Bounded rationality: Cognitive limitations or adaptation to the environment? The implications of ecological rationality for management learning

Abstract

This paper examines why bounded rationality continues to be considered an inferior form of rationality in the field of management and what this implies for business education and practice. We develop a critique of the dominant and widespread conceptualization of heuristics as flawed and error-prone and argue that it poses unnecessary constraints for the field of management. We discuss consequences of that interpretation of bounded rationality and propose ecological rationality as an alternative, positive interpretation. Ecological rationality considers a decision maker's environment and aims to identify how and when heuristics generate good outcomes. Evidence suggests that heuristics perform best when problems are ill-defined, many information cues are available but they are not equally valuable, and there are many possible courses of action, that is, in the uncertain environments that are characteristic of managerial decision making. We contribute by (1) highlighting the distinctiveness of the ecological rationality framework for management learning, (2) acknowledging how it can help rehabilitate bounded rationality in the field of management against its widespread characterization as an inferior form of rationality; and (3) by identifying how it can provide practicable recommendations for managerial learning and decision making.

Keywords: bounded rationality, ecological rationality, heuristics, decision making

INTRODUCTION

Since its inception, bounded rationality (Simon, 1957) has been progressively adopted in the field of management to illustrate how decision making takes place in organizations (Cyert & March, 1963; Foss, 2003; Levitt & March, 1988; March, 1991). Despite Simon's (1957, 1972, 1979, 1980) description of boundedly rational agents as making efficient use of information by adopting heuristics (i.e., rules of thumb that economize on information gathering and processing), the predominant interpretation of bounded rationality among management scholars views "the glass half empty" (Bendor, 2015). By emphasizing the mistakes resulting from cognitively limited decision makers, this view positions bounded rationality as inferior to the classical account of rationality. A quick search through some of the most reputed sources in management scholarship shows that boundedly rational agents are generally described using negative terminology: They "misperceive" information (Hallen & Pahnke, 2016, p. 1535), do not "accurately assess" the value of information (Yang & Peng, 2011, p. 1070), are "hampered by imperfect information and limits in their ability to gather, interpret, and process new knowledge" (Cohen, Bingham, & Hallen, 2019, p. 811), or have "to cope with" bounded rationality (Peteraf & Shanley, 1997, p. 165).

This view contrasts with Simon's conception of bounded rationality, which focused on "the glass half full" (Bendor, 2015). Simon's work deviated from existing theories that assumed utility maximization capacities, and pointed out that humans do not optimize; rather, they satisfice by using heuristics: They do not need to collect exhaustive information, evaluate all possible options, then pick the best option. The actual decision making process is simpler, faster, and feasible for humans and organizations. Importantly, it also leads to reasonably good decisions. In describing his positive view of bounded rationality, Simon (1979) emphasized that

> if our interest lies in descriptive decision theory (or even normative decision theory), it is now entirely clear that the classical and neoclassical theories have been replaced by a superior alternative that provides us with a much closer approximation to what is actually going on. (p. 510)

In this article we make the case that, if anything, bounded rationality should be treated as a superior, not an inferior, account of rationality because as a descriptive model it offers a more realistic portrayal of how decision-making processes take place; as a normative model it offers time-saving advantages and cognitive economizing. Yet the dominant view on boundedly rational managers is still embedded in and legitimized by many of the classical lenses taught in business schools (e.g. transaction cost economics or modern portfolio theory), implicitly delegitimizing the simpler decision rules often used by practitioners (Wübben & Wangenheim, 2008) and contributing to their disenchantment with scholarly work in management studies.

This construal of bounded rationality as an inferior form of rationality has been criticized by advocates of the emerging theory of ecological rationality (Gigerenzer & Brighton, 2009; Gigerenzer & Selten, 2001; Gigerenzer, Todd, & the ABC Research Group, 1999; Goldstein & Gigerenzer, 2002). Decisions are ecologically rational when they are adapted to a decision maker's environment (Gigerenzer et al., 1999). A recurrent point in this framework is that the supposed shortcomings or biases resulting from the heuristics used by boundedly rational agents may actually reflect superior strategies in the particular context in which they emerge and evolve. For example, a recent study by Luan, Reb, and Gigerenzer (2019) showed that when tasked with predicting which of two candidates is more likely to perform better in the future, a simple heuristic that relies on a small set of information—the delta-inference heuristic—can be more successful than a complex logistic regression (i.e., a prototypical rational process) that uses

substantially more data to calculate the optimal weights for multiple variables. Consistent with the ecological rationality approach, Luan et al. (2019) studied the conditions under which the delta-inference heuristic outperformed the more complex method: In environments with higher uncertainty and fewer learning opportunities—in other words, when the decision environment more closely resembled a managerial decision situation—heuristics did better.

In line with recent studies that describe the advantages of the ecological rationality framework (Artinger, Petersen, Gigerenzer, & Weibler, 2015) or juxtapose it with the dominant view of rationality (Loock & Hinnen, 2015), we offer a critique of the dominant interpretation of bounded rationality and explore two questions: Can the ecological rationality framework prove useful to rehabilitate bounded rationality in the field of management against its widespread characterization as an inferior form of rationality? And how can ecological rationality provide practicable recommendations for managerial learning and decision making? In addressing these questions, we first provide a contribution of an argumentative nature, by reexamining the literature and acknowledging the ecological rationality framework as a distinct approach to conceptualize rationality than the heuristics-and-biases program despite both sharing a common origin in Simon's work. We argue that ecological rationality is more closely related to Simon's original conception and can help rehabilitate bounded rationality in the field of management against its widespread characterization as an inferior form of rationality. Our second contribution is of practical nature, by providing recommendations to practitioners and management learning that stem from the ecological rationality framework and proposing ecological rationality as a more suitable frame for management learning. Figure 1 provides a roadmap of the arguments that follow in the paper.

INSERT FIGURE 1 HERE

The assumption that complex organizational decisions need to be addressed by complex optimization processes remains at the backbone of management education. This is one of the factors contributing to the view of boundedly rational managers as falling short of the requirements for solving complex problems (Ghoshal, 2005). Our critique is centered on three beliefs about boundedly rational agents that persist in management under the dominant bounded rationality interpretation: (1) simple decision rules produce inferior outcomes than sophisticated computations based on more information, which are always preferable (this is reflected in the omnipresence of optimization-based techniques in many business school curricula), (2) boundedly rational agents rely on heuristics only because of their cognitive limitations (Kahneman, Slovic, & Tversky, 1982), and (3) heuristics can be used in trivial but not in consequential strategic decisions, where the costs of biases are too high. This debate joins a growing conversation on rationality by scholars reconsidering reason in managerial decision making (Foss, 2003; Foss, Klein & Bjørnskov, 2019; Ghoshal, 2005), and has important implications for management learning and education. First, to assess whether heuristics can outperform more complex methodologies, we need to take into account that managerial environments are characterized by an uncertainty that is not fully quantifiable, instead of the computable risks assumed in optimization models based on full information (Knight, 1921). In a context of Knightian uncertainty, viewing heuristics as successful decision strategies that help managers solve ill-structured problems with incomplete information can encourage educators to teach a repertoire of heuristics instead of relying solely on sophisticated methods that assume full rationality on the part of decision makers. Second, through examples taken from the literature,

we illustrate how heuristics can become powerful tools to make predictions when variability (and not bias) is the main obstacle to accurate decision making. Third, the ecological rationality view can increase educators' and managers' interest in identifying and evaluating heuristics, which in turn can lead to successful heuristics being promoted and transferred through convenient fast-and-frugal decision trees.

We next present a brief overview of Simon's arguments on bounded rationality and how they have unfolded in the field of management. We then analyze how the ecological rationality framework relates to Simon's work and how it went further in describing and assessing the performance of heuristics for decision making. Finally, we discuss how embracing the conception of ecological rationality can prove fruitful for practitioners and management educators.

BOUNDED RATIONALITY IN MANAGEMENT: AN OVERVIEW

Simon's View of Bounded Rationality

Simon's initial work attempted to provide a descriptive theory of how people actually make decisions. In referring to the computations that economic agents were supposed to undergo in the classical model of rational choice, Simon (1955) claimed that "there is a complete lack of evidence that, in actual human choice situations of any complexity, these computations can be, or are in fact, performed" (p. 104). This initial research agenda was driven by his interest in developing "theories of *how* to decide rather than theories of *what* to decide" (Simon, 1979, p. 498).

He described human rational behavior as the result of simple rules called *heuristics*—the key building blocks of boundedly rational action. Simon (1979) believed that heuristics' "basic

mechanisms may be relatively simple, … but that simplicity operates in interaction with extremely complex boundary conditions imposed by the environment" (p. 510), suggesting that people rely on heuristics not only due to limited cognitive capacities, but also as a response to the characteristics of the environment. This vision is best illustrated with his analogy for human rational behavior, which "is shaped by a scissors whose two blades are the structure of task environments and the computational capabilities of the actor" (1990, p. 7). That is, to establish whether behavior is rational, one must look beyond the cognitive capacities and processes of decision makers: It is also crucial to understand how behavior fits the environment.

Later in his career, Simon's work took a normative approach, trying to identify processes that managers could use to make good decisions, which he referred to as "procedural rationality" (Simon, 1976). This shift led Simon to view management as a research discipline whose objective was "to specify good (or best) methods for finding good (or best) decisions in complex managerial situations" (Simon, 1978, pp. 494–495), and "to help [businessmen] in inventing and constructing ... appropriate decision-making procedures" (Simon, 1976, p.75).

Over time, the notion of bounded rationality became a core feature of important advancements in contemporary management theory (Porac & Tschang, 2013). It was a foundational concept in the behavioral theory of the firm (Cyert & March, 1963), agency theory (Jensen & Meckling, 1976), transaction costs economics (Williamson, 1981), the evolutionary theory of the firm (Nelson & Winter, 1973), organizational learning and routines (Nelson & Winter, 1982), and heuristics and biases (Kahneman, 2003); more recently, it has greatly influenced entrepreneurial cognition (Mitchell et al., 2007), behavioral finance (Barberis & Thaler, 2003), and behavioral strategy (Powell, Lovallo, & Fox, 2011). However, the concept of bounded rationality later evolved into different, and sometimes opposed, interpretations as it

gained popularity in various traditions of management research. For example, research on entrepreneurial cognition has argued that entrepreneurs prevail in the face of biases by developing "scripts of knowledge" and "mindsets" that make them better than nonentrepreneurs at detecting and exploiting opportunities (Chaston & Sadler-Smith, 2012; Mitchell et al., 2007). In behavioral strategy, researchers assume that individuals' cognitive biases are deeply ingrained and hard to remove, and therefore suggest that firms must design behaviorally informed strategies that account for and benefit from those biases (Sibony, Lovallo, & Powell, 2017). We now turn to the key differences between the dominant interpretation of bounded rationality and the one brought about by ecological rationality; in doing so, we argue that the latter more closely reflects Simon's legacy and provides managers with a more practical knowledge of heuristics and their applications.

Two Interpretations of Bounded Rationality

As noted by Katsikopoulos (2014), "bounded rationality does not speak with one voice" (p. 361). The earlier theoretical frameworks influenced by bounded rationality (e.g., agency theory, transaction cost economics, evolutionary theory of the firm), rested on a "thin" treatment of the concept (Foss, 2001), viewing it merely as a rhetorical device to describe decision makers' cognitive and information-processing limitations (Foss & Weber, 2016). This became a background assumption that did not need to be explicated or modelled (Foss, 2001; Milgrom & Roberts, 1992), and led to a sentiment among organization theorists that bounded rationality was not a necessary building block for theories of the firm (Hart, 1990).

Bounded rationality played a greater role in the heuristics-and-biases program, which took into account the wider consequences of the simple rules that boundedly rational agents use

(Tversky & Kahneman, 1974). This research paradigm, also rooted in Simon's work, provided an innovative and bold approach to modelling the choice behavior of boundedly rational agents (Kahneman & Tversky, 1979), the heuristics they relied upon (Tversky & Kahneman, 1974), and their resulting biases (Gilovich, Griffin, & Kahneman, 2002; Hastie & Dawes, 2001). In line with Simon's view, the heuristics-and-biases program showed that decision makers are far from following the precepts of classical rationality (Gilovich et al., 2002). Yet, people's violation of these precepts was seen as the result of the use of heuristics, thereby establishing the view of heuristics as mental shortcuts that lead to systematically biased behavior (Kahneman, 1974).

The dominant interpretation of bounded rationality in management was greatly inspired by the heuristics-and-biases tradition (Kahneman et al., 1982; Tversky & Kahneman, 1974). It views managerial decision making as impaired by limited cognitive capacities and emphasizes the mistakes in judgments and decisions that result from the use of heuristics, leading to a "small-brained" view of managers (Hastie, 1991; Porac & Tschang, 2013). This view places the focus on people's cognition, comparing it to the benchmark of probability theory (or related frameworks like expected utility theory) to conclude that while managers tend to rely on heuristics, they should not— heuristics are inferior strategies that lead to detrimental biases (Dean & Sharfman, 1993).

Like the heuristics-and-biases program, the emerging ecological rationality framework agrees with the claim that classical rationality does not provide a realistic description of how people make decisions. By contrast, ecological rationality places the focus on the interaction between people's cognition and their environment (Rieskamp & Reimer, 2007), much like Simon's scissors analogy: Just as one cannot understand how scissors cut by looking at only one blade, one cannot understand managerial behavior by studying either decision makers' cognition

or their environment alone (Gigerenzer, 2008). Both Simon's work and the ecological rationality framework have been influenced by the work of Brunswik (1956), who advocated the study of judgment and decision making *within* the environment in which people operate, suggesting that studies using nonrepresentative laboratory settings eliminated the ecological structure of real-world environments.

A behavior is ecologically rational when it is adapted to a decision maker's environment. The work led by Gigerenzer is based on Simon's positive view of heuristics, but provides a stronger defense of the suitability of heuristics as decision-making tools: if a heuristic produces a structural bias that is well-adapted to the task environment, then this bias may be an advantage for making accurate and fast decisions in that particular environment rather than a liability. Then, the goal of the ecological rationality approach is to study in which environments and why a given heuristic performs well. This important departure from Simon's initial idea led the ecological rationality tradition to focus on the systematic test of heuristics, in which a given heuristic is tested for its predictive ability in comparison to other mechanisms, not its ability to fit already observed data (Gigerenzer and Gaissmaier, 2011).

Heuristics and Biases: Cognitive Limitations

Despite producing a better understanding of the cognitive strategies that agents may use, heuristics became linked to bias and systematic error in the heuristics-and-biases tradition. For instance, Barnes (1984) stated that heuristics are sometimes valid but often "lead to large and persistent biases with serious implications" (p. 199). Consequently, the study and teaching of heuristics in management has mostly focused on the flaws resulting from their use, while placing little emphasis on the understanding of how they can improve decision making (Highhouse,

Dalal, & Salas, 2013; Luan et al., 2019), thereby leading to insights that are difficult to translate into practice. This direction is a departure from Simon's goal of understanding heuristics from a normative perspective.

In his Nobel Prize lecture, Kahneman (2003) stated: "Our research attempted to obtain a map of bounded rationality, by exploring the systematic biases that separate the beliefs that people have and the choices they make from the optimal beliefs and choices assumed in rational-agent models" (p. 1449). This dominant tradition rests on the assumption that the conditions for fully rational models exist and therefore that classical rationality must be the benchmark for rational behavior. From that perspective, identifying and understanding the biases and errors in decision making is necessary to solve them and improve managerial decisions—that is, to bring them closer to the benchmark of full rationality. However, Simon's (1989) work focused on a fundamentally different question: "How do human beings reason when the conditions for rationality postulated by the model of neoclassical economics are not met … ?" (p. 377). Since managerial environments are mostly characterized by Knightian uncertainty, Simon's question could then be extended to: How do people reason in the decision environments faced by management practitioners and organizations?

In modern organizations, the environments in which decisions are made change quickly and drastically: Product life cycles are short, customer preferences shift suddenly, and technologies emerge and evolve rapidly—all of which lead to quick reconfigurations of industries. In changing environments, as shown by Bendor, Kumar, and Siegel (2009)—and contrary to the claim of the heuristics-and biases tradition—"no one knows how to achieve goals such as maximizing the sum of discounted expected payoffs. Lacking a complete theory of optimal decision-making in changing environments, it makes sense to study the behavior of

heuristics such as satisficing" (p. 13)—that is, the ecological rationality of heuristics. Because of the complexity and varying nature of the business environment, the dominant understanding of heuristics in management—namely, that heuristics are faulty processes that lead to systematic biases—can hardly inform scholars and practitioners about which heuristics are typically used in the workplace, or when and why they perform well. Yet these questions should be at the heart of any attempt to understand the behavior of boundedly rational people in organizational settings.

Ecological Rationality: Adapting to the Environment

While Simon's work set the ground for social scientists and managers to start debating the role of heuristics in managerial action, it did not evaluate the relative efficacy of heuristics and the environmental conditions in which these were differentially superior to more complex methodologies. It was the ecological rationality framework that went a step further, by specifying (and formalizing) the building blocks of different heuristics, and identifying the environmental conditions under which a heuristic should be adopted (Gigerenzer & Goldstein, 1996).

Instead of focusing on the biases produced by heuristics, the ecological rationality approach supplements the heuristics-and-biases approach by exploring in which environments a heuristic will work well, where it will fail, and why (Gigerenzer, 2008). This view differs significantly from the classical view of rationality, according to which choices and behavior are rational when they comply with the norms of logic, statistics, and probability theory (Rieskamp & Reimer, 2007).

The ecological rationality view is in line with Simon, who believed that "to describe, predict and explain the behavior of a system of bounded rationality, we must both construct a

theory of the system's processes and describe the environments to which it is adapting" (Simon, 1990, pp. 6–7). Simon's agenda is reflected in the two main goals of the ecological rationality framework. The first goal is descriptive: to analyze the heuristics people use to make decisions, their building blocks, and the steps involved, trying to describe heuristics in the form of models (Gigerenzer, 2008). The second is a normative goal: to determine the environmental conditions in which a given heuristic works well—that is, to understand the interaction between cognitive process and environment (Gigerenzer, 2008).

Our central argument is that the ecological rationality view is better suited to address Simon's aim of understanding how managers think in situations where the conditions for rationality as postulated by the neoclassical economic model are not met (Simon, 1955)—that is, how managers rely on heuristics to make good decisions in the uncertain environments in which they tend to operate.

BIASED OR ADAPTED HEURISTICS?

In this section, we borrow from the ecological rationality literature to explain the main mechanisms that lead heuristics to be successful, even if they produce some bias, and well adapted to many managerial settings characterized by Knightian uncertainty, where they outperform complex, prototypically rational processes. We also summarize in a systematic way the steps needed to study heuristics from an ecological rationality view point and discuss how management can benefit from such an approach.

The Benefits of Heuristics: When Less Information Can Be Better

Simple heuristics can be successful in complex and uncertain environments. The objective of the

ecological rationality approach is to understand when and why. To illustrate the benefits of heuristics, we elaborate on the key points discussed in Gigerenzer and Gaissmaier (2011). Take the example of a marketing department trying to distinguish customers who are likely to continue buying from them (active customers) from those who have stopped buying (inactive customers) for a targeted marketing campaign (Wübben & Wangenheim, 2008). Because of the wealth of data available to them, managers may be tempted to run a sophisticated estimation model such as the Pareto/NBD model, taught and recommended in business schools (Abe, 2009), to estimate the probability that a customer is still active based on detailed purchase rates, dropout rates, and other variables. Yet, according to Wübben and Wangenheim (2008), a closer look at what actual marketing managers do paints a different picture. They rely on a simple rule based only on the recency of a customer's last purchase. Customers who have not made a purchase in the last 9 months are classified as inactive; those who have are classified as active. Wübben and Wangenheim (2008) tested this simple heuristic against the Pareto/NBD model (i.e. a prototypical rational process) and consistently found that the heuristic classified active and inactive customers better than the sophisticated model did. This heuristic, coined the *hiatus heuristic* (Gigerenzer & Gaissmaier, 2011), ignored much of the information available to the managers and focused instead on just one good reason. It made better predictions, with less effort, compared to sophisticated estimations that relied on vast amounts of data. This example illustrates how knowledge of the information environment (e.g., assigning all the weight to a single information cue like recency of purchase) saves cognitive effort without losing accuracy.

Another example comes from asset allocation. Bardolet, Fox, and Lovallo (2011) referred to a cognitive bias resulting from a heuristic called *naïve diversification* or *1/N*, which is the tendency to divide investments in equal parts among the total number of assets (i.e., a bias to

allocate 1/Nth of the capital to each of N units). In two experimental studies and a third study using archival data, Bardolet et al. (2011) showed that people tend to use naïve diversification instead of allocating a larger share to a high-performing asset and a smaller share to the slow-performing one. The authors interpreted the findings as robust evidence for a biased investment strategy. By contrast, DeMiguel, Garlappi, and Uppal (2009) tested the performance of the 1/N approach to investments in comparison to several optimization-based portfolio strategies. These more sophisticated strategies included Bayesian and non-Bayesian models for optimal choice that incorporated estimation error. In an out-of-sample test, they found that none of the sophisticated models could consistently beat the heuristic on various financial metrics (Sharpe ratio, certainty-equivalent return, or turnover). Importantly, 1/N was not always superior to the optimization models. However, from an ecologically rational viewpoint, the important question is: In which environments does the heuristic perform better or worse than an alternative rule? DeMiguel et al. (2009) found that the number of assets and the size of the learning sample greatly determined the superiority of the heuristic: The larger the number of assets and the smaller the size of the learning sample, the better the heuristic performed relative to other strategies.

In 1990, Harry Markowitz received the Nobel Prize in economics for his work on asset allocation proving that there is a theoretically optimal portfolio that maximizes return and minimizes risk. Yet, in an interview cited by Benartzi and Thaler (2001), Markowitz reported having relied on the 1/N heuristic when he made his own retirement investments, not following modern portfolio theory but rather basing his decision on a simpler notion of reducing future regret (Zweig, 1998). Markowitz's choice to adopt a simple heuristic instead of a more sophisticated optimization-based model can hardly be due to cognitive limitations. This example,

together with the evidence showing that professional investors rely on the 1/N heuristic (Benartzi & Thaler, 2001; Huberman & Jiang, 2006), demonstrates that the use of heuristics is not limited to unimportant decisions. Furthermore, heuristics can outperform optimization-based processes that rely on more information in complex and dynamic environments, such as investment situations where the number of assets is large and there is a small time window of past periods to estimate the parameters of more sophisticated methods.[1]

Finally, what is sometimes perceived as cognitive bias if the benchmark is complying with the norms of logic, statistics, and probability theory (Rieskamp & Reimer, 2007) can actually be an advantage once the characteristics of the environments are considered. For example, Simon, Houghton, and Aquino (2000) gave business students a text describing a business venture, then asked them whether they would be willing to start the venture themselves. Students were also asked to provide evidence from the text that had influenced their decision. If the answers indicated that the student had relied on a small sample of information (e.g., feedback from only two people), they were rated as having a cognitive bias called the "belief in the law of small numbers"—the tendency to rely on a limited number of informational inputs to draw important conclusions. However, the conclusion that this bias harms decision making is problematic for two reasons. First, this experiment may not reflect how entrepreneurs decide in the environment in which they operate (e.g., a more complex, information-rich context, with contradictory or ambiguous cues and important costs involved in collecting and processing information); second, in a real entrepreneurial environment, speed matters (Heirman & Clarysse, 2007). Relying on small samples of data may be beneficial in deciding whether to start a business: Collecting exhaustive data to make decisions in line with the law of large numbers (i.e.

[1] According to DeMiguel et al. (2007), for a portfolio with only 25 assets, the estimation window needed is more than 3,000 months; for a portfolio with 50 assets, it is more than 6,000 months.

the idea rooted in statistics that more information leads to less biased decisions) can delay market entry, thus reducing early-mover advantages, when in fact, research has shown that people detect meaningful covariations fairly rapidly (Kareev, 1995). Relying on small samples allows people to detect relationships in the environment because of, not despite, limited information or working-memory capacity: This is rooted in a mathematical principle that states that small samples tend to overestimate correlations, i.e. lead to higher perceived relations between variables than they actually are (Goldstein & Gigerenzer, 2002). Therefore, from an ecological rationality viewpoint, using small samples can be an adaptive behavior in fast-moving environments (e.g., entrepreneurial settings, where being among the first movers can prove advantageous). Even if the detected correlation is not highly accurate, if speed matters, it is better to detect covariation early than to be accurate, because the cost of not detecting an important covariation can be higher than the benefit of being accurate.

Why Heuristics Work Well in Managerial Settings

Key to Simon's defense of heuristics was Knight's (1921) distinction between uncertainty and risk. While classical rationality relies on probability theory to find optimal solutions in well-structured problems under risk (i.e., well-stated contingencies with known probabilities), ecological rationality focuses on time-saving heuristics that ignore information in ill-structured problems under uncertainty (i.e., ill-defined contingencies with unknown probabilities). Risk and uncertainty are extremes in a continuum. Most of the decision situations faced by a manager can be situated between the extremes; there are a few consequences that can be predicted and many others that are uncertain. An important mathematical principle that explains why heuristics work in situations of uncertainty is the bias–variance dilemma (Artinger et al., 2014; Gigerenzer,

2016), related to the following equation: $total\ error = (bias)^2 + variance + \varepsilon$. Consider Gigerenzer's (2016) analogy of two people throwing darts at a dartboard. The person on the left of Figure 2 throws darts with a systematic bias with respect to the bullseye (e.g., the unknown true value), with little variability. The person on the right of Figure 2 throws all the darts exactly around the bullseye with no systematic bias, but considerable variance. Despite their systematic bias, the player on the left outperforms the player whose darts, on average, are focused around the target. Now consider a prediction task, such as predicting the demand for a product next year. Complex prediction models that rely on several parameters will more likely produce estimates with high variance and little bias (right panel), while simple heuristics, with a few or no parameters, will more likely produce biased predictions with little variance (left panel).

INSERT FIGURE 2 HERE

Bias and variance are the two fundamental sources of error when making inferences and predictions. The true underlying value to be predicted is unknown but must be estimated from a sample. Each dart in Figure 2 corresponds to an estimate made from a random sample. However, many samples can be drawn from a population, so the more that each estimate is fine-tuned to a specific sample—which is what a complex model does—the more the results will vary from sample to sample, which increases variance (Gigerenzer, 2016). In contrast, a central feature of a heuristic is its simplicity. It estimates few or no parameters and ignores the rest of information. Heuristics have bias but little variance.

Relying on small samples can sometimes produce bias (Simon et al., 2000), but it can be more suitable than sophisticated approaches that rely on large samples of data in contexts where

reduced variance in predictions is desirable. In the same vein, complex models such as the Pareto/NBD model or portfolio strategies for optimal asset allocation are likely to have a smaller bias, but their fine-tuning generates error due to variance, reflecting overfitting (i.e., oversensitivity to the properties of a specific sample). Overfitting relates to the idea that information coming from collected data can fall into two groups: (1) relevant for the future or (2) irrelevant for the future (e.g., noise). With higher uncertainty, past information becomes noisier and some of it must be ignored. A heuristic adapted to an uncertain world relies on a small sample of reliable information and discards the rest (Gigerenzer, 2008). In the investment example, the optimization models were better than the 1/N heuristic at fitting past data because they could adjust several free parameters. Crucially, however, they were worse at predicting the future. The 1/N heuristic does not include free parameters to estimate and so cannot overfit data; its prediction accuracy is therefore higher than that of more sophisticated methods.

The 1/N and hiatus heuristics illustrate an important lesson for educators and practitioners: A decision-making tool should be evaluated on its ability to make accurate predictions, not to fit past data. To make good decisions under uncertainty, managers need to make a trade-off between bias and variance—that is, between considering too little and too much information (Gigerenzer, 2016).

The structure of the information present in the decision environment can also determine whether heuristics work (Artinger et al., 2014). In some environments, information is structured in such a way that the most important information cue substantially outweighs the predictive value of all other information cues available. These are called *noncompensatory environments* (Artinger et al., 2014). Returning to the problem of classifying active and inactive customers, the recency of a customer's last purchase has much more predictive value than does a combination

of detailed purchase rates, dropout rates, age, and gender. Good predictions can be made without taking into account all the available information. In noncompensatory environments, relying on too much information and applying sophisticated methods (e.g., linear regressions to estimate the weights of the different cues) can lead to overfitting and therefore to poor predictions. In compensatory environments, the predictive value of a single cue can be compensated for by the predictive value of a combination of other cues. Therefore, heuristics that use a single or few important cues are more accurate in noncompensatory environments than in compensatory ones. An important implication for managers is that they should evaluate the rationality of heuristics in their context. Even in information-rich contexts with multiple information cues, it is not always fruitful to examine and weight all of them, because oftentimes one or a few information cues carry most of the discriminant weight for making predictions (noncompensatory environments); managers should strive to assess the structure of the environments, compensatory or noncompensatory, in which they operate (Artinger et al., 2014).

ADOPTING ECOLOGICAL RATIONALITY: IMPLICATIONS FOR MANAGEMENT

In this section, we elaborate on the advantages of heuristics for management education, and suggest how practitioners and scholars can identify and promote the transferability of simple heuristics.

Learning from the Ecological Rationality Framework: Next Steps

A major contribution of the research on heuristics and biases is that it has clearly illustrated that (1) decision makers in organizational settings do not make decisions as postulated by optimization models, and (2) they resort to simple heuristics to solve most problems. The

ecological rationality approach builds on these two points and takes a natural next step: It seeks to understand what decision makers are good at and identify when heuristics emerge, when they perform well, and how decision makers can be trained to identify, test, and transfer them. In doing so, it provides distinct, practicable recommendations for managerial learning and decision making.

To identify when heuristics are used and when they outperform optimization-based processes, one must first understand the characteristics of the decision-making problem. Decision theory has emphasized the distinction between problems characterized by risk on one hand and uncertainty (Knight, 1921), or "organizationally intractable decision problems" (Bettis, 2017), on the other. For example, chess players use heuristics successfully (Simon, 1972). Superior to simple computer programs, they are now being outperformed by supercomputers because the problem and rules are well-defined and the payoffs can be calculated with high computational power. In situations like chess, bounded rationality results only from people's cognitive and computational limitations, so powerful optimization programs can outperform heuristics (although it is worth noting that these programs are not readily available to most organizations and decision makers). However, most challenges faced by managers are organizationally intractable and therefore not suitable for optimization. March and Simon (1993) claimed that "effective control over organizational processes is limited … by the uncertainties and ambiguities of life, by the limited cognitive and affective capabilities of human actors, by the complexities of balancing trade-offs across time and space, and by threats of competition" (p. 300). More simply, most important organizational decisions are made under substantial uncertainty, not under risk.

Among the challenges that further increase uncertainty within organizations, decision

makers face multiple objectives that can change unexpectedly (e.g., sudden reactions to competitors or unexpected changes in policy or technology can completely alter an organization's goals) or may contradict each other (e.g., seek efficiency while diversifying, or focus on the short and long term); there is often a short time period from which decision makers can learn, and the number of alternative courses of action is very large, further complicating the tractability of any intricate optimization process. In these complex environments, organizations satisfice instead of optimizing because a firm is unlikely to possess a well-articulated global objective function in part because individuals have not thought through all of their utility tradeoffs and in part because firms are coalitions of decision makers with different interests that are unlikely to be fully accommodated in an intra-firm social welfare function. (Nelson & Winter, 1982, p. 35). Moreover, not only are organizational settings ill-structured and too complex for identifying optimal solutions, there are also "no known formal techniques for finding answers to most of the important top-level management problems" (Simon & Newell, 1958, p. 4). By contrast, heuristics work well in complex, ill-structured environments where optimization procedures are not feasible.

Consider the popular notion of profit maximization. Technically, maximizing a firm's profit function requires knowing all possible ways of spending each dollar of its budget, knowing its expected return, and choosing the combination of investments that yields the highest return. It also requires that a time horizon for maximization be specified (maximize profits over the next five years, or maximize profits today?). Maximizing a firm's profits today could imply liquidating all assets immediately, which would preclude the firm from continuing operations and making profits in subsequent years. In other words, the notion of profit maximization is often intractable, hardly realistic, and has little descriptive or prescriptive value. The heuristic-

like guiding rule of "increase on last year's profits" is simpler and tractable, and more genuinely reflects what firms can actually do.

The insistence in management research on using optimization-based vocabulary—which tends to transcend research and move into the classroom—is a signal that classical rationality underlies the management discourse, and that bounded rationality has been relegated to a supporting role that consists solely of invoking limited cognition (Foss & Weber, 2016). Simon (1979), however, believed "that decision making is the heart of administration, and that the vocabulary of administrative theory must be derived from the logic and psychology of human choice." (p. 500). Due to the practice-oriented nature of management, as reflected in many mission statements of management journals[2], we believe that the vocabulary of bounded rationality—reflecting behavioral assumptions that describe actual human behavior—is more suitable than the vocabulary derived from classical rationality, which does not describe actual human choice.

Identifying and Unpacking Heuristics in the Workplace

As a result of the intrinsic uncertainty characterizing organizational phenomena, heuristics are ubiquitous in the workplace and need not be designed from scratch. An incipient line of research in management has attempted to identify heuristics used in different management settings, such as executive roles in technology firms (Bingham & Eisenhardt, 2011), investment decisions by venture capitalists (Åstebro & Elhedhli, 2006), new venture decisions by entrepreneurs (Busenitz & Barney, 1997), and personnel selection among human resource managers (Luan et al., 2019). This renewed interest in unveiling organizational heuristics is in line with an important postulate

[2] For example: http://aom.org/Publications/AMJ/Welcome-to-AMJ.aspx or https://pubsonline.informs.org/page/mnsc/editorial-statement

of ecological rationality that suggests that a fundamental step in analyzing heuristics is to observe and identify which heuristics emerge in the workplace. In other words, to understand whether a heuristic performs well or is superior to another mechanism, managers should first identify where and when the heuristic emerges (e.g., who in the organization uses it? In which settings is it more prevalent? What are the steps involved?).

One possible starting point for identifying heuristics is to observe expert employees or teams who consistently perform well. Here it is important to focus on consistency in performance and not solely on whether the performance has been outstanding. An indirect consequence of the dominant view of rationality is that extreme successes become an indication of superior decision-making abilities—as if they reflected "closer-to-optimal" behavior—that are worthy of imitation, while an occasional failure is an indication of faulty decision processes (Denrell & Liu, 2012). Yet because noise and self-reinforcing dynamics make a firm's performance highly unpredictable and weakens the association between ability and performance (Denrell, 2004; Denrell & Liu, 2012), it is not obvious that sporadic outstanding performance reflects superior decision making. In fact, exceedingly high performance can indicate lower abilities in noisy environments where performance can be substantially influenced by chance events, where relatively unskilled agents take risks because their skill is not sufficient to achieve high performance, and where current performance depends heavily on past performance (Denrell & Liu, 2012). These are all conditions that are often observed in competitive business settings. Therefore, a key to identifying valuable heuristics is to search for well-performing mechanisms adopted in the workplace that reflect low variability in performance.

It is important to notice that precisely in contexts where the correlation between ability and performance is weaker (Denrell and Liu, 2012), an appropriate decision process can lead to

an undesirable outcome due to the non-deterministic nature of uncertain environments. A valuable feature of heuristics in these environments is their low variability in outcomes due to their computational simplicity and lack of parameters to estimate. Likewise, it is in such environments where optimization or full-fledged plans based on vast data and computations do not work. This logic has been recently adopted in the entrepreneurship literature by closely observing how entrepreneurs behave in their noisy environments (Sarasvathy, 2001; Blank, 2017) and now assumes that expert entrepreneurs, instead of following detailed business plans that attempt to analyze all contingencies, follow a low-cost and simple information search process that allows them to experiment and learn from mistakes.

Once heuristics that are in use in managerial settings have been identified, the next step according to ecological rationality is to attempt to understand them as models of choice. Modelling implies explicitly laying out the building blocks and precise steps followed by decision makers when they use a given heuristic. In the ecological rationality literature, three key building blocks have been proposed as the core of any heuristic (Gigerenzer et al., 1999): (1) search rules that specify in what direction the information search extends (i.e., where to look for information) in the information space; (2) stopping rules that specify when the search is ended; and (3) decision rules that specify how the final decision is reached. Other building blocks may be added for specific heuristics. Using the example of the hiatus heuristic for discerning active from inactive customers, a manager would (1) search for recency-of-last-purchase information; (2) stop when it is found, ignoring further information; and (3) use a 9-month threshold to make the decision. Similarly, Simon's (1955) satisficing heuristic establishes that a manager searches through options in any order, stops as soon as the first option exceeds a predetermined aspiration level, and chooses this option (Gigerenzer & Gaissmaier, 2011). Describing heuristics as models

of choice with explicitly transparent steps can improve the testing of heuristics, their transferability to others, and their usability in real management settings.

When a heuristic is understood in all its constituent steps, it should be tested against other mechanisms. In the example of financial investments, the 1/N heuristic was tested against many other methods. Its suitability for a particular set of environmental conditions (i.e., large number of assets, small time window of prior historical data) can be deemed superior to, or more ecologically rational than, the other methods, which did not perform as well.

Transferability of Heuristics

Once heuristics are unpacked and tested, they can be transferred to others. One way of doing this is through fast and frugal decision trees (FFTs; Dhami & Ayton, 2001; Gigerenzer & Todd, 1999), which are based on the steps of the heuristic itself. An FFT is a simple decision tree designed to guide effective classification decisions. Each node in an FFT represents a step in the heuristic process and has only two child nodes, of which at least one must be an exit (final classification/decision) node. Unlike traditional classification techniques (e.g., logistic regression), FFTs do not consider all available cues of information and decision makers do not have to go through the entire tree before making a classification decision. Studies show that domain experts rely on this type of decision tree to graphically represent and propagate the use of heuristics in decisions under uncertainty, including in medical, legal, and regulatory decision making (Fischer et al., 2002; Green & Mehr, 1997; Neth et al., 2014).

Consider the example of an emergency room manager trying to decide which incoming patients suspected of having had a heart attack should be assigned to an intensive care unit (Green & Mehr, 1997; Neth et al., 2014). The reality of an emergency room shows that trained

professionals can perform this task quickly. Their process may remain implicit and be categorized as "gut feeling" by an observer, making it difficult to transfer to others. Emergency room managers certainly do not follow a sophisticated process reminiscent of classical rationality, which would consider many different variables (age of patient, blood pressure, full analysis of all variables in an electrocardiogram, etc.), assign them weights, and then produce an estimate that has to be interpreted by a doctor. The decision-making process can be described, and therefore taught, using an FFT containing three cues, as depicted in Figure 3. This approach is fast and frugal because at every node (i.e., question) a final decision can be made based only on a yes-or-no answer, and further information can be ignored as soon as a cue allows for a classification. More information is required only when a node cannot provide a final answer. This type of formalization provides heuristics with more credibility than would be accorded to a mere gut feeling, and can be used in training managers to make good decisions.

INSERT FIGURE 3 HERE

ECOLOGICAL RATIONALITY IN BUSINESS EDUCATION

Nudge or Educate Future Managers?

As a result of the pessimistic view of boundedly rational agents held by the heuristics-and-biases approach, management research places little faith in people's ability to make good ("rational") decisions on their own (Katsikopoulos, 2014). This has led to the idea that for people to behave rationally, an authority must nudge them toward better decisions (Thaler & Sunstein, 2008). In other words, people need to surrender to the well-meaning designs of experts (Katsikopoulos,

2014).

The ecological rationality view proposes a more optimistic message (Polonioli, 2012). If management education abandons the dominant interpretation of rational action, which benchmarks on probability and optimization theory, in favor of an ecological view, which benchmarks on the feasible alternative models in a given environment, the takeaway for future managers changes: Managers should not be viewed as small-brained decision makers who fall short of perfection, but rather as skilled decision makers who can make good-enough decisions under uncertainty. On this account, future managers can indeed learn to make good choices themselves, without being nudged. Moreover, ecological rationality conveys an empowering message for practitioners: Complex models are often outperformed by heuristics, and due to their simplicity, practitioners can easily learn and transfer heuristics that are adapted to their environments. In the words of Katsikopoulos (2014), the tradition of ecological rationality is "centered on education" (p. 370).

Poor Assumptions Lead to Poor Recommendations

According to Bettis (2017), in management education the emphasis is placed on frameworks for solving decisions using the kind of complex analytical procedures taught in MBA programs, with little or no emphasis on frameworks to make practical decisions in highly complex settings characterized by Knightian uncertainty. As a result, students are taught classical theories (e.g., agency theory, transaction cost theory, or the net-present-value approach) and the necessary technical apparatus for applying them, with the assumption that these approaches are actually tractable for real managers working under time constraints in real organizations (Bettis, 2017). Yet unrealistic assumptions in theories often lead to bad advice in practice and contribute to a

general disenchantment towards management as a profession (Ghoshal, 2005).

Similarly, Akrivou and Bradbury-Huang (2015) argued that business schools perpetuate the dominant view "through the replication and reinforcement of an executive habitus, which reflects the adoption of economic rationality as a core, single value" (p. 2), extending the idea of profit-maximization and optimization-based techniques as guiding rules for organizations. Complex decision-making models grounded on unrealistic assumptions that do not reflect what managers tend to do—namely, adopt simpler rules that are equally or more accurate—are likely to increase the disconnect that managers often perceive between academia and their daily management practice. The ecological rationality approach, which attempts to understand how and when simple heuristics generate good managerial outcomes, has the potential to reduce the gap between academics and practitioners.

Putting heuristics on par with more complex methodologies for important organizational decisions could challenge the sort of complex optimization-based tools used by financial experts before the financial crisis of the late 2000s. These tools are often only understood by a small group of people with highly specialized technical skills. Decisions made using simpler rules can be scrutinized, evaluated, or compared to others by laypeople—who are often impacted by the consequences of such decisions. Simpler methods are generally more transparent and egalitarian than complex ones.

The Challenges of Adopting an Ecological Rationality Program

Adopting the ecological rationality program in management would not be free of challenges. As with any relatively new approach or field of inquiry, there are aspects to criticize and issues to overcome. An important critique of the ecological rationality program lies in how to define the

important characteristics of the environment in which a decision maker operates. Researchers have identified this issue as an important topic for future research (Gigerenzer, Hoffrage, & Goldstein, 2008). Todd and Gigerenzer (2012) have already identified three key dimensions of the environment that determine the suitability of heuristics: uncertainty (how well the criterion can be predicted), redundancy of information (the correlation between information cues), and variability in weights of cues (the distribution of cue weights, e.g., uniform or skewed). Using the example cited previously about a marketing manager trying to distinguish active from inactive customers (Wübben & Wangenheim, 2008), uncertainty is reflected in how difficult it is to predict future purchases, and redundancy can be reflected in a high correlation between spacing of previous purchases and likelihood of subsequent purchases. Finally, heuristics that weight cues equally, like the 1/N investment heuristic, perform better when the environment also weights cues equally.

Embracing the ecological rationality program will require a clearer delimitation of what constitutes a manager's decision environment and the characteristics that determine the suitability of certain heuristics. A natural implication of emphasizing the ecological vision of rationality is the need for an empirical research approach towards heuristics, and for managers-in-training to acquire (and learn how to test) an array of heuristics as aides for decision making in a variety of contexts. Through an empirical approach, managers should be able to identify the necessary links between the environment and suitable heuristics. For scholars, this implies that systematic, in situ observation of managerial action is a valuable approach to understanding the emergence of heuristics that could lead to the development of grounded theory about the ecological rationality of heuristics: Instead of assuming a given rationality framework (e.g., expected utility theory) and then collecting data to support or reject it, theory would evolve

through inductive reasoning based on empirical observations of the actual use of heuristics in the workplace (Glaser & Strauss, 2017).

Another criticism of the ecological rationality research program is the lack of understanding of how people select amongst heuristics. Gigerenzer (2008) referred to the repertoire of heuristics that people rely on as the "adaptive toolbox." This toolbox presumably includes a small number of heuristics that are easily applied by decision makers and can be rapidly accessed to solve problems. According to Otworowska et al. (2018), the ecological rationality program is missing a precise understanding of the "meta-decision process" of selecting an appropriate heuristic for a given environment. Rieskamp and Otto (2006) suggested that this process emerges from reinforcement learning from initial subjective expectations. It is worth noting that although this critique has been formulated for heuristics (Newell, 2005), it also applies to the selection of statistical models.

An additional challenge of ecological rationality comes from its reliance on what Polonioli (2012) defined as the "optimistic perspective on decision-making" (p. 4), which considers heuristics not as sources of biases, but rather as "fitness-enhancing behaviours" (p. 5). The ecological rationality research program must be able to show that heuristics perform at least as well as more complex models in specific environments. Tests of the relative performance of ecologically rational heuristics have so far been rare, in part because the research program is relatively new, but also because of the difficulties in observing and modelling heuristics. Ecological rationality can only be tested once the heuristic decision has been implemented, which may pose practical problems for promoting its use *ex ante*. However, considering that heuristics are already present in organizations, the challenge is not the *ex nihilo* development of heuristics adapted to a specific context, but rather a more reasonable one: testing whether the

heuristics that have emerged in practice indeed show superior performance—that is, whether they are ecologically rational.

CONCLUDING REMARKS

The view that managerial heuristics are deviations from optimal behavior that produce undesirable and systematic biases leads to the discrediting of widely used heuristics in uncertain organizational situations and reinforces the view of managers as small-brained actors who are not rational enough to solve important problems. We have argued that a better understanding of what decision makers do in certain contexts (i.e., which decision processes they adopt and how they perform in a particular environment) may bring more fruitful recommendations for management education and practice than trying to understand the extent to which individuals fall short of classical rationality.

The ecological rationality approach provides a roadmap for modelling heuristics as step-by-step decision processes that have explicit rules. An implication of emphasizing the ecological rationality of heuristics is the need for a shift towards empirical research aimed at understanding heuristics (how they emerge, when and why they perform well), and towards training managers to identify, acquire, and learn how to test a set of heuristics for decision making in the workplace. A possible advantage of training future managers in the use of heuristics is that heuristics are likely to be easier to teach than complex methodologies. Moreover, in many cases heuristics can be adopted for important strategic decisions without sacrificing decision accuracy. However, it is important for managers and educators to understand when they should promote heuristics and when not. When dealing with risk one should rely on the notions of probability

theory and optimize, but when dealing with uncertainty one should forego some information, rely on heuristics and simplify.

Economics, psychology, and decision sciences have already begun to embrace the concept of ecological rationality (Smith, 2003), and the field of management has a good reason to follow suit: Managerial decision environments are uncertain, change rapidly, and provide few opportunities for exhaustive investigation and sophisticated quantitative methods. There are often many alternative courses of action, and decision makers have to ignore some information and adapt their decision strategies to changing conditions, which is precisely the ecological rationality approach.

While traditional business education has emphasized prototypically rational tools for decision making (e.g., regression analyses that optimize on many variables, based on large-scale data) that are unbeatable at fitting past data, these tools underperform at out-of-sample predictions. This is critical because decision making within modern organizations often involves predictions for intractable problems: in situations of uncertainty, with few or no precedents, and where there are many alternative courses of action and some information has to be disregarded. For these out-of-sample predictions, heuristics are likely to perform better than optimization models. Following the call by Loock and Hinnen (2015) to "explore what portfolios of heuristics exist, how heuristics interact with one another, and how these constitute organizational design" (p. 2034), we believe that the incipient effort to understand when and how these heuristics improve (rather than harm) decision making in organizational settings should continue to grow among scholars, educators, and practitioners.

An unanswered question related to this debate is why the idea of classical rationality continues to thrive in management education and research. One possible reason may relate to the

field's emphasis on intricate theory building, ornamented with sophisticated methodologies, which leads more management scholars to express concerns about the state of the field (Tourish, 2020).. In the words of Hambrick (2007), "the requirement of an articulation of theory in everything we write, actually retards our ability to achieve our end: understanding" (p. 1346). The call to produce management-specific theories opens the door to simplifications of human cognition, such as the classical view of the rational human being, backed by complex but unrealistic optimization models. For Tourish (2020), management scholars "increasingly resort to pretentious and long-winded prose to at least create the illusion of 'theory development'" (p. 99), further increasing practitioners' disenchantment with management academia, and producing scholarly work that can only be understood by those already inside the debates it references. Simple rules and heuristics that reflect actual decision making, and not an idealized view of optimization-based rationality, can help counter this disenchantment.

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