What Makes a Decision Strategic?
Strategic Representations*

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Abstract

This paper delves into the effects that strategic representations have on firm performance. It does so in four ways. First, it describes different types of representations—internal, external, and distributed—and it points to their pervasiveness in strategy. Second, it presents a framework to study the effects of these representations on firm performance and shows how several strategy theories can be mapped into this framework. Third, it provides three detailed illustrations of how this framework can be used to address important questions in strategy; namely, what are the antecedents of strategic foresight, how the simplicity or complexity of representations affects firm performance, and how to incorporate the role of managerial cognition into the resource-based view. Fourth, it proposes a research agenda to further the study of the representation–performance link. Overall, this paper proposes that studying strategic representations is paramount since the success of strategies—and the realism of the strategy field—hinges on understanding how representations affect performance. Strategic representations, thus, are a central element of "what makes a decision strategic."

Keywords: representation; managerial cognition; Carnegie tradition; aggregation

1 Introduction

What makes a decision strategic? One straightforward answer to this question emerges from the definition of the academic field of strategy; namely, the study of what determines a firm's performance. We might then answer that a decision is strategic if it affects firm performance. This answer, however, offers no actionable details. Scholars have therefore tried to answer the question at a lower level of analysis; specifically, by asking: What characteristics do strategic decisions have in common? Several such characteristics have been identified. Strategic decisions are typically: (a) complex, as they involve many elements and interactions (Simon 1962); (b) surrounded by novelty and uncertainty because firms make decisions for which there are no clear precedents and outcomes cannot be confidently predicted (Mintzberg et al. 1976); (c) ambiguous, as conditions and factors can be interpreted in multiple ways (Nickerson and Zenger 2004); (d) irreversible (Ghemawat 1991); and (e) high stakes (Eisenhardt and Bourgeois 1988). From a practical standpoint, however, the answer provided by these characteristics amounts to admitting that strategic decisions are difficult. We are still left without actionable details.

Another way to answer the question—what makes a decision strategic?—is to go yet one level deeper and ask how such decisions are made. A more "operational" approach may yield the actionable details that previous approaches have not. It is apparent that any decision is made on the basis of a representation. As Pylyshyn (1984:xii) observed, "One of the main things that cognizers have in common is [that] they act on the basis of representations." In cognitive science, a representation is defined as a model with which to make decisions (Craik 1943:61). The central idea of cognitive science is that thinking is composed of (a) representations and (b) computational operations performed on those representations. Thagard (2005:11) summarizes this as "thinking = representations + computation."[1]

[1]Making intelligent decisions without using a representation is implausible, as this would require either making random decisions or making decisions without keeping any internal state. Thus, it is

If strategy is fundamentally a matter of making decisions that affect firm performance and decisions depend on representations, then representations must affect firm performance. That is the premise of what I call the *representational view of strategy*. Currently, the strategy field does not know much about *how* representations affect firm performance. We would like a representational approach to strategy to be able to answer such questions as: What are the best representations to use to make a particular type of decision in a particular competitive situation? What are the best representations to use under particular constraints such as the amount of time and the type of managers available?

Studying how representations affect firm performance therefore involves three requirements. First, we need to observe representations; that is, what models are individuals using to make decisions? Second, we need to observe the performance outcomes of using these representations. Third, we need to establish how the representation–performance link is contingent on the environment in which the decisions are made. All three requirements are typically difficult to meet. The representations themselves may be invisible—oftentimes in the individuals' head and not necessarily explicit even to them. Performance outcomes may be more tangible, but causally linking them to representations is far from obvious given the delays and events that occur between when a decision is made and when performance becomes visible. Finally, understanding the role of the environment is difficult given that both representations and environments are multidimensional constructs that can interact in myriad ways.

Despite these difficulties, an emerging stream of research has started to advocate paying more attention to the role of representations on firm performance. Levinthal (2011) highlights the inevitability of representations in strategy and links them to the many

generally accepted that representations underlie decisions (this is sometimes called the "representational metapostulate" (Pylyshyn 1992:123) or the "physical symbol system hypothesis" (Newell and Simon 1976:116)). The necessity of representations has not gone unchallenged (see, e.g., Brooks 1991, Beer 1995). However, these "anti-representational" approaches have been shown to smuggle representations (i.e., to include representations without calling them by their name) and to only allow for overly simple behavior (Clark and Toribio 1994).

frameworks used as representations by practitioners. Gary and Wood (2011) show that individuals with more accurate mental representations are better at making predictions when playing a business simulation. Helfat and Peteraf (2015) theorize about the cognitive capabilities that may underlie dynamic capabilities. Csaszar and Levinthal (2016) model managers searching for superior strategic representations. Also using a model, Martignoni et al. (2016) show that the accuracy of mental representations has different effects depending on whether or not managers control choice variables. Menon (2018) discusses aspects of strategic interactions that should depend on managers' representations. Nevertheless, this stream of work is still small and most of it has been theoretical; that is, either verbal theories or simulations. As a result, we still do not know very much about (a) the characteristics of representations, (b) how these characteristics relate to firm performance, and (c) how that relationship is contingent on the environment.

The study of representations in strategy is related to several other lines of research. One of these is the Carnegie tradition, which applies the sensibilities of cognitive science to the study of how organizations make decisions. It would have been natural for the Carnegie tradition to study representations, but it has instead focused so far on other more directly observable constructs such as adaptation, learning, and routines. Essentially, the Carnegie tradition has conceptualized bounded rationality in mostly noncognitive ways (Gavetti et al. 2007:530, Posen et al. 2018a:209). For example, a manager is modeled as performing a semi-random sampling from a subset of alternatives, as when searching an NK landscape (Levinthal 1997), but typically the manager does not hold a representation of the landscape. Thus, the representational approach develops a central but overlooked area of the Carnegie tradition.

Another related line of research, managerial cognition, has shown that different managers use different representations. Managers can differ in how they represent almost any aspect of their business, including market uncertainty (Milliken 1990), competitors (Porac et al. 1989), product features (Benner and Tripsas 2012), and technological opportunities

(Eggers and Kaplan 2009). This literature has not, however, shown the link between representation and performance; that is, how representations affect performance (Gary and Wood 2011:570).

The research on top management teams (Hambrick and Mason 1984, Finkelstein et al. 2009) has made a strong case for cognition affecting firm performance, but it has not observed managers' representations. Rather, it has proxied cognition—and implicitly representations—mostly by looking at demographics such as educational and professional background and age (Finkelstein et al. 2009:84, Hodgkinson and Sparrow 2002:170–177). The literature on the attention-based view (Ocasio 1997) has acknowledged the role of representation, but has examined only one aspect of it: what dimensions managers pay attention to. This leaves out another essential and vast aspect of representation: how these dimensions to which managers pay attention are combined to produce managers' decisions.

Thus, the representation–performance link is an important but under-explored part of strategy. We know from cognitive science that strategic decisions must depend on representations, but there has not been much research on *how* they affect firm performance.

This article delves into the effects that representations have on firm performance. It does so in four ways: (i) by describing different types of representations and pointing to their pervasiveness in strategy, (ii) by presenting a framework to study the effects of representations on performance, (iii) by illustrating the use of this framework with three examples that cover different empirical and theoretical research methods, and (iv) by proposing a research agenda on how to continue studying the representation–performance link. Achieving a better understanding of the role of representations in strategy sheds new light on the question "what makes a decision strategic."

2 Three types of representation

To understand the pervasiveness of representations in strategy, it is useful to distinguish between three types of representation: internal, external, and distributed. The distinctions between them stem from the system holding them.

Internal representations. The system holding an internal representation is an individual's brain. For example, a manager might have in his or her head a representation of what drives the performance of his or her firm. Charles Merrill—the founder of the brokerage named after him—thought that his firm would perform better the more it resembled a financial supermarket (Gavetti and Menon 2016); that is, he had a representation of a brokerage as having—or lacking—certain characteristics of a supermarket. Internal representations are the focus of the literature on managerial cognition, which has documented how they differ across managers.[2]

Outside strategy, internal representations have been the main focus of analysis of cognitive science and artificial intelligence. The field of cognitive science studies the different types of representations used by human beings. In fact, most cognitive science textbooks are structured in terms of the different representations humans use to solve problems in different domains (see, for example, Lindsay and Norman 1977). The field of artificial intelligence, a close cousin of cognitive science (Gardner 1985), studies how computers might be able to represent and solve problems that so far have not been solvable by computers (see, for example, Russell and Norvig 2010). It can be argued that organizations are a type of artificial intelligence—nonhuman but nevertheless engaged in decision-making. Hence, it should not be surprising that ideas from the fields of artificial intelligence and cognitive science are useful in understanding organizational

[2]This literature has referred to representations under different labels, such as: schema, knowledge structure, mental model, cognitive map, dominant logic, interpretive scheme, thought world, and managerial lens. For an exhaustive list, see Table 1 in Walsh (1995). Representations have also permeated the practitioner discourse with terms such as a firm's theory (Rumelt 2011, Zenger 2013), hypothesis (Ries 2011), and business model (Osterwalder et al. 2010); all constructs that are usually held in a manager's head and are used to predict performance.

decision-making.

External representations. The system holding an external representation is not an individual's brain but rather an artifact, such as a drawing on a blackboard representing a Five Forces analysis of the attractiveness of an industry. External representations exist because there are situations in which it is more efficient and effective to think with the aid of an artifact than to think entirely in one's head (Kirsh 2010:443). It is often the case, for example, that one can do a better job figuring out how to get from one place to another with the use of a map than by simply thinking about it. It is generally easier to add up two long numbers on paper—that is, using a written representation—than to do so in one's head.

The practice of strategy uses many such external representations, generally called "frameworks"; well-known examples include the Five Forces, the strategy canvas, and the firm value chain. Strategy textbooks are full of such representations, as is the typical output report of a consulting project. Interestingly, the strategy literature has little to say about external representations.[3] And unlike the case of internal representations, cognitive science has only recently started to pay attention to external representations (Clark 2008, Kirsh 2010).

External representations can take multiple forms. Architects, for example, often use 3-D models and physicists use computer simulations. In strategy, external representations are typically visual representations. In fact, strategy relies on these representations in a different way than other business fields: the visual representations used in strategy are predominantly diagrams (like the Five Forces or the strategy canvas), not graphs, pictures, or tables. Table 1 compares the percentage of the page area devoted to different graphical elements in MBA textbooks for different business fields; strategy uses diagrams twice as much as the closest other field. Arguably, this is because diagrams allow strategists to

[3]In the organizations literature, there has been some research on external representations, mostly focused on their potential for communication (and miscommunication) and their political use (Carlile 2002, Bechky 2003, Kaplan 2011, Jarzabkowski and Kaplan 2015).

	Diagrams	Graphs	Pictures	Verbal Tables	Numeric Tables
Strategy	64.1	2.6	11.8	20.3	1.2
Operations	34.4	22.4	18.2	12.8	12.3
Marketing	31.4	10.8	34.4	17.3	6.2
Accounting	12.7	5.0	3.5	8.3	70.4
Finance	10.7	44.7	0.9	13.6	30.2

Table 1: Comparison of the types of visual representations used by different business fields. The numbers represent percentages.

expand their cognitive capacity in order to deal with the aforementioned complexity of strategic decisions. For instance, using diagrams boosts managers' long-term memory by allowing them to more easily remember the elements and relationships in a framework. Diagrams also expand managers' working memory by allowing them to write down and organize more aspects of the strategic problem that what would be possible if they were only using their head. Csaszar et al. (2018) elaborate these arguments and theorize how different characteristics of external representations affect strategic decision-making.

Distributed representations. The system holding a distributed representation is a set of individuals and possibly artifacts. Distributed representations exist because it is often the case that no single individual or artifact contains all the information necessary to solve a problem. Hutchins (1995b), for example, shows that the information needed to land a large airplane is distributed across the pilot, the co-pilot, and the dashboard instruments. No one of these sources alone has enough information to land the plane. Distributed representations are pervasive in strategy. For example, usually the top management team—but no one member alone—can decide what new product to launch. A sales manager plus the firm's customer relationship management software (including a possibly huge database) are needed in order to decide which potential customers to target.

Distributed representations have received some attention in cognitive science (Hutchins 1995a, Robbins and Aydede 2009). But because organizations are the quintessential

holders of distributed representations, arguably the vast majority of research on such representations has been done in the strategy and organizations literatures rather than in the cognitive science literature. For example, research on learning and innovation in networks (e.g., Fang et al. 2010), flat versus hierarchical organization (Csaszar 2012), and information aggregation (e.g., Csaszar and Eggers 2013) is all fundamentally concerned with distributed representation.

The three types of representation are pervasive in strategy. All decisions made by human beings are affected by internal representations. Any decision informed by frameworks, rules, procedures, or software is affected by external representations. And any decision that combines the opinion of multiple sources—including human beings, frameworks, rules, procedures, or software—is affected by distributed representations. Since all decisions made by organizations fall under at least one of these cases, it seems imperative to better understand how representations affect strategy.

3 A framework to understand representations

Brunswik's (1952) lens model offers a simple, yet powerful framework to conceptualize representations. It states that any prediction task includes the following elements:

- An *environment*, which corresponds to the relationship between cues (characteristics of the environment) and an outcome. More formally, the environment is a function f that takes as inputs cues $x_1, \ldots, x_N$ and produces an outcome y; that is, $y = f(x_1, \ldots, x_N)$.

- A *representation* that attempts to predict the outcome. This is another function $\hat{f}$ that takes some cues and produces a predicted outcome $\hat{y}$; that is, $\hat{y} = \hat{f}(x_1, \ldots, x_N)$.

- A *measure of the goodness* of the representation. That is, a "loss function" that describes how costly is for the representation's predictions ($\hat{y}$) to deviate from the

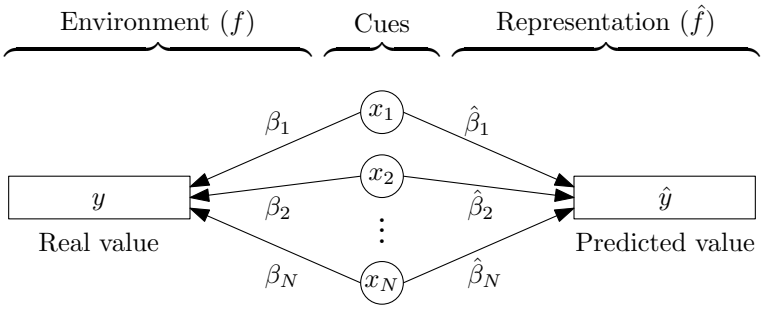

Figure 1: Brunswik's lens model.

environment's outcomes (y).

The defining characteristic of bounded rationality—that representations are inaccurate and incomplete models of the environment (Simon 1947/1997:17)—is clearly captured by this framework. Imagine, for example, that the sales of a car are given by the environment equation: $y = 3x_1 + 2x_2 - x_3$, where x_1 = economic growth, x_2 = miles-per-gallon, and x_3 = inflation. But a particular manager may overestimate the effect of the economy on sales, underestimate the effect of mileage, and entirely overlook the effect of inflation, such that his or her representation is given by: $\hat{y} = 4x_1 + x_2$.

The Brunswik lens model is typically depicted graphically as shown in Figure 1, with the cues in the middle, the environment on the left, and the representation on the right. Note, however, that the model itself is more general than this depiction, because the functions f and $\hat{f}$ do not need to be linear and they do not need to depend on the same set of cues (x_1, x_2, and so on).[4]

Several concepts in the strategy literature can be understood in terms of the lens model. For instance, NK landscapes that describe the actual environment where firms search (e.g., Levinthal 1997), correspond to the left-hand side of the lens model (i.e., f). A manager's "theory" of his or her firm—the key construct of the problem-solving perspective

[4]Since any function can be approximated by polynomials, a general way to model the functional forms of f and $\hat{f}$ is as polynomials on $x_1, \ldots, x_N$. One could also imagine representations that include nested representations (e.g., a model of a firm that includes models of the firm's departments) to be akin to multi-layered neural networks.

(Nickerson and Zenger 2004, Felin and Zenger 2017)—corresponds to the right-hand side of the lens model (i.e., $\hat{f}$). A manager's attention—the key construct of the attention-based view (Ocasio 1997)—corresponds to the set of x's that feed into the representation (e.g., $\hat{f}(x_1, x_2)$ "attends to" cues 1 and 2, $\hat{f}(x_3)$ attends to cue 3). And the idea that different environments penalize omission and commission errors differently (depending on how imperative exploration is versus exploitation; Csaszar 2013), is captured by loss functions that have different slopes when $\hat{y}$ under- and over-estimates y. Later sections develop detailed connections of the lens model to other concepts of strategy, including strategic foresight, simple and complex rules, and the resource-based view.

Brunswik's lens model is agnostic with regard to the type of representation; it can be used to analyze internal, external, and distributed representations. For example, a representation function, $\hat{y} = x_1 + x_2$, can depict (a) an internal representation, such as that of an individual who pays attention to two cues and weights them equally; (b) an external representation, such as that of a framework that takes into account two cues and weights them equally; or (c) a distributed representation, such as that of a CEO who makes a certain type of decision by equally weighting the opinion of two subordinates. Of course, representations can be more complex than that particular function. The Five Forces framework, for example, represents an industry as a point in a five-dimensional space and deems the industry more attractive the closer that point is to the origin of this five-dimensional space.

Brunswik's model is useful to strategy for several reasons. First, it is general, allowing us to study internal, external, and distributed representations. Second, it describes and interconnects key elements relevant to strategy; namely, the environment, the representation, and the quality ("goodness") of that representation. Third, every element has a mathematical definition, which allows for (a) clear theorizing, (b) the definition of empirical measures, and (c) the development of formal models. The lens model serves as a foundational model in the judgment and decision-making literature (Hastie and Dawes

2010) and underlies many empirical investigations in that literature (see Karelaia and Hogarth 2008 for a survey of 249 lens studies).

Brunswik's lens model offers a fruitful way to add representations to the Carnegie tradition, with which, in fact, it shares a lineage. Simon's principal influences when writing his dissertation, which later became *Administrative Behavior*—the foundational book of the Carnegie tradition—were (a) Carnap, one of the key members of the Vienna Circle, which influenced Brunswik greatly and (b) Tolman, a close collaborator of Brunswik.[5] Brunswik and Simon had similar goals: Brunswik was trying to build a clear cognitive foundation for psychology, dominated at that time by the acognitive approach of behaviorism; while Simon was trying to build a clear cognitive foundation for organizational behavior, dominated at that time by the acognitive discipline of economics. The lens model was not core to the foundational texts of the Carnegie tradition simply because it had not been published at that time; Brunswik published an initial version of the model in 1952 and it took its current, clear mathematical form with Hursch et al. (1964). But Simon later acknowledged the relationship of his work with that of Brunswik in the historical addendum to *Human Problem Solving* (Newell and Simon 1972:874).

Of course, Brunswik's lens model is not the only way to incorporate representations into strategy (see, e.g., Huff 1990 for various other methods to map managers' internal representations). But it is a valuable one for the reasons mentioned above. The next three sections illustrate the use of this framework with three examples that cover different empirical and theoretical research methods.

[5]For an account of these influences on Simon's work, see Crowther-Heyck (2005:101–102) and the multiple references to Carnap and Tolman in Simon (1996).

4 How do representations affect strategic foresight?[6]

Foresight—the ability to make accurate predictions—is at the core of many strategy theories. For example, the resource-based view asserts that a firm generates above-normal returns by accurately predicting the value that a resource will generate once it is bought, sold, or developed (Barney 1986). According to the positioning school, a firm generates above-normal returns by accurately predicting the future attractiveness of the industries it can enter (Porter 1980). And according to the value-based view, a firm generates above-normal returns by accurately predicting its opportunities to create and capture value vis-à-vis its competitors, customers, and suppliers (Brandenburger and Stuart 1996).

It seems clear that knowing what leads to better foresight should be central to strategy. The representational approach sheds light on this issue, as the accuracy of predictions depends on the representations used to make them. Csaszar and Laureiro-Martinez (2018) explore this line of thinking. Here I summarize their method and results, as it helps illustrate how representations—and their effect on performance—can be measured in realistic settings. Understanding their setup also sets the stage for a number of extensions discussed later.

Csaszar and Laureiro-Martinez (2018) study an experiment that takes place in two rounds. In Round 1, students watch two videos, each describing a startup's business plan and main product. Strategic foresight in this setting corresponds to a participant's ability to extract information from the videos and then to use that information for predicting which startup is more likely to succeed. Both startups are trying to raise money on a crowdfunding site. The two companies were chosen for their sharp contrast: although both met their fundraising goals, one went on to technological and commercial success and the other failed. The students, however, have no previous knowledge about the startups. Their task is to predict which will be more successful and to explain why by writing an

[6]This section is based on Csaszar and Laureiro-Martinez (2018).

open-ended list of each startup's pros and cons. Each item in this list is a short sentence followed by a valence (from -2 to $+2$). For example, a student might think that one of the startups has too many competitors (-2) or has an appealing product ($+2$). In Round 2, students work in groups of two to jointly produce a list of pros and cons for each of the startups.

We use the data from Round 1 plus demographic data such as the students' ages, GMAT scores, and business backgrounds to determine what drives strategic foresight at the individual level. For example, our analysis allows us to say that in our setting GMAT scores do not affect the probability of predicting correctly and that individuals whose representations had higher breadth (a measurement to be discussed below) were more likely to predict correctly. Comparing the results of Rounds 1 and 2 allows us to say whether working as a group improves foresight vis-à-vis working alone.

The method used in this experiment to measure representations was the following: Each item in each student's list of pros and cons was coded into a category. For our set of categories, we chose the main topics of the strategy course in which this experiment was conducted; for example, the response "too many competitors" was coded as "industry structure." Thus, from each individual's list of pros and cons, we could code his or her representation of the startup. We then could measure three main characteristics of each representation: breadth—the number of categories captured by the representation; depth—the average number of items per category; and consensus—the distance between the individual's representation and the average representation for the whole class. (This average representation can be understood as representing the "wisdom of the crowd."). Figure 2 illustrates how these measures are computed.

We find that greater breadth increases the chances of picking the successful startup; that is, breadth increases strategic foresight. Consensus also has a positive effect; having a representation that is close to the crowd's representation increases the probability of making the right decision. In this setting, the average of the crowd is an accurate description

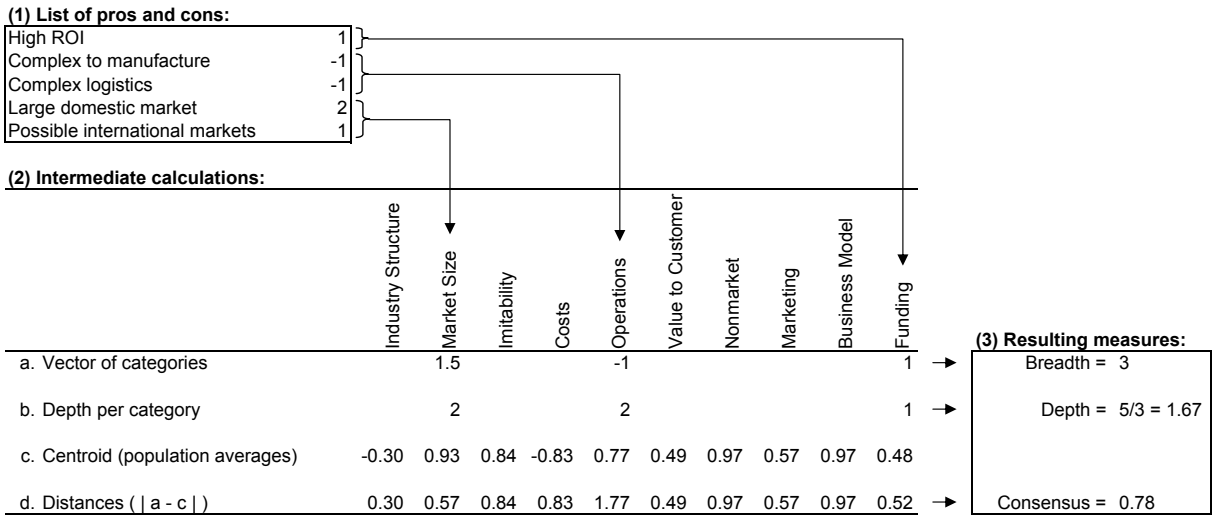

Figure 2: Illustration of how to compute breadth, depth, and consensus starting from a list of pros and cons.

of each startup's pros and cons, as most members have relevant knowledge to evaluate the startups (which sell consumer products). That is, in this setting, the logic of the "wisdom of the crowd"—that individual errors will cancel out—holds. This may not be true, however, in situations in which most members of the crowd are ignorant about the type of product involved; for example, if one of the startups were offering a production technology rather than a consumer product.

An interesting result is that depth does not have a significant effect; simply providing more pros and cons per category does not contribute to strategic foresight. This result is consistent with the research on unit-weighting schemes (Einhorn and Hogarth 1975) and on other "improper" decision-making models (Dawes 1979), which has shown that, in many settings, simply getting a directional assessment of the effect of cues is enough to make accurate predictions.

Finally, we find that for the groups in Round 2, the only driver of foresight is the "quality" of the individual members; that is, how accurate their predictions had been in Round 1.

4.1 Implications for strategy

First, this research demonstrates an effect of representations on performance in a more realistic setting than previous research, which has used computer simulations and business simulations. Second, it shows that the performance of internal and distributed representations depends on different drivers: the success of internal representations depends on breadth and consensus and the success of distributed representations depends on the participation of high-quality individuals (i.e., individuals whose foresight is high). The fact that breadth matters but many strategy frameworks have a limited focus (e.g., the five forces framework focuses on market power and the strategy canvas focuses on value to the consumer) suggests that the education of strategists should include a broad repertoire of frameworks and that there may be value in frameworks that integrate multiple dimensions. A more general contribution of this research is that it provides an empirical method to analyze representations and their effect on performance.

5 How complex should representations be?[7]

A long-standing debate in the strategy and organizations literatures involves how complex representations should be. The arguments fall into three camps. Some argue that representations should be as simple as possible. This argument has been made in the heuristics literature (Gigerenzer and Goldstein 1996) and some empirical evidence has been produced; for example, work showing that successful companies use simple decision-making processes (Fredrickson and Mitchell 1984) and simple rules (Bingham and Eisenhardt 2011). Philosophers and mathematicians have long advocated for simplicity (i.e., Occam's razor principle; see, MacKay 2003:343–54), although a debate exists over whether this principle is justified (Domingos 1999).

Others argue for more complexity, as exemplified by Weick's (1979) advice to managers

[7]This section is based on Csaszar and Ostler (2018).

to "complexify yourself"; that is, to use more complex organizational structures and processes. Again, some empirical evidence has been marshaled, including McNamara's (2002) finding that banks that use more complex systems perform better and Connelly et al.'s (2017) finding that using complex competitive repertoires is associated with higher performance.

Finally, there is an intermediate view, which might be termed "complexity-matching," that a representation should be as complex as the environment in which it is to be applied. This is Ashby's (1956) idea of "requisite variety." However, there is not much empirical support for the success of complexity-matching representations (Walsh 1995:302).

This is not just a theoretical discussion. In practice, the three camps prescribe different actions in the same circumstances, leaving it unclear what types of managers, frameworks, and organizational structures firms should use (i.e., what internal, external, and distributed representations firms should employ). Moreover, the fact that there is some empirical support for the research on simple and on complex representations suggests that both views are correct under certain situations. Hence, the optimal complexity of representations may depend on particular contingencies; simple, complex, and perhaps even complexity-matching representations may each be preferable under the right circumstances. However, the strategy and organizations literatures do not currently offer a theory capable of describing what these contingencies are and how they co-determine the optimal complexity of representation. The goal of the research illustrated here is to provide such a contingency theory by developing a model that uses key characteristics of the environment and of the decision maker to predict the optimal representational complexity.

5.1 The model

The proposed model will use Brunswik's lens model and ideas from statistical learning theory (Hastie et al. 2009) to develop a mathematical model of the optimal representational

complexity. Recall that in the lens model the environment is a function describing how cues affect the outcome. The current model describes environments in terms of two contingencies: complexity (how many terms and interactions the environment has) and uncertainty (how unpredictable the environment is, which is modeled as a random error term in the environment equation).[8]

The decision maker must decide how complex her representation of the environment should be. For example, should she use a simple model such as $\hat{y} = \hat{\beta}_1 x_1$, or an intermediate model such as $\hat{y} = \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2$, or a more complex model such as $\hat{y} = \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + \hat{\beta}_3 x_1 x_2$?

Two contingencies describe the decision maker. The first is experience: how many previous projects has he or she seen? That is, how many sets of cues (x_1, x_2, and so on) with their corresponding outcomes (y)? The second is informedness: does the decision maker know which x's are more relevant than others? This captures the difference between domains with and without established knowledge; for example, the difference between real estate, which is very well understood, and Internet search in 1999, when it was so new that no one knew what mattered most.

The decision maker's task is to predict whether a new project (for which he or she sees only the x's) will have a positive or negative outcome (y). The decision maker chooses a representational complexity and then estimates the coefficients in her representation (this is done using OLS, but the results are robust to using other estimation methods). The decision maker's performance is measured as the actual average outcome of those projects for which he or she predicted a positive outcome.

The question the model answers is: What is the optimal representational complexity in a given set of circumstances? That is, given the environment's complexity and uncertainty and the decision maker's experience and informedness, what representational complexity

[8]That is, uncertainty in this model corresponds to "aleatory uncertainty." In turn, uncertainty due to lack of knowledge—that is, "epistemic uncertainty"—is captured by the experience and informedness contingencies described later. For alternative characterizations of uncertainty, see Spender (1989, chap. 3), Burton and Obel (2004, chap. 6), and Posen et al. (2018b).

will maximize the decision maker's performance?

5.2 Results from analyzing the model

We find that each of the three types of representation—simple, complexity-matching, and complex—is the most appropriate under particular conditions. Simple representations (Gigerenzer and Goldstein 1996) are the most appropriate when uncertainty is high (for example, when a firm faces a market made unpredictable by political turmoil) and when the manager is informed but inexperienced (for example, when a newly minted MBA launches a "low-tech" startup). In such cases the manager is best served by using her reduced experience to estimate a few relevant cues accurately. Although uncertainty depreciates the value of all representations (because they become less able to predict the environment), the value of simple representations decays the least as uncertainty increases.

Complex representations (Weick 1979) are the most appropriate when the manager is uninformed; for example, a manager working in a radically new industry, as Google managers were in 1999. In such cases, using a complex representation increases the chances of including the cues that drive performance.

Complexity-matching representations (Ashby 1956) are the most appropriate when the manager is both informed and experienced; for example, a manager with extensive experience in a well-established industry with well-understood principles, such as banking or real estate.

5.3 Implications for strategy

Complexity is a fundamental characteristic of all representations. There has been a long-standing discussion—unresolved by the contradictory empirical evidence—on what is the optimal representational complexity. We can use ideas from Brunswik and from statistical learning to shed light on this question.

The main implication of this model is that there is no one-size-fits-all representational complexity. Both simple and complex representations can be the best under certain circumstances; neither always is. Optimal representational complexity depends in nuanced ways on characteristics of the environment and of the decision maker.

6 Using the representational approach to better understand the resource-based view

The resource-based view (RBV), a central theoretical lens in strategy, sees the firm as a collection of resources (Wernerfelt 1984, Barney 1986). The RBV is valuable because it provides an internal explanation of firm performance that complements external explanations, such as those provided by the positioning school. It has been widely used to analyze phenomena such as acquisitions, divestitures, hiring, resource development, and R&D.

The RBV does, however, have problems. Its theoretical underpinnings have been extensively criticized (see, e.g., Mahoney 1995, Priem and Butler 2001, Connor 2002, Foss et al. 2008, Lockett et al. 2009, Kraaijenbrink et al. 2010, Leiblein 2011). Some of these problems have been fixed. In fact, the RBV was not proposed all at once, but has developed through accretion and revisions (Makadok 2001a). Nevertheless, at least two criticisms remain open: lack of clarity on the definition of a resource (Priem and Butler 2001, Kraaijenbrink et al. 2010:358) and lack of clarity regarding the role of managerial cognition in the RBV (Connor 2002:312, Kraaijenbrink et al. 2010:351).

The goal of the following illustration is to use the representational approach to address these two issues by providing a definition of a "resource" and an understanding of the role of cognition in the process of resource picking (Makadok 2001b). The method will be to develop a formal language with which to talk about the different elements of the RBV, again using Brunswik's lens model as the underlying framework.

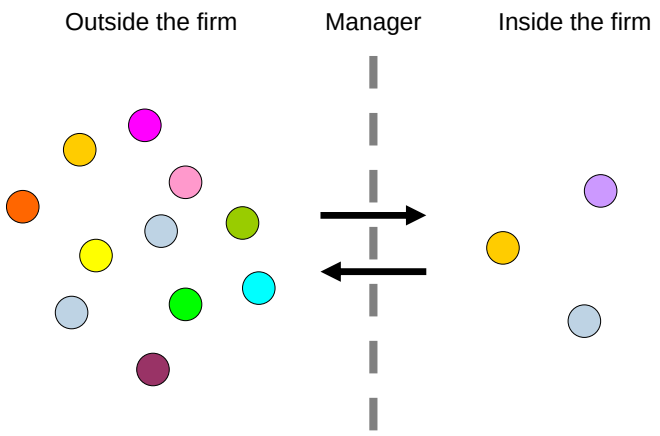

Figure 3: Graphical understanding of the RBV.[9]

It will help to begin with a "picture" understanding of the RBV.[9] As illustrated in Figure 3, outside the firm are many possible resources and inside the firm are the resources controlled by the firm. The manager's role is to act as a "filter," choosing which resources to keep inside and which outside.

To apply a Brunswikian lens to our understanding of the RBV, let us imagine a restaurant. One of the two "sides" of the lens model is the environment. This particular restaurant's environment is described by the profit function:

$$\pi = 20x_{\text{quality}} + 10x_{\text{tables}} + 2x_{\text{quality}}x_{\text{tables}} - c,$$

where the x's—x_{quality} and x_{tables}—are the restaurant's process inputs: its quality and the number of tables. The term $x_{\text{quality}}x_{\text{tables}}$ is the interaction of those two inputs; for example, the effect through word of mouth about how good the restaurant is. The coefficients (β's) are the process characteristics; that is, relatively how much a given input contributes to profits (π). And c is the cost of the restaurant given those inputs and process characteristics.

Recall that the RBV has been criticized for lack of clarity about the definition of a

[9]I owe this graphical understanding of the RBV to Todd Zenger, who presented it at INSEAD in 2011.

resource. Here, though, we can define a resource as a bundle of changes to the firm profit function. Imagine, for example, that the restaurant decides to replace its cook with a well-known chef, changing the x's, β's, and c in the profit function in the following ways:

$$\Delta\mathbf{x} = (4, -2)$$
$$\Delta\boldsymbol{\beta} = (0, 0, 1)$$
$$\Delta c = 50.$$

That is, the higher quality of the chef's cooking increases x_{quality}, but reduces x_{tables} because fewer tables can be served—it takes longer to produce these higher-quality dishes. The coefficients on x_{quality} and x_{tables} remain the same, but the coefficient on their interaction increases as word gets around about how good the new chef is. The cost increases, as the well-known chef will certainly have to be paid more than the previous cook. Thus, we have a clear answer to the question of what exactly is a resource: it is the bundle of changes to the firm profit function described by the tuple $\langle \Delta\mathbf{x}, \Delta\boldsymbol{\beta}, \Delta c \rangle$.

To address the second open question—the role of managerial cognition in the RBV—we will examine the restaurant manager's representation. Imagine that this manager has an inaccurate understanding of the restaurant's utility function, taking it to be:

$$\hat{\pi} = 30x_{\text{quality}} + 10x_{\text{tables}} - c.$$

This manager overestimates the effect of quality and does not take into account the interaction of x_{quality} and x_{tables}. In deciding whether or not to hire the well-known chef, the manager must calculate whether the chef will generate enough new profit to outweigh the higher cost. More generally, the manager will acquire a resource if the expected profits

with the resource are greater than the expected profits without it:

$$\hat{\pi}(\hat{\mathbf{x}} + \Delta\hat{\mathbf{x}}, \hat{\boldsymbol{\beta}} + \Delta\hat{\boldsymbol{\beta}}, \hat{c} + \Delta\hat{c}) > \hat{\pi}(\hat{\mathbf{x}}, \hat{\boldsymbol{\beta}}, \hat{c}) \tag{1}$$

Note all the "hats" ($\hat{}$) in this equation. They imply that the manager does not know the real profit function nor exactly how the resource will end up changing the profit function. Instead, the manager makes a decision based on her representation of the profit function ($\hat{\pi}$, determined by $\hat{\mathbf{x}}, \hat{\boldsymbol{\beta}}, \hat{c}$) and her representation of the new resource ($\Delta\hat{\mathbf{x}}, \Delta\hat{\boldsymbol{\beta}}, \Delta\hat{c}$). Here, then, is an answer to the question of the role of managerial cognition on the RBV: cognition—in the form of representations of the firm and resources—determines how resources are evaluated, thus, affecting what resources are kept inside and outside of the firm. This cognitive understanding of the RBV opens a number of ways in which the resource evaluation process could be examined, which we discuss next.

6.1 Implications for strategy

Thinking in terms of representations increases the theoretical precision of the RBV by providing a mathematical definition for "resource" and a precise understanding of how cognition affects the RBV. Doing so helps address key criticisms of the RBV. It also points to another limitation of the RBV, which the representational approach may illuminate.

From the theorizing so far, it follows that the value of a resource is not only firm-specific but representation-specific. This is so because decisions are always made on the basis of a representation (humans cannot "see" the left-hand side of the lens model). Hence, barring omniscient access to the real characteristics of the resource and of the firm, one can only define the value of a resource in terms of Equation 1 (i.e., the added value of a resource is the value of the firm with the resource minus the value of the firm without the resource, where everything describing the firm and resource is a representation; it has a "hat"). This definition hints at how representations can be a source of competitive

advantage. In a strategic factor market, a representation is valuable to the extent that it allows predicting profits that others cannot predict. Such ability may stem from seeing characteristics of resources more accurately or by conceiving superior uses of resources (e.g., from perceiving β's that others do not or from conceiving an altogether different profit function stemming from a novel use of the resource). The RBV has emphasized the relevance of scarce resources but, perhaps, in many situations good representations are scarcer than resources.

Further research could ask, for example, whether managers are more likely to make mistakes in their representation of the firm or of resources; what is the best way to search for valuable resources (e.g., by focusing first on simple resources or on complex ones? on familiar or on unfamiliar resources?); whether there are systematic errors on how managers evaluate particular types of resources (and whether these errors stem from misjudging inputs, process characteristics, or costs); and to what extent such mistakes vary depending on industry, resource type, and experience.[10]

7 Discussion

The logic of the representational view of strategy is that because representations affect decisions and strategic decisions affect firm performance, then representations must affect firm performance. The research approach suggested here is to study how representations—internal, external, and distributed—affect firm performance. The promise of this line of research is that understanding how strategic decisions are made should allow us to (a) make better decisions and (b) design better decision-making systems.

Contributing to the representational view of strategy is challenging not just because of

[10]Regarding the role of experience, the logic of pre-adaptation (Denrell et al. 2003:989, Cattani 2005) suggests that firms will be more accurate when making decisions about resources that are the most similar to resources they have evaluated in the past. Yet where that accuracy comes from (i.e., from the representation of the resource or of the firm's profit function) is unclear.

the empirical constraints discussed earlier but also because of theoretical challenges. When presenting his celebrated foundations of decision theory, Savage (1954:85) acknowledged the key role that representations play in decision making (which he called the problem of constructing a "small world" from the "grand world") but conceded, "I am unable to formulate criteria for selecting these small worlds and indeed believe that their selection may be a matter of judgment and experience about which it is impossible to enunciate complete and sharply defined general principles" (p. 16). Decision theory and related disciplines like economics have focused since then on studying stylized problems; that is, problems where a particular small world is taken as given. Yet, the field of strategy cannot afford that luxury, as the job of strategists is precisely to deal with very complicated problems, which can only be addressed by turning the grand world into a small one. In other words, strategy is fundamentally about creating representations.[11] So, although studying representations is challenging, doing so is paramount, since the success of strategies—and the realism of the strategy field—hinges on understanding how representations affect performance.

7.1 A research agenda for the study of representations

We have shown some examples of research on how strategic representations affect firm performance. But certainly many questions remain to be answered. For example:

1. *How do representations change?* How, for example, do they change with experience at a particular firm? How do they change while taking a course on strategy? How do they change when managers are made more aware of aspects of their representations? (for initial research on this question in the context of the lean startup methodology, see Camuffo et al. 2017). Better understanding representational change can help guide how strategy is taught.

[11] Bruce Henderson, the founder of the Boston Consulting Group, captured this idea well by saying that strategy consulting sells "powerful oversimplifications" (Ghemawat 2002:45).

2. *What determines an individual's representational capability?* Why are some people able to choose powerful, effective representations while others choose less-useful or even counterproductive ones? Arguably, this is the most important capability for managers and consultants. Understanding this capability calls for understanding how the representation formation process works and how it can be made more effective. It is likely that the process of forming a representation depends on the repertoire of representations the manager knows.[12] This process may also look very different depending on the task at hand. For example, strategy evaluation tasks (such as picking the best startup in Csaszar and Laureiro-Martinez 2018) may be less cognitively demanding that strategy design tasks (such as coming up with the business plan of a startup). Capturing detailed data on the process of representation formation will likely require pushing the methodological boundaries of the strategy field.

3. *How do representations and competition interact?* Many treatments of managerial cognition imply that the most important characteristic of a representation is its accuracy. For example, Gavetti (2012) proposes that profits stem from accurate representations of "cognitively distant opportunities." At the same time, we know that evolution favors the fitness of representations, not their accuracy (Mark et al. 2010). This suggests that a fuller understanding of the interplay between representations and competition should take into account tradeoffs such as the one between accuracy and speed (a trivial example is that in an industry with network effects, a firm with an overly optimistic representation would be more likely to move first and become the market leader). Other problems involve the dynamics of competitive interactions, such as how firms learn representations and how the representations

[12]Because each representation focuses attention on a limited set of dimensions, collective characteristics of the repertoire may be relevant. For instance, the investor Charles Munger argues that managers should have a collection of representations (which he calls a "latticework of mental models"; Munger and Kaufman 2005:55–56) that is coherent and collectively exhaustive.

of competing firms interact (a related line of research is how representations and collaboration interact; for initial research see Puranam and Swamy 2016).[13]

4. *What interactions occur across different types of representation?* For example, which internal representations work well with which distributed representations? In practical terms, that might help a firm decide what types of manager would work best in a given type of organizational structure. A related question is the extent to which different types of representation compensate for each other. For example, in what situations can external representations (e.g., frameworks) compensate for weak internal representations? Managers with flawed internal representations may nevertheless produce good decisions when placed in the correct, compensatory structure or when aided by the right strategy tools.

5. *What are the most valuable representations?* What, for example, would be the most valuable frameworks to teach MBAs? It is odd that the field of strategy, which is concerned with what determines performance, has not studied how what we teach affects performance.[14] Another question along these lines is the degree to which it is better to teach simple, generic representations (such as strategy frameworks that can apply to different situations) or more complex, firm-specific representations (such as the specific "theory" that explains the profitability of a given firm; Felin

[13]A further research opportunity regarding how representations and competition interact is to formalize the concept of cognitively distant opportunity. Doing so would require defining a distance metric. Currently, it is unclear whether the concept implies a distance between actual and potential projects (i.e., involving $\mathbf{x}$'s), between the representations of different actors (i.e., involving $\hat{\boldsymbol{\beta}}$'s), or something else. What it cannot be is a distance between $\mathbf{x}$'s and $\hat{\boldsymbol{\beta}}$'s, as these two live in different spaces. Also it could not be some type of intra-individual distance, as the gist of Gavetti's (2012) argument is that what is distant for some individuals is not for others (akin to Adner and Levinthal's 2008 "flatland" argument, that exploration looks like exploitation from the viewpoint of the explorer). Having a formal definition of "cognitively distant opportunity" could help clarify how to discover such opportunities, for example, by enabling researchers to model and measure the opportunity discovery process.

[14]It may even be possible that a framework was detrimental (akin to Frank et al.'s (1993) and Ghoshal and Moran's (1996) arguments against the value of knowing neoclassical economics and transaction cost economics, respectively) or that it created a self-fulfilling prophecy (akin to MacKenzie and Millo's (2003) analysis of option pricing theory).

and Zenger 2016). This question has parallels with the question of choosing the teaching method for a strategy course: how much should the course rely on lectures that present general frameworks versus case discussions that delve into the specifics of a firm? From the discussion on representational complexity above, it is likely that the answer to these questions will depend on characteristics of the individuals (such as their experience) and of the task environment they will face (such as its complexity or degree of interdependence).

6. *How can we design better external representations?* Are there guidelines for designing better frameworks or computer systems to support strategic decision-making? This is important because once a problem is well represented, it becomes easy to solve. As Simon (1969/1996:132) noted, "solving a problem simply means representing it so as to make the solution transparent." So if, as a field, we find better ways of representing different types of strategy problems, we will get closer to solving strategists' problems. In the very long run, this effort would move us closer to creating an "artificial strategist." (Such a development would have some resemblance to what happens in finance, where investment decisions are increasingly made by algorithms).

7. *To what extent can representation substitute for search (and vice versa)?* Recall Thagard's (2005) maxim: thinking = representations + computation performed on those representations. Here, we have been exploring representations, but what is the role of computation? Previous research in strategy has highlighted one type of computation: search. An open question, then, is the extent to which representation and search can compensate for each other and the situations in which such compensation is feasible. In what circumstances, for example, can a poor representation and a lot of search generate good performance? Another important question is how relevant is representation vis-à-vis search—which one has a larger

effect on performance?[15]

These questions show that much work remains to be done. We still know little about what makes a great strategist and how to organize so as to make great strategic decisions. Furthering our understanding of the representational view of strategy can help answer these questions.

7.2 A story

A story may illustrate how little we know about representations and highlight the opportunities available if we understood them better. In 2004, 19-year-old Alex Tew created the Million Dollar Homepage (http://www.milliondollarhomepage.com). It displayed a blank image with one million pixels (a square of 1,000 $\times$ 1,000 pixels). Hoping to make one million dollars, Alex offered to sell each pixel for one dollar. The owner of a set of pixels could, thus, use the space to promote some brand. It may sound like a silly business idea, but in a matter of weeks, Alex had sold the million pixels and made his million dollars.

Why did Tew's idea work? People found the idea so strange that they talked about it. Soon, it was all over the news. People visited the webpage. Firms, realizing that all these visitors would be a valuable target audience for their ads, rushed to buy pixels on which to put their ads.

But why was the Million Dollar Homepage invented in 2004 and not 1999? Even in 1999, all the necessary elements were in place: sufficient Internet connectivity, sufficient screen resolution, and millions of users. What was not there, though, was the idea.

Why did it take millions of Internet entrepreneurs five years to discover what has to be one of the simplest business models imaginable? It must be that all those entrepreneurs

[15] A practical version of this problem is this: Imagine you have to organize a one-day strategy retreat. What percentage of the day would you allocate to formulating the problem and what percentage to devising solutions? A quote often ascribed to Einstein is "If I had only one hour to save the world, I would spend fifty-five minutes defining the problem, and only five minutes finding the solution." What would be strategy's advice?

were searching in the wrong place. No good representation of the search space had been developed, so everybody represented it in his or her own way. Many of these representations must have been nearly useless. Acting on such representations would be like playing chess without knowing the rules of the game. One might try a variety of useless or illegal moves, such as going off the board or turning a piece upside down as a move.

If entrepreneurs had known how to represent the search space, the Million Dollar Homepage would have been among the first to be discovered, simply because it is among the simplest possible business models. (The good news is that if it took five years to find such a simple business model, there must be many other profitable business models still awaiting discovery.) This story suggests that enormous cognitive difficulty underlies the design of even the simplest strategies (otherwise, what explains that millions of entrepreneurs did not discover the idea for years?). It also illustrates the idea (mentioned above in the context of the RBV) that the scarcity of useful representations may be more critical than that of resources. Finally, it suggests that a better understanding of representations may enable the discovery of new business ideas, boosting economic progress.

7.3 Conclusion: What makes a decision strategic?

We began with the question: What makes a decision strategic? Answering that question in an actionable way called for restating it as: What characteristics do strategic decisions have in common? The leitmotif of this article has been that decisions are made on the basis of representations. The overall implication of this article is, then, that strategic decisions can be characterized in terms of the strategic representations that produce them.

Although the representational view of strategy is at a nascent stage, a preliminary characterization of strategic representations becomes apparent. Strategic representations are pervasive: they not only take the form of internal representations (held by managers in

their head) but of external and distributed representations (held by artifacts and organizational structures, respectively). External representations, in the form of visual frameworks, are especially conspicuous in strategy. Strategic representations are consequential: they affect all strategic decisions and are at the core of many theories of strategy (i.e., the RBV and the other theories of competitive advantage that depend on strategic foresight). The quality of strategic representations depends on the extent to which they capture the main drivers of profits, which in turn depends on breadth (the number of relevant aspects that are captured by the representation) and consensus (how closely the representation matches a well-informed opinion). Different situations call for strategic representations of different complexity, and key contingencies determining the optimal representational complexity are the managers' experience and the environment's uncertainty.

We are just beginning to understand the effect of representations on firm performance. Hopefully, this article has provided some ideas to further the study of this phenomenon in ways that are relevant and rigorous. Bringing representations to the forefront suggests that the firm is to a large extent a nexus of representations. It also suggests that representations are so central to strategy that it may not be an exaggeration to say (paraphrasing Dobzhansky 1973) that nothing in strategy makes sense except in the light of representations.

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