of papers has examined behavioral interdependencies within a multi-divisional firm or business group. These studies explore both the horizontal differentiation of subunits within a larger corporation and the role of internal social comparison affect subunit responses to performance feedback. For example, scholars have usefully examined what happens when multiple units or individuals must assess performance feedback in the context of others’ performance, a form of interdependence that reflects competition over resources.

Although partly an incentive story, Obloj and Zenger’s (2017) study examined the formal and informal design elements shaping the structural, geographic, or social distance of advantaged peers at a retail bank. They found that, in organizational structures facilitating the development of frequent and close social interactions between subunits, there is a greater tendency to engage in social comparisons. Hu, He, Blettner, and Bettis (2017) called the internal social comparisons with other divisions a “political reference point” and suggested that, because relative performance determines the amount of resources and attention received from the corporate

office, it shapes (in concert with external social comparisons) the firm's aspirations. These authors found that inconsistent feedback leads to more attention being given to the social reference point relative to which the focal division is underperforming. Tarakci et al. (2018) find that comparing performance to peers and other subunits better motivates managers' divergent strategic behavior. Managers who identify more with the organization pay more attention to organizational rather than individual attainment discrepancies. In a computational model, Baumann, Eggers, and Stiglitz (2018) also argued that intraorganizational comparisons are a natural part of the firm's political landscape. Their study demonstrates that internal social comparisons as a function of corporate membership, create—more so than do historic comparisons—winners *and* losers and thus are more likely to result in a better balance between exploration and exploitation activities at the organizational level. In other words, units that are performing better than their peers engage in exploitation whereas underperforming units explore.

Finally, Knott and Turner (2019) suggest a key role for the corporate headquarters in stimulating these internal dynamics. Using an analytical model and a case study of Banc One, they argue that headquarters promotes both interunit community which affords cooperation, and interunit competition which stimulates social comparison and innovation as units attempt to maintain their favorable position in the corporation.

Integration through knowledge sharing. A distinct subset of work examines how organizations adapt by adding, redeploying, recombining, or divesting knowledge and resources to achieve efficiency, to explore new opportunities, and to innovate (e.g., Helfat & Eisenhardt, 2004; Karim, 2006; Karim & Mitchell, 2000). Adaptation occurs as units evolve (or “morph”; Rindova & Kotha, 2001) and as corporate executives patch (or “re-architect”) their line of business portfolios by creating new divisions (Gilbert, 2005), by shifting product market charters

from one business unit to another (Galunic & Eisenhardt, 2001), and by eliminating, splitting, or combining extant units (Karim, 2006). These studies are broadly concerned with interactions and movement between individual decision makers but much less concerned with internal interdependencies or performance aspirations.

For example, Karim and Mitchell (2000) find that under certain conditions, structural recombination serves as a mechanism to recombine intraorganizational knowledge and to disrupt the firm's own knowledge base. Similarly, Karim and Kaul (2015), find that structural recombination has a more positive effect on firm innovation when there are knowledge synergies within the organization, when the technology is novel, and when the disruptive effects of structural recombination are contained.

Integration through knowledge sharing may be especially critical for coupling divisionalized firms seeking to take advantage of new external opportunities. Fang et al. (2010) picks up this theme in an agent-based model and argues for the benefits of improving the *information flow* across individuals and groups. They discovered that moderate levels of information exchange between subunits is optimal for allowing superior choices to diffuse across groups without reducing the diversity of those ideas too quickly. In an empirical study of the telecom industry, Williams and Mitchell (2004) find that links between business units is beneficial in that they provide the cooperating units with new sets of information.

Martin and Eisenhardt (2010) studied how executives create high-performing cross-business unit collaborations in multi-business firms. They find that the highest-performing collaborations occur when business unit GMs interact. The highest system-level performance results from small events that bring lower-level managers together (e.g., an industry conference) and from interactions that make it easier to share information and make collaborative decisions.

In another an empirical study of in vitro fertilization clinics, Stan and Puranam (2017) showed that *integrators*—in this case, healthcare professionals who set the treatment course and handle idiosyncratic patient adjustments—help the organization avoid “superstitious” learning (i.e., misattribution of causal linkages between behavior and outcomes) through active questioning, seeking justification for procedures, and so forth. In Brusoni and Prencipe’s (2006) in depth case study of Pirelli, they examined how the integration of product and process knowledge created a new kind of tire designer: that of an engineer who was competent in the entire process of tire design and production. The key to the integration were modular design rules at the plant level which lead to the unintended consequence of creating an integrated body for engineering know-how.

Synthesis. The adaptation stream is a highly diverse one, incorporating many properties of structure and exploring many kinds of decisions. The modeling papers are similar to those in the screening literature in that the focus is on information or (more accurately) choice aggregation structures. Here the organizational structure acts as a mechanism that aggregates individual perceptions into a group-level evaluation of alternatives. Alternatively, empirical studies of hierarchy, the multidivisional firm, coupled search, and knowledge sharing are closer to the cognition papers (below) in that – rather than aggregation - they convey a sense of the constraining and enabling role of structure. For example, the multidivisional firm creates a context for peer unit social comparison. In a firm with coupled search, the higher level choices may constraint those made at lower levels.

This research is distinct in that it explicitly considers ways to manage interdependences and integrate the organization through limiting the interactions among decisions, providing hierarchical oversight, and increasing shared knowledge. The focus is on how firms can organize

to ensure that misunderstandings, misrepresentations, misattributions, or simply bad luck that arises from uncertainty about the interactions among activities are mitigated through structural choices. Hierarchy, in particular, is a mechanism used *to provide an integrated evaluation of alternatives*. Senior managers search and evaluate alternatives with their interdependencies in mind and so are better able to manage such decisions (e.g., Sengul and Gimeno, 2013; Joseph et al., 2016; Eggers & Kaul, 2018). In addition, this literature pays attention to the role of knowledge sharing and recombination (Karim & Mitchell, 2000; Fang et al., 2010) in promoting adaptive behavior.

Research on adaptation also differs from prior work also in that the information problem is one of uncertainty about the consequences of interdependencies—that is, rather than a skill gap or questionable proposal quality. As a result, costs are not directly modeled; information processing costs are driven by uncertainties in resolving interdependencies, not by the direct costs associated with information acquisition or those associated with the adulteration of information that happens through communication.

Though a common theme in the literature concerns search, it offers a diverse set of decision outcomes including imitation (Ethiraj, Levinthal & Roy, 2008), new product development (Sosa et al., 2004; Kotha & Srikanth, 2013), radical innovation (Eggers and Kaul, 2018), product exit (Joseph et al., 2016), alliances (Aggarwal et al., 2011), strategic renewal (Albert et al., 2015), and learning (Stan & Puranam, 2017) among others. Based on this variety, it is evident that no one structure that is best for search or adaptation. Also learning from positive feedback does not imply, a fortiori guarantee, better performance. Because of interactions, individuals may not recognize when the conclusions they draw from feedback are inaccurate. Instances of positive feedback may therefore lead to superstitious learning, flawed decision

making, and performance-impairing behavior with significant long-term consequences (Levinthal & Posen, 2007) – and hence suggest a role for centralized decision makers.

Overall, the studies in this stream have effectively demonstrated how the structural context can successfully address not only the environment's fundamental complexities but also the difficulties that this complexity creates for problem solving and decision making. But it also suggests that structure is fundamentally viewed as a coordination tool and any potential frictions when managing interdependencies are not fully articulated or explored.

Cognition

The fourth stream of research broadly concerns the relationship between organizational structure, individual cognition, and decision making. The cognition strand draws from Simon's notion that managers bring a set of simplified models to the problems they identify, the feedback they receive, the solutions they find, and the decisions they make (Gavetti & Levinthal, 2000; Gavetti, Levinthal & Rivkin, 2005; Simon, 1991). The idea that managerial cognition is consequential for organizational behavior and strategy is well established (Walsh, 1995; Gavetti and Levinthal, 2000; Eggers and Kaplan, 2013; Helfat and Peteraf, 2015). Yet in much (but not all) of the research covered so far, the simplified models employed by individuals are either implicit or neglected (Csaszar, 2018). Of central interest here is the idea that these models, derived from the structural properties of the organization, assist individuals in categorizing environmental signals, managing uncertainties, and focusing attention. This research recognizes that organizational structure creates differentiated contexts that lead to distinct responses to environmental information.

Integration through mutual knowledge. One substream considers how firms may create shared mental models by increasing the *mutual knowledge* between individuals, teams, or units and thereby severely reducing the need for direct communication or hierarchical intervention. Postrel (2002) referred to this as trans-specialist knowledge and suggested that it may be especially helpful in the face of “glitches” or potential mis-understandings between two units (Hoopes & Postrell, 1999). Mutual knowledge is necessary for coordination, especially when there is “epistemic interdependence” (Puranam et al., 2012). That is, mutual knowledge allows agents to *predict* what other agents will do amidst interdependencies, thereby making it easier for individuals to make better choices.

For example, a series of studies examining problems of coordinated exploration, considered the role of common ground—knowledge that is both shared and known to be shared—in creating shared representations. In a study that examined the process of offshoring business processes, Srikanth and Puranam (2011) demonstrated that mutually shared knowledge may reduce the need for explicit communication or for plan-based coordination mechanisms even in situations of complex interdependence. Puranam, Singh, and Chaudhuri (2009) found that interdependence motivates the structural integration of an acquired firm but that pre-existing common ground gives acquirers an alternative means to integrate. Knudsen and Srikanth (2014) examine the common knowledge provided by *individuals with T-shaped skills* (i.e., deep knowledge in one area combined with adequate knowledge in other domains). Such individuals serve as effective integration mechanisms when the goal is exploration; the reason is that they can search for solutions to problems while sufficiently accounting for constraints related to how their choice is likely to interact with other constraints that a joint solution must satisfy.

In one of the few empirical studies to link representations and performance, Csaszar and Laureiro-Martínez (2018), use an experimental research design to explore the relationship between individual's mental representations and the ability to predict strategic outcomes (what they call strategic foresight). At the individual level, they found two that strategic foresight is greater in individuals whose mental representations are broad and accurately match the consensus. Further, in comparing individual and group performance, they also found that groups exhibit greater strategic foresight than do individuals. But this was mainly due to aggregating group members' predictions than to aggregating their representations.

Hierarchy and cognition. A second subset of studies explicitly incorporate the role of hierarchy. Gavetti (2005) presented a treatment of mental representations within multi-unit organization structures—and of what these structurally-driven representations imply for information processing. Results derived from Gavetti's model revealed that a fundamental driver of organizational search, and hence of accumulated capabilities, is managers' cognitive representations of their strategic decision problem. The author showed also that the accuracy of a manager's representations varies as a function of that manager's position in the organizational hierarchy.

Jacobides (2007) also linked hierarchy and cognition in a study that examined how Greek's military and diplomatic hierarchical structure failed to prevent escalating tensions with Turkey. He found that the government hierarchy failed precisely because different governmental divisions focused on different aspects of the problem and overlooked key information. In addition, the Greek government made no effort to overturn routine inappropriate responses and the divisionalization within the government further led to events being framed in ways that

encouraged—rather than discouraged—escalation. In this case, the hierarchy failed to uniformly frame the escalation and focus attention on key issues.

Joseph and Wilson (2017) explicitly argued that both top-down and bottom-up information processing help explain how organizations move away from routine patterns of behavior and sustain the allocation of cognitive resources to new opportunities. Using examples drawn from Motorola's entry into cellular technology, these authors showed that the corporate office can not only provide frames for the organization; it can also intervene directly in divisional decision making. It was only through the corporate office's framing and attention-directing efforts that the new technology was allowed to grow in one division—despite rising opposition to that technology within another division.

Attention/cognitive availability. Several empirical studies have considered the attention patterns and cognitive availability afforded by the location of a manager or unit within a complex organization. In a study of Korean business groups, for example, Rhee, Ocasio, and Kim (2018) hypothesized that business group membership makes group-level issues and solutions more *cognitively accessible* to managers and their subunits. In other words, if particular problems or solutions are viewed as group-level issues, then they are more easily retrieved from memory and so managers will direct attention to them when evaluating performance. These authors found that member units engage in more R&D search when there are more member firms performing poorly and a greater number of R&D-intensive firms within the business group.

Gaba and Joseph (2013) implicitly linked interactions between corporate and business units or among business units with the emergent properties of responding to feedback. They argued that, because managers of corporate units and those of business units *focus on different response repertoires*, they have different ideas about what constitutes a “local” search for

solutions. In their study of new product introductions, these authors found that business units—when responding to negative performance feedback—tend to focus their attention on tactical solutions (e.g., revenue enhancements and efficiency improvements to increase product output); in contrast, the corporate office will focus on reallocating resources and may even resort to disruptive firm-level reorganizations (which stifle the introduction of new products).

Several related studies draw more directly on the attention-based view (ABV; Ocasio, 1997). As a modern extension of the Carnegie School tradition, the ABV is considered to be an information processing perspective because it views managerial attention as the organization's key constraint. Yet the ABV also has expanded information processing perspectives by recognizing that (a) the distribution of attention within complex organizations is not uniform and (b) the relevance, interpretation, and use of particular problems and solutions may vary (in part) with the structural position of individual decision makers (Blettner, He, Hu & Bettis, 2015; Bouquet & Birkinshaw, 2008; Gaba & Joseph, 2013; Joseph & Ocasio, 2012; Joseph & Wilson, 2017; Rerup, 2009; Tuggle, Sirmon, Reutzel & Bierman, 2010; Gaba & Greve, 2019).

For example, Barreto and Patient (2013) studied how deregulation affected frames (problem representation) of a single firm in the oil and gas industry. They found that a subunit close to that environmental shock's locus is more likely (than is the corporate office) to frame the shock as a threat than as an opportunity. In related work, Dutt and Joseph (2019) explored how corporate structure affects a corporate agenda in the face of regulatory uncertainty in the renewable electricity industry. These authors found that since corporate managers are likely to be more sensitive than subsidiary managers to the preferences and intentions of external stakeholders, and they also have more information about the likelihood of future regulatory changes. Hence corporate managers are less likely (than subsidiary managers) to exhibit

uncertainty avoidance and will more likely respond to regulatory uncertainty by including renewable sources of electricity on the firm's agenda.

Another set of empirical studies make the notion of interactions more central in order to examine agenda setting. In a study of the pharmaceutical company Novo Nordisk, Rerup (2009) found that absent deliberate interactions between staff at different levels of the hierarchy, the attention given to particular issues—and the extent to which those issues are infused with specific beliefs and meaning—will vary. Rerup documented that adopting a new value system which shaped beliefs and instituting management review sessions (a key information channel) enabled the organization to direct its attention to key issues across the chain of command and to coordinate activities in response to those issues.

Even loosely coupled organizational forms such as communities and crowds, which bring people together in what Dahlander et al. (2017) labeled “interstitial spaces”—have unique attention-directing properties. These spaces are an “assembly of actors in a shared online space (e.g., social media users, open-source contributors, crowd-funding lenders) or what emerges among and between these actors as they continue to engage in social interaction.” In Piezunka and Dahlander (2015), the authors find that the aggregation of crowd contributions narrows organizational attention, and that rather than capture distant knowledge, which is an oft mentioned benefit of such organizational forms, can instead lead the organization to pay attention to alternatives that are familiar.

However, interactions are themselves linked in a formal network: issues and initiatives flow through communication channels, and organizational members participate in a variety of different firm channels. In a series of papers, Joseph and Ocasio (Ocasio and Joseph, 2005; Joseph and Ocasio, 2012) examined the effect of a system of communication channels on

situated attention patterns within the firm and on the corporate agenda. They found that, at GE, senior managers' perceptions did not always dominate within-channel interactions; in fact, business unit managers often played a leading role in shaping an emergent collective perspective. The authors discovered that the firm's combining of specialized and integrated channels increases its ability to adapt because that combination highlights key issues and facilitates agenda setting across corporate and business unit managers.

Digital information sources (e.g., intranets, social media) are channels of communication through which individuals may engage in both direct and indirect interaction. The latter, as occurs when a passive receiver is merely "lurking", offers decision makers what scholars refer to as *communication visibility* (Leonardi, 2014). Such visibility transforms previously invisible communication between organizational members into visible knowledge about who knows what and about who knows which third-party individuals. In his analysis of a large financial services firm's social networking platform, Leonardi argued that this visibility enables co-workers to better accommodate new ideas and so should result in products that are more innovative. Moreover, greater communication visibility may reduce the organization's dependence on meetings or liaison positions for increasing direct lateral communication among employees or subunits; it may also increase "transactive" memory (Ren and Argote, 2011)—which has been shown to improve decision quality—as well as reduce the duplication of work.

Synthesis. As the cited papers demonstrate, cognitive expression is evident in how organizational structure—in particular, hierarchy—provides the decision-making context and shapes the mental models used for decision making. The role of the organizational structure in this stream of literature is to mostly *constrain* the cognition of individual actors. Decision-making constraints are reflected in mental models (Gavetti & Levinthal, 2000) and in the

attention-directing properties of organizational structure (Ocasio, 1997). In particular, hierarchy is a mechanism for *providing decision premises and channeling attention* for the entirety of the organization. But whereas modeling papers tend to rely on different initial beliefs or experience, empirical work places greater emphasis on different locations in complex organizations.

Although these studies offer a simplified form of cognition and rarely measure it, individual cognition is the key theoretical apparatus that links structure and decision making. The cognition literature – like the adaptation stream - are also similar in their occasional reliance on a performance feedback mechanism for shaping attention and cognition—mostly in support of some kind of search. Although this is the only substream in which some consideration of agendas and problems is evident.

Also, as in much of the empirical work in the adaptation stream, the notion of interactions is mostly implicit and underdeveloped. While these feedback studies recognize such interactions occur, the focus is again on individuals; shared cognitions are ancillary to the theory. The qualitative ABV-related papers do provide some accounts of attentional variation, but we need more research linking it with the cognitive representations of managers. Since it is within and across channels that both the cognitive representations and the emergent properties of the attention-directing interactions may come together, it follows that such channels are a prime subject for future research. Despite this recognition that cognitions and attention vary within the firm, very little of the research considers the potential for conflict to arise.

Insert Table 3about Here

TAKING STOCK OF THE EXISTING LITERATURE

Our cross-sectional review of the literature demonstrates that the information processing properties of an organizational structure remain of considerable interest to a diverse group of scholars interested in decision making. The research reviewed here has advanced our understanding of the information processing challenges that organizational structure is designed to solve. The review also showed that despite the common use of the term “information processing”, these studies describe different ways through which structure – in particular hierarchy - affects different aspects of decision making.

From these observations, we can trace three critical issues. First, extant research is divided—implicitly focusing on one of two aspects of organizational structure and decision making: aggregation or constraint. The *aggregation* view reflects how different types of structure enable individuals to come together (i.e., to interact) for the purpose of making collective decisions. This perspective is dominated by the screening and adaptation literatures, which focus on (respectively) *aggregated voting patterns (rules)* and *choice sets*.

The *constraint* view reflects how the context established by the organizational structure *enables or constrains individual decision making*, including a sense for how structure may affect heuristics and biases. This view includes problem-skill matching, which addresses the limits of specialized knowledge, adaptation which focuses on structurally imposed limits on search, and cognition which shows the constraints that a problem solver’s context (e.g., location) puts on the choice of problems and solutions. Most constraint studies abstract from how the organizational structure aggregates managers’ choices and so, in effect, discount the effects of individuals, teams, or units interacting.

In neither set of studies is *cognition* is especially *social*. Researchers have yet to account fully for the idea that shared representation is a social construction, and how organizational structure shapes the cognitive processes underlying shared understanding. At root of this issue is that, with a few important exceptions (e.g., Knudsen & Srikanth, 2014; Puranam & Swamy, 2016; Csaszar and Laureilo-Martinez, 2018), what matters most in these studies are the features of *individuals'* limited attention and simplified mental representations (see e.g. Gavetti & Levinthal, 2000; Csaszar, 2018) or heuristics (Gavetti et al., 2005), which shape decision-making processes. Although there is interest in organization-level implications (Knudsen & Srikanth, 2014; Menon, 2015; Martignoni, Menon & Siggelkow, 2016; Puranam & Swamy, 2016), the focus is on the individual actor—the strategist, the manager, the “cognizer”—whose own perspective (based on mental representations, beliefs, and experience with the local world) offers some general guidance for making decisions (Levinthal, 2011; Csaszar & Eggers, 2013; Eggers & Suh, 2019).

Second, the studies we have reviewed almost universally ignore the potential for conflict.⁶ Conflict, according to March and Simon (1958: 132), can result from the need for joint decision making and differences in attention, or differences in perception of reality, or both. Underlying this lacuna is the literature’s assumption of uniformity in how information is interpreted, shared, and stored. Variation in the interpretive aspect of organizational structure is important because, if a situation is ambiguous, its meaning must often be adjudicated before decision making can proceed (Denis, Dompierre, Langley, & Rouleau, 2011). Variation in the sharing and storing aspects of information are important because it is through socio-cognitive processes and communication practices by which information is transformed into abstract

⁶ See Gulati et al., (2005)

representations, compared to what is in organizational memory, and ultimately used to make decisions.

Yet, as Daft and Lengel (1984: 554) lamented, a major problem for managers is ambiguous information, not a lack of data. Ambiguity implies that there are multiple interpretations of an organizational situation (Feldman, 1989). Ambiguity, unlike uncertainty, cannot be resolved – at least theoretically - with additional information. In such cases, the information processing problem is not how best to manage uncertainty via the availability or distribution of information but rather how to align different meanings in order to reduce ambiguity. Given that environmental cues are often ambiguous (Rerup, 2009; Weick & Sutcliffe, 2015), the implications of interpretive variation and structure's role in the (mis)alignment of meanings may in turn have ramifications for conflict in decision making.

We also observe that most studies in our purview assume that in order to deal with the attentional burden (Simon, 1955) and potential discord (Cyert & March, 1963) commonly associated with multiple and often conflicting goals, attention to goals is selective. In the empirical adaptation and cognition research, this often translates to fairly strong assumptions that (a) managers and other decision-making groups do not jointly consider multiple goals and (b) goal prioritization is both plausible and uncontested. However, these assumptions do not account for goal interdependencies, and largely assumes that tensions will continue to exist among subgoals (March & Simon, 1958) but that it will be managed through sequential attention (Greve, 2018) or temporal and structural differentiation of goals (Ethiraj & Levinthal, 2009). In the literature on adaptation, for example, theories of performance feedback propose that attention to goals is sequential and based on the need to resolve pressing problems or to close gaps

between performance and aspirations (e.g., Cyert & March, 1963; Greve, 2008; Gaba & Bhattacharya, 2012).

Also, there is an assumption that organizational goals are largely agreed upon prior to decision making and do not change over time. Only recently, studies have begun to account for the decision making outcomes when multiple goals either are difficult to prioritize or offer inconsistent signals on appropriate courses of action (Hu & Bettis, 2018; Gaba & Greve, 2019). While it is useful to consider conflicting goals and goal prioritization as a function of their importance and of the performance relative to the aspiration level, other possibilities include formation of temporary coalitions in support of different goals or alternatives and environmental links to the distinct activities in which organizational members are engaged (sales, production, and research and development). Thus, we suggest that any roadmap should redirect research to how elements of the specific situation affect which goals are activated and command the attention patterns of decision makers. Doing so should provide a window into coordination and into information-based conflict.

Third, recall that Simon (1947) articulated four steps in the problem-solving or decision-making process: setting an agenda, representing the problem, searching for alternatives, and evaluating alternatives. Yet modeling and empirical studies so far have focused primarily on search and, to a lesser extent, on alternative evaluation. This gap originates from the fact that much of the prior research presents decision makers as “modelers” or “updaters” and takes a relatively passive approach to cognition (Gavetti, 2005: 614). However, the notion of interpretive variation and variegated attention posits a more active approach to cognition and decision makers as “interacting selective shapers” who may guide the selection, retention, and

reconstitution of such information. As a result, our approach should be especially helpful in providing a window into agenda setting and problem formulation.

The dearth of research on these aspects of decision making has implications for our roadmap. The “downstream” aspects of decision making (i.e., search and evaluation) are largely determined by the agenda and problem representation, as they are defined by the organizational structure— and more specifically subgroup membership. For a problem or opportunity to be addressed, it must be on the agenda, and as Simon (1947: 124) argued, “different representations of the problem will produce different proposals for solutions.” Without proper theory about the information processing mechanisms of agenda setting and problem representation, we cannot fully articulate a theory of decision making.

Also, there is recursive relationship between search and evaluation and subsequent agendas and problem representations. That is, as certain solutions become familiar, they are more likely to shape the agenda itself (Ocasio and Joseph, 2005). For example, the outcomes of search and evaluation may impact subsequent goals chosen to pursue (rather than just their aspiration levels). Thus, the search and evaluation space in which the organizational explores is not only bounded by the agenda and problem representation, but there is a process at work where by successful initiatives emerging from search and evaluation, reinforce the existing cognitive models and attention patterns and so narrows the agenda and the way the problems are represented.

Since some shared cognitive models used for interpreting information are more accessible and more frequently activated than others, it follows that information processing can be viewed as an ecology.⁷ However, in the focal literature, aggregation is accumulative, and

⁷ We thank Willie Ocasio for making this distinction clear.

cognitions do not vary even with their diffusion. Although this approach might be reasonably accurate if one assumes that higher-level aggregates truly reflect of lower-level elements (Simon, 1947; Puranam, 2018), they may not fully reflect the idea that attention is selective and that shared representations result from social interactions.

A ROADMAP FOR INTEGRATING AND ADVANCING FUTURE RESEARCH

In this section, we offer a perspective that emphasizes opportunities for integration and promotes a more comprehensive view of the role of structure in decision making. To do so, we incorporate research on embedded agency (Seo & Creed, 2002) and attention in organizational theory (Ocasio, 1997) as well as work on social cognition, which argues that the availability and accessibility of shared representations and their activation is predictive of individuals' actions (cf. Higgins, 1996). In this endeavor, we emphasize how organization's structural context both embeds (in the institutional and organizational environments) and socially situates (in a particular time and place) decision makers and their collective interactions.⁸ Our information processing point of view emphasizing structure's role in shaping collective interactions (joint meaning making) and selective attention introduces the possibility of information-based conflict. It also suggests that organizational structure may play especially important role in setting agendas and representing problems – “upstream” aspects of decision making. See Figure 1 for a stylized version of our perspective.

Insert Figure 1 about Here

⁸ Establishing a link between embeddedness and situatedness to account for organizational behavior is an important development in institutional theory (cf. Thornton et al., 2012); however, it has not yet been applied by studies to information processing and decision making.

Embedded and situated interactions

Embedded interactions. Embedded interactions draw on the embedded agency model of human behavior (Seo & Creed, 2002), which holds that social action is embedded in the institutional environment and that shared representations (e.g., cognitive frames, cultural categories, and vocabulary structures) are expressed in sets, toolkits, or repertoires (cf. Giorgi et al., 2015). In our model, the external environment makes available shared representations as well as their expression through organizational structure and identities (Simon, 1947: 110). The organizational structure's socio-cultural properties reflect the shared representations that are accessible to decision makers.⁹ Organizational structure serves as a key mechanism for assembling the repertoire and establishes that not all available representations in the environment are readily accessible. For instance, the language associated with a particular specialization is a function of the shared representations associated with the social systems in which individuals are interacting.¹⁰ An engineering department in a cloud services firm may reflect both an engineering culture (Kunda, 2009) and the repertoires associated with the cloud services division.

The canonical example is the multi-divisional firm. The environments and industries in which an multi divisional firm operates makes certain resources cognitively available. Because the multi-divisional firm operates at the confluence of multiple industries, it serves as a mechanism to make accessible those frames, categories, and vocabularies supplied by each of its

⁹ The notion of embedded behavior or embedded agency is a subject important to sociologists (e.g., Granovetter, 1985) and organization theorists (cf. Thorton et al., 2012). Embedded behavior which implies individual agency, albeit subject to constraints is neither under- nor over-socialized.

¹⁰ (Simon, 1952: 1138) put it this way: It is an important question as to how far specialization is determined by constraints external to the organization ... and how far it is determined by internal constraints—[that is,]the psychological and sociological limitations upon rational adaptation.”

constituent industries (Harrison & Corley, 2011; Dalpiez et al., 2016).¹¹ Research has established that firms may proactively integrate these resources to formulate strategies and allocate economic resources (Weber, 2005), build support for new agendas (Rao & Giorgi, 2006), develop new products (Rindova et al., 2011), or adopt new practices (Ocasio & Joseph, 2005).

Firms may undertake this integration organically—that is, by creating a new division that incorporates the necessary set of resources from corresponding industries or logics (Gaba & Meyer, 2008; Perkmann, McKelvey, & Phillips, 2019)—or it may acquire another firm that is already integrated in that way (e.g., Canato et al., 2013). Firms may also do this through hierarchy or specialization. For example, the hierarchy may impose new frames or vocabularies on the firm; on the other hand, it might strengthen the existing complementarities among them (Bertels, Howard-Grenville & Pek, 2016; Rafaelli, Glynn & Tushman, 2019).

Situated interactions. Situated interactions encompass social interactions among organizational members that transform individual acts of meaning construction into collective ones; these interactions include communication events and practices. Situated interactions reflect the idea that interactions occur within a particular social context—key properties of the decision making situation (Nisbett & Ross, 1991). Formal organizational structure provides the contexts within which any of the various frames, categories, and vocabularies can be activated—and thereby shapes the meaning construction of incoming information. Adopting this approach acknowledges the interactive and situated nature of cognition (Elsbach et.al, 2005) and suggests

¹¹ This set of resources is referred to as an “industry register”. Weber (2005) found that the pharmaceutical industry’s register includes action strategies (e.g., product development and divestiture) as well as frames that give the organization a means to view itself and its potential actions. In Rindova’s (2011) analysis of Alessi, a design-forward producer of high-end kitchen and bathroom products, the author found that the company was at the confluence of several different register components: arts, crafts, anthropology, and psychoanalysis.

that activation occurs not at the level of the individual level but rather at the level of the interaction, with notable implications for organizational behavior (Soderstrom & Weber, 2019).

In our approach, there is no assumption that that cognition is necessarily internally coherent. So in this way our view deviates somewhat from the Simon's strong notion that the boundaries of common maps—and corresponding subgroup membership—are fully “reified” (Simon, 1952; March & Simon, 1959). Our approach recognizes that organizational members have multiple—and often loosely coupled or even contradictory—mental representations derived from the logics of internal and external memberships, technologies, and industries (Thornton et al., 2012). Actors may flexibly draw on a repertoire of shared cognitive resources when constructing their “strategies of action” (Swidler, 1986; Weber, 2005; Weber & Dacin, 2011), and do so when interacting in decision situations.

Moreover, it is within communication channels (formal and informal) that social interactions occur and that individuals (jointly and selectively) attend to information and its properties. The activation of particular frames, categories, and vocabularies results from a combination of channel characteristics (Ocasio & Joseph, 2008) and the communication practices occurring within that channel (Ocasio et al., 2017). In other words, shared cognition arises from the regularized within-channel “social interaction that builds on speech, gestures, texts, discourses, and other means” (Cornelissen, Durand, Fiss, Lammers & Vaara, 2015: 11). For example, some categories or vocabularies may be collectively attended to more than others. Certain ones may be altered so as to conform to the particular properties of the situation in which they are introduced (Cornelissen & Durand, 2012; Durand & Paoletta, 2013); others may simply fall into disuse. It is therefore the organizational structure that yield the ecological space in which the learning, comparing, blending, or diffusion of shared representations occurs.

Integrating aggregation and constraint views of structure

Our perspective suggests that the structural context makes *accessible* certain common maps or shared representations (e.g., frames, categories, vocabularies) from the variety available in the environment. The structural context also shapes the social interactions which *activate* (or draw attention to) particular representations during collective decision making. The resulting conflict and/or coordination yielding particular decisions, and the corresponding shared representations and attention patterns which led to them, are reinforced (making them more accessible over time). Thus over time, the organizational structure guides the selection, alteration, and retention of particular frames, categories, and vocabularies. And so our perspective may help us understand structure's impact on information processing, not as an aggregation/summation process or that of individual constraint, but as an ecology.

Although embedded and situated interactions are neither uniformly nor explicitly conveyed in most prior research, our review indicates widespread agreement concerning this claim: it is the joint interactions and shared meanings created within a particular structural context that generate the attention patterns necessary to coordinate activities. Thus, our call is for a more integrated approach that links: (a) the common maps that the organizational structure makes accessible with (b) the social interactions among organizational members, where particular aspects of these maps are activated in order to process information in support of decision making.

Our argument recalls Simon's (1947) argument that human behavior is not just boundedly rational; it is *intendedly* rational or what March (1979) called "behavior with constraints". The notion of intended rationality recognizes that information processing is shaped

not only by the limits of individual attention and heuristics (Simon, 1947; Simon & Newell, 1971) but also by common maps. These common maps serve as a perceptual mechanism that supplies interacting individuals with the “social definition of a situation” (Simon, 1952). They include such shared cognitive representations as schemas, frames, categories, classifications, systems of concepts, and vocabularies (March & Simon, 1958/1983: 184–86). Simon notably argued that it is only to the “extent that such maps are held in common, [that] they must be counted among the internal constraints on rational adaptation” (1952: 1135), suggesting that the *shared* aspect of these maps is especially important.

Our approach addresses the aggregation-constraint dichotomy because it explains how structure simultaneously brings together and constrains individual decision makers. That is, it incorporates the idea that individual cognitions are shared and that creation of shared representations can act as a constraint on decision making. That way, we move from distinct aggregation and constraint perspectives to an approach that links aspects of both.

Informational sources of conflict

Our perspective offers an avenue for understanding how organizational discord manifests and when conflict over differences in interpretation of information and attention to goals can impede or improve organizational decision making. Here again we articulate a role for interactions that are situated and embedded—in this case, linking organizational structure and conflict in decision making.

Differences in information interpretation. We must bear in mind that information processing problems are driven by uncertainty and ambiguous information both. Recall from our literature review that decision making may be clouded by various situational aspects, which

include the tacit nature of knowledge (Garicano & Wu, 2012), the variable quality of proposals (Csaszar, 2013), and the complexity of the organization (Baumann & Siggelkow, 2011) and of the environment (Greenwood et al., 2010). That information is open to multiple interpretations is consistent with the theorizing about mechanisms discussed in the feedback and cognition streams, where these concerns are more central.

Since decision makers must construct meaning in the presence of ambiguous information, it follows that the situated and embedded nature of interactions will figure prominently in how information is interpreted. The potential variation in frames, categories, and vocabularies and their activation in situated decision opportunities leaves open the possibility for different applications of them in decision making. Interpretations may diverge either unintentionally or intentionally.

For example, the specialization that results from structurally segregated interactions usually leads an organization's members to hold different mental models, which in turn results in a natural divergent interpretations of issues. Variations in perceptions may fuel debate concerning the best course of action in response to feedback (Kaplan, 2008) and may provide managers the chance to "self-enhance" (Jordan & Audia, 2012) through over-favorable interpretation of feedback (Joseph & Gaba, 2015). Divergent interpretations may lead to disagreements about the best course of action or the evaluation of alternatives. For example, it might shape whether new opportunities are viewed as threats or opportunities (Gilbert, 2005). It may also lead to inaction as organizational members continually undo or reverse decisions already made (Denis, Dompierre, Langley & Rouleau, 2011).

Organizational members may also purposely distort information which can also amplify the potential for conflict in decision making. As Cyert and March (1992: 67) emphasized, one

can expect the information transmitted among subunits to exhibit some bias, and there may be attempts to manipulate information toward the end of altering decisions. A few studies (e.g., Fang et al., 2014; Reitzig & Maciejovsky, 2015) have explicitly examined the distortion of information in hierarchies, but more research is needed. Most of these studies examine individual distortion and not the possibility that groups of interacting individuals might deliberately distort information to maintain extant cognitive models. The resulting dynamic could, in turn, create opportunities for processing and communicating information in ways that polarize and support parochial interests and agendas.

In the cases of both inadvertent and intentional divergence, the potential for *intraorganizational conflict* over problems and solutions will increase. For instance, disagreements among subunits about the firm's agenda may create conflict related to resource allocation and control (i.e., autonomy). Research has shown that subunits often compete over new domains (Galunic & Eisenhardt, 2001), especially when the domain is seen as encompassing problems related to—and offering solutions of relevance to—their current operations (Birkinshaw & Lingblad, 2005).

Scholars have described the potential negative effects of such conflict, which include reduced information processing efficiency and increased difficulties with coordination (Birkinshaw & Lingblad, 2005). That said, benefits have also been observed: such competition may encourage subunits to exploit existing resources more completely and to develop new resources more thoroughly, to reduce the “time to market” for new products, and to increase the firm's overall market coverage (Joseph & Wilson, 2018; Bauman, Eggers & Stiglitz, 2018). We conclude that more work is needed to sort out the positive and negative effects of conflict, which

would enable a deeper understanding of its informational drivers in the context of multiple (competing) goals and divergent interpretations.

One promising line of inquiry would be to examine the source of interpretive differences—whether it is one due to limits of accessibility or one of activation. Recall from our framework, that accessibility depends on the environment in which the individual is embedded. A stable organizational structure (subgroup membership) reflects the situation’s social definition; this means that only a subset of representations may be cognitively accessible to decision makers. An illustration is offered by Gaba and Joseph (2013), who recognized that the corporate office and business units have access to different repertoires when responding to performance feedback.

Activation depends on the situation. Not all proposals, information, or feedback receive the same *quality* of attention, and selective attention to issues depends on the decision situation. Within such situations, a variety of factors are at play: the decision makers’ previous experiences (Eggers & Kaul, 2018; Gaba et al., 2019), rules invoked at the time of the decision (Knudsen & Levinthal, 2007; Csaszar, 2012), the common ground on which decision makers agree (Puranam et al., 2015), communication acts (Ocasio et al., 2015), and other material properties of the channels through which decisions are made (Joseph & Ocasio, 2012). Some progress has been made in understanding such attention quality (e.g., Rerup, 2009), but more research is needed to connect it with structure and decision making.

For instance, adaptation studies could make shared representations and the active sharing of those representations an important parameter in their models. Cognition studies should focus more closely on the actual interactions that shape, for instance social comparisons and responses to feedback. Along these lines, Vissa, Greve, and Chen (2010), and Rhee, Ocasio, and Kim

(2019) each acknowledged the cognitive accessibility provided by interactions between the subunits of a multi-divisional firm; however, none of those papers captures the dynamics of interactions. Both Jacobides (2007) and Joseph and Wilson (2018) offered some evidence for hierarchy's role in the provision of frames, but neither study detailed the circumstances of their activation.

Differences in attention. Organizational scholars have long noted the attention problems arising from the pursuit of multiple goals as well as the conflict that follows from that goal diversity (e.g., Cohen, 1984; March & Simon, 1958; Perrow, 1961; Simon, 1964; Ethiraj & Levinthal, 2009; Greve & Gaba, 2017). Conflict is likely to arise when individuals in different roles and situated in different decision-making structures pursue goals linked to those positions and therefore process different pieces of information in the pursuit of those goals.

Interdependences and complex linkages in the task environment can further contribute to a general sense of uncertainty, which not only introduces coordination challenges but also creates latent or overt conflict within the organization. For example, organizational subunits with distinct functions are expected to develop their own objectives and norms and to compete for scarce resources with other units, even though they must cooperate in support of decisions. Many of these objectives are assumed to be essential, continuous, and operative, which means that they can pose problems—in the form of potential conflict—for the organization.

As mentioned previously, the sharing of task environments entails that actions taken in pursuit of one goal directly affect the organization's performance vis-à-vis other goals. And as the number of technological goals increases, so will the complexity of assigning credit to the individual or team responsible for a single goal or component. Thus the limitations imposed by a shared task environment have the potential to cause conflicts and to impede the achievement of

multiple goals. For example, Hu and Bettis (2018) found that feedback interdependency across multiple technological goals (e.g., speed, fuel efficiency, reliability) in automobile manufacturing can lead to severe and misleading confusion about learning from the feedback related to pursuing those goals. Gaba and Greve (2019) examine airlines' dual focus on safety and profitability as two high priority goals on the decisions regarding fleet changes. They argue and find that pursuit of safety goals cannot be understood in isolation from profitability goals and, in fact, responsiveness to safety goals is strengthened by low profitability because safety is associated more closely with survival. These studies are important in that they more directly examine the implications of goal conflict and technological interdependencies for decision making. Still, the process through which decision makers may address goal conflict and more broadly interdependencies among multiple goals remains an overlooked area of research.

Our approach suggests that decision makers could deal with multiple goals in a different manner. From a situated and embedded perspective, goals are not necessarily prioritized or agreed upon prior to the consideration of alternatives; rather, they are drawn from a pool of existing goals as the decision-making process proceeds. Thus our approach makes central the concern of when multiple goals are made available, accessible, and activated. From this perspective, managers are aware of constellations of organizational goals yet only a subset of those goals are activated through interactions among agents.

Future research may want to examine cases where decision makers and their corresponding subunits are embedded in different institutional environments and thus could face a variety of goals. Such "institutional complexity" exists when the firm simultaneously pursues various goals prescribed by different industry logics (Greenwood, Diaz, Li & Lorente, 2010) and can be spread by the diffusion of rating and ranking systems as externally imposed goals

(Rowley, Shipilov & Greve, 2017). For instance, it is implicitly assumed that growth and size goals are central to large publicly traded corporations—just as safety goals are central to players in the airline industry (Gaba & Greve, 2019). The resulting complexity creates competing demands on organizational decision makers.

Whereas the problem-skill matching and screening literature do not directly consider goals *per se*, the adaptation literature relies primarily on goal activation through feedback. However, our approach offers an important alternative under which organizational goals are contested overall and in specific decisions. Questions for future research include—in light of the competition for managerial attention (Ocasio, 1997)—why some goals receive more attention than others and whether there are some goals that can be ignored (Cyert & March, 1963). Goal activation reflects our proposition that, throughout a decision-making process, the organization will attend to only a subset of its goals and thereby increase the likelihood of those goals being satisfied (Simon, 1964).

It follows that goal activation may be as much a process for prioritizing appropriate goals as for finding ways to achieve them. In this sense, goals can be viewed as frames and may be used accordingly in support of selling the importance of issues to more senior managers (Dutton & Ashford, 1993), for purposes of “sensegiving” to others in the organization (Gioia & Chittipeddi, 1991; Sonenshein, 2010), to build coalitions and recruit allies through recognition of shared interests (Zhang & Greve, 2019), to exert political influence (Kaplan 2008, Kaplan & Tripsas 2008), and to engage in the symbolic manipulation of information (Elsbach & Sutton, 1992). Thus organizational goals are a function of social interactions and can be deployed as needed in the decision-making process.

By extension, much of the literature implicitly treats attention to goals and their consequentiality for decisions as invariably linked, though they may not be. Theories of “loose coupling” suggest that organizational goals need not affect decision making despite being used to justify action (Cohen, March & Olsen, 1972; Weick, 1976) rather than provide an explanation for purposeful decision making (Eisenhardt & Zbaracki, 1992). However, no adequate account has been given of exactly how loose coupling explains which of multiple organizational goals are consequential and under what circumstances. Loose coupling also highlights the importance of goals as motivators and of undertaking alternative evaluations (Keum & Eggers, 2018) and suggests the need for a more nuanced understanding of when failure to achieve a goal leads to goal activation, which may not occur uniformly (Rowley, Shipilov & Greve, 2017; Gaba & Greve, 2019).

Perhaps most importantly, loose coupling confirms the necessity of paying close attention to the role of organizational structure. The formal hierarchy may play a critical role in the matching of organizational goals and subunit divisions (Galunic & Eisenhardt, 2001). In particular, interactions between the corporate office and business units may drive empirical regularities in the relationships among interactions, goal activation, and decision making (Gaba & Joseph, 2013; Joseph & Wilson, 2017). Our formulation—whereby decision makers can choose which constraints to satisfy—stands in contrast to other models, most of which assume that goals either are either inconsequential or serve as hard constraints. It would be worthwhile to examine *whether* any commonly held goals serve as implicit constraints on decision making. If so, then we should also like to know which of these goals emerge from a goal activation process. When one considers the ubiquity of goal conflict in organizations, it is clear that more work is

needed to understand the subtle connections between structure, attention, and decision making as well as the trade-offs via which such conflicts are resolved in organizations.

Agenda setting and problem representation

Our view may be especially helpful in articulating the overlooked aspects of Simon's decision making process—the intensive cognitive process of agenda setting and problem definition and its importance for strategy making (Nickerson & Zenger, 2004; Nickerson, Yen, & Mahoney, 2012), problem solving, and search (Posen et al., 2018). In recognizing the particular aspects of common maps that are likely to be accessible and activated, we may better predict how certain agendas or problem representations may come to dominate within an organization. Because our view transcends Simon's conception of reified groups, it acknowledges the potential for dynamic changes to the common maps employed. That is, we might see a recursive relationship between the search and evaluation of alternatives and the subsequent common maps used in decision making. The solutions chosen may be recognized as a decision-making pattern (Mintzberg, 1979) and hence come to serve as an input to the firm's agenda.

Successive rhetorical use over time may reinforce the selection (and preferred use) of particular categories or vocabularies with those who share similar perceptual references. When certain representations appear frequently in a single decision situation or across many decision situations, those representations are selectively retained and become an enduring part of the system's information structure.

Those aspects that are frequently activated through interactions become more broadly diffused over time—even as other aspects remain unattended (Ocasio & Joseph, 2005).¹²

¹² The interactions may also reflect an ecology. As Rivkin and Siggelkow (2007: 1084) pointed out: "Patterns that improve 'searchability' may very well prevail in ecological competition among interaction patterns."

Throughout this attention selection process, information may be reinterpreted (Ocasio et al., 2015). Thus differences in the shared representations used within the organization derive from the availability of various frames, categories, and vocabularies within a particular subunit as well as from the emphasis with which elements are activated across the broader organization (Weber & Glynn, 2006).

Overall, then, an embedded and situated perspective of interactions suggests an ecology whereby the processing of information—and the corresponding shared representations that allows organizations to do so—follows an evolutionary pattern. As the structure aggregates, some aspects of these representations are accessible, attended to, and altered in meaning. Selective attention results in the retaining of certain information and of the shared representations used to interpret it.

In pursuing such a program, researchers should give greater emphasis to the content of shared representations. In particular, they should explore how common maps are socially constructed, reinforced, and altered through the situated interactions guided by the organizational structure—in particular, the firm's formal hierarchy. It may also be worth examining how attention may be apportioned among the tasks of setting agendas, formulating problems, and searching and evaluating alternatives. Little is known about the hierarchical properties of such systems. Moreover, hierarchy in the decision-making process may themselves reflect different stages in the ecology of information processing (e.g., agenda setting at the top, problem formulation in the middle, searching and evaluating at the bottom—which in turn may have implications for agenda setting again at the top). This evolutionary reconstitution of a problem representation and the firm's agenda is a fruitful avenue for future research, one that may inform a more dynamic version of Simon's social definition of the situation.

Methodologies

We encourage the use of a variety of methods to explore these various relationships. One promising option for expanding the scope of research in this field is to conduct more individual-level experiments in information processing (Puranam, 2012). A good example of such work is the paper by Turner and Makhija (2012), who examined the relationships among organizational structure, individual information processing, and problem solving. These authors took an experimental approach to examining how “organic” and “mechanistic” structures affect the way individuals gather, interpret, and synthesize information—and on how those structures affect individuals’ problem-solving orientation.

The perspective we have outlined would also benefit greatly from case studies of organizations. As a result of such qualitative approaches, research on culture and organizations (e.g., Rindova et al., 2011) have made great strides in understanding the implications of shared cognition and cultural resources—although their focus is less on organizational structure than on decision making. However, such an approach is needed if we are to understand the nuances of interactions, the nature of evolutionary process of attention and interpretation, and the consequences for behavior (e.g., agenda setting and problem formulation) of a less public nature. An illustrative example, is Valentines’s (2019) study, which examines the use of artificial intelligence (AI) at an online clothing retailer. The algorithm used by the AI group created new categories into which the retailer organized its activities, categories that were new and that crossed previous division of labor. Valentine found that the centralization of an AI unit within the organization had two notable effects: it centralized decisions about product portfolios and threatened the role of planners at the product level, flattening the organization’s hierarchy. In

essence, the problems' definitions changed. More studies in this vein are in order, since we must learn how such technology can alter the agenda of a firm by affecting its structure.

Yet another option is to adopt a micro-structural approach to information processing research (Puranam, 2018)—that is, focusing on the “micro-structures—small groups of interacting individuals that are the crux of the design or decision problem the organization faces.” Several different studies adopt this approach, including lab experiments (Raveendran et al., 2015) and agent-based models (Csazar & Eggers, 2013). The advantage of such research over studies that adopt a more macro-structural approach (e.g., Burton & Obel, 1984) is that decision makers are proximate to the decisions they make, which makes it easier to identify causal linkages between structural properties and the various problem-solving steps. Moreover, if one assumes that subsystems exhibit the same pattern of relationships as the systems they constitute, then the micro-structural approach can be applied at any hierarchical level in the organization through careful application of aggregation principles such as scaling and recursion (Puranam, 2018).

Finally, recent advances such as big data, machine learning, and natural language processing methodologies offer substantial opportunities to more directly capture the decision making implications of common maps. As researchers strive to model more complex organizations and in particular the language (shared cognitions) employed in those organizations, new topic modeling and text analysis techniques are leading to a new stream of research which can account for the emergence and performance consequences of culture (Srivastava, Goldberg, Manian & Potts, 2017). For example, Corritore, Goldberg, & Srivastava (Forthcoming) use computational linguistics tools to derive time-varying measures of interpersonal and intrapersonal cultural heterogeneity. They further demonstrate that interpersonal heterogeneity—

the extent to which organizational members diverge in their understanding of firm culture—is negatively associated with effective coordination and execution, whereas intrapersonal heterogeneity—the breadth of cultural beliefs about the organization that are held by members—is positively linked to creativity and the capacity for recombinant innovation. With these new tools, it is now possible to explore systematically tradeoffs and performance implications of a variety of organizational structures.

CONCLUSION

Our review of the literature offers both a retrospective and a roadmap for new avenues of inquiry. Our efforts identified four streams of structure and decision-making research: problem-skill matching, screening, adaptation, and cognition. We also identified several limitations and proposed opportunities to advance our understanding of structure's information processing properties.

First, the bifurcation of the literature into aggregation and constraint perspectives highlights the focus on individual cognition and has overlooked shared representations and common maps; as a result, current decision-making theories do not fully capture the spirit of Simon's social definition of the situation and its attendant constraints. Second, the literature has largely abstracted from interpretive and attentional processes and so has not sufficiently addressed the potential causes and consequences of intra-organizational conflict. Third, we apply this process to less studied aspects of decision making. Accounting for a closer correspondence between upstream and downstream steps in decision making and a recursive relationship between evaluation and agendas, our approach re-conceives information processing as an ecological rather than a summation or combinatorial process. Therefore, in order to advance our

understanding of organizational structure and decision making, we outline an evolutionary process of embedded and situated interactions within the organization.

Through this, we (and other researchers) recognize that the notion of “interactions” is changing and that advances in information processing have led to changes in the informational regularities within complex systems (Van Kippenberg, Dahlander, Haas & George, 2015). The “empty world” hypothesis states that reality can be adequately described by accounting for only a small fraction of the possible interactions—that is, because there are only weak connections among most of our world’s constituents (Simon, 1962). Yet even though our reality may reflect an empty world, it has evolved in terms of what is loosely versus tightly coupled (Bromley & Powell, 2012). It is therefore incumbent on organizational scholars to revisit the information processing properties of complex systems, which include familiar (yet changing) organizational structures as well as new organizational forms. So despite the prominence, for example, of large multi-divisional organizations in world economies, there has been a resurgence in the use of functional organizational structures and flatter hierarchies. Witness the rise of the *holocracy*, an organizational form without a formal hierarchy, job titles, or job descriptions (Puranam & Håkonsson, 2015) and that will almost certainly require novel ways of integrating agents and their activities within and across firms.

From our perspective, one research implication of this approach is that organizations with business models that span multiple industries, blur industry boundaries, or require highly coupled activities should be especially adept at marshalling and integrating various cultural resources (in support of search, for example). The combination of institutional complexity and decreasing near-decomposability in ecosystems and complex business models suggests that firms will have

a more often and more urgent need to adjudicate external demands. Hence it is important for future research to consider both embedded and situated interactions in decision making.

We can also observe the increased adoption of platforms, ecosystems, and crowds that is meant to help solve organizational design problems. Each of these approaches reflects a type of meta-organization that encompasses many corporations, communities, or individuals linked not by contracts but rather by technology and/or a common goal (Gulati et al., 2012). These new organizational forms clearly differ from a bureaucratic hierarchy. Many such forms are “new” in the sense that they address core design concerns by translating—in a novel way—individual efforts into collective action (Puranam, Alexy & Reitzig, 2014).

Yet meta-organizational forms are distinct not only from the traditional bureaucratic hierarchy but also from other organizational forms and relationships (Kapoor, 2018). Instead of exhibiting vertical integration or sequential interdependence, they reflect systems of “epistemic” interdependence (Puranam et al., 2012), unprecedented availability of data (Van Kippenberg, 2018), and the hyper-specialization of agents (Malone, Laubacher & Johns, 2011). These differences add considerable complexity both to the shared representations on which the firm may draw and to the types of interactions that may occur between actors. At the same time, these diverse features remind us not to assume too much coherence in common value and assumptions (Schein, 2004; Van den Steen, 2010).

As part of these changes, information processing is affected by the growth of social networking sites as sources of ambient information. Experts in this field argue that digital information sources (e.g., intranets, social networking) offer decision makers access to meta-knowledge. Although the notion of ambient information is a recent topic of research interest, it

may offer information processing scholars an entirely new lens through which to examine arenas for the activation of particular representations.

An area worth mentioning again is the impact of artificial intelligence on decision making. Most would argue that AI should reduce the information processing requirements demanded of individuals and increase the firm's overall information capacity. Such advances may result in artificial neural networks learning to solve complex problems—thereby realizing Simon's early efforts in this domain (Newell & Simon, 1972). Of course, AI increases the potential for more rapid cognitive adjustments thanks to its nearly instantaneous analysis of Big Data. These developments raise difficult questions, however. Do such fundamental changes in technology, when combined with novel organizational forms, presage (cf. Puranam et al., 2018) something fundamentally new for organizational decision making? Do these converging trends suggest that the sun is now setting on the Weberian bureaucracy? And do they, perhaps, herald the dawn of a new paradigm? Explicating the complex relationship between AI-assisted information processing and decision making requires that we understand how the organization and its chosen technology sort through the voluminous information acquired. Attempting to process all available information can, paradoxically, result in the firm resorting to a narrower focus (Sullivan, 2010; Piezunka & Dahlander, 2015) if it doesn't lead to cognitive overload (Castellaneta & Zollo, 2014; Laamanen, Maula, Kajanto & Kunnas, 2018). Therefore, another opportunity for research involves the *quality* of attention that can be devoted to information in a Big Data world.

Finally, our ecological approach also suggests that neither the source nor quantity of information is sufficient for understanding how it is processed. Although far more data are available now than before, the common maps that aid in their interpretation and attention are far

from unlimited and may even be more constrained than before. We are awash in a sea of information, yet are limited, in that new shared models by which we can navigate it have yet to emerge. This calls for new theory in our field.

In any event, changes in organizational form and advancements in technology are certainly indicative of a shift in information processing, and they strongly imply a need to advance current theory and means of analysis. As certain aspects of organizations (e.g., business models) become more tightly coupled, it may well become more difficult to identify the optimal combination of design choices for achieving desired outcomes. Given that organizations have become increasingly characterized by *distributed* decision making (i.e., across ecosystems, platforms, or communities), we shall require a more complete understanding of how organizations can adapt to changing circumstances. The themes advanced in this paper emphasize that distributed information processing is increasingly embedded and situated—and that a more integrated approach to exploring aggregation and constraint in information processing offers the promise of renewed and profitable research into organizational structure and decision making.

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Table 1: Representative studies

Theme	Examples		
Problem-skill matching	• Garicano 2000 • Garicano & Wu 2012	• Bloom, Garicano, Sadun & VanReenen 2014 • Wu 2015	
Screening	Decision rules • Knudsen & Levinthal 2007 • Christensen & Knudsen 2010 • Csaszar 2012 • Csaszar & Eggers 2013	Psychological mechanisms • Reitzig & Sorenson 2013 • Fang, Kim & Milliken 2014 • Reitzig & Maciejovsky 2015 • Keum & See 2017	
Adaptation	Modularity • Ethiraj & Levinthal 2004 • Siggelkow 2002 • Billinger, Steiglitz, & Schumacher 2014 Integration through hierarchy • Rivkin & Siggelkow 2003 • Siggelkow & Rivkin 2005 • Sengul and Gimeno 2013 • Joseph, Klingebiel & Wilson 2016 • Eggers & Kaul 2018	Coupled multi-level learning • Siggelkow & Rivkin 2009 • Lee & Puranam 2016 • Levinthal & Workiewicz 2018 Interdependencies in the M-form • Obloj & Zenger 2017 • Baumann, Eggers & Stiglitz 2018 • Tarakci, Ates, Floyd, Ahn & Woolridge 2018 • Knott & Turner 2019	Integration through knowledge sharing • Karim & Mitchell 2000 • Helfat & Eisenhardt 2004 • Williams & Mitchell 2004 • Brusoni & Prencipe 2006 • Fang, Lee & Schilling 2010 • Karim & Kaul 2015 • Stan & Puranam 2017
Cognition	Mental models/frames • Gavetti 2005 • Jacobides 2007 • Srikanth & Puranam 2011 • Puranam & Swamy 2016 • Joseph & Wilson 2017 • Csaszar & Laureiro-Martinez 2018	Attention/cognitive accessibility • Rerup 2009 • Rhee, Ocasio & Kim 2018 • Gaba & Joseph 2013 • Joseph & Ocasio 2012 • Piezunka & Dahlander 2015 • Dutt & Joseph 2019	

Table 2: Organizational Structure and Decision Making

Literature theme	Key information processing challenge	Primary decision making focus	Form of organizational structure	Role of hierarchy	Primary view of structure and info processing	Key results
Problem-skill matching	How do you devise an optimal org structure given the costs of communication and acquiring information?	Evaluation	Rank order of skills (skill hierarchy) aligned with flow of problems	Exception management	Constraint in decision making comes from specialized knowledge	Hierarchy of skill through which problems flow bottom up is optimal design.
Screening	How do we structure decision rights in a group so that they make few errors of omission and commission?	Search, evaluation	Polyarchy and hierarchy; all combinations	Validation of proposals	Aggregation of decisions via decision rules (e.g., voting rules)	Different decision structures produce different ratios of Type 1 to Type 2 errors.
Adaptation	How does org structure help agents evaluate choice sets in situations of coupled and parallel search?	Search (parallel and coupled)	Symmetric (dyads, integrators) and asymmetric (authority) influence structures	Evaluation of choice sets	Aggregation of decisions via interactions within and among subsystems; Constraint in decision making comes from coupled multi-level search	Parallel search: optimal clustering produces most diversity and preserves it. Coupled search: the benefits of asymmetric influence and “common prior” effect/shared beliefs can help with coordination even when they are wrong.

Cognition	How does org structure influence which information and decisions are prioritized?	Agenda setting, problem formulation, search	Authority hierarchy	Provision of decision premises; direct attention;	Constraint in decision making comes from structure limiting cognition (cognitive structures, attention)	Problem formulation and importance varies by location of problem solver in the structure
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Table 3: Roadmap for Future Research

Key issues in literature	Explanation of key issues	Future research agenda	Example questions
The role of structure in decision making divided into aggregation vs. constraint perspectives	The aggregation view reflects how different types of structure enable individuals to come together (i.e., to interact) for the purpose of making collective decisions. The constraint view reflects how the context established by the organizational structure enables or constrains individual decision making, including a sense for how structure may affect heuristics and biases.	Need greater focus on capturing the impact of structural context - through which individual cognitions are created <i>and</i> shared - to inform organizational decision making.	• How does the organizational structure shape shared representations in support of decision making? • What is the process by which the shared representations resulting from social interactions (joint meaning making) and selective attention affect decision making?
Disproportionate focus on structure as a source of coordination rather than conflict	Lack of conflict reflects assumptions of uniformity in interpretation of information. Fails to fully account for variation in attention patterns of decision makers which may contribute to conflict.	Need to better understand: • The effect of structurally induced interpretative variation of information on decision making • Role of multiple goals and variegated attention on decision making.	• When does organizational structure yield conflict in particular decision making? • Is the source of conflict structurally-driven accessibility or activation of particular goals? • When is such conflict beneficial for organizations?

Uneven treatment of various steps in the decision making process

Disproportionate emphasis on search and evaluation (i.e., downstream aspects of decision making).

Lack of attention to relationship between steps in the decision-making process.

Need more emphasis on:

- Agenda setting
- Problem representation

(That is, structure's impact on upstream aspects of decision making)

- How does the structural context affect upstream aspects of decision making?
- How do the downstream aspects of decision making interact with the structural context to affect the upstream aspects?

Figure 1: Ecological view of information processing

Institutional, industry, technological environment

Availability of frames, categories, vocabularies

