Received: 31 January 2020 | Revised: 30 September 2021 | Accepted: 12 October 2021 | Published on: 14 December 2021

DOI: 10.1002/smj.3350

SPECIAL ISSUE ARTICLE

STRATEGIC MANAGEMENT JOURNAL WILEY

Resource origins and search

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Abstract

Research Summary: The search for new resources is costly and difficult within the resource-based view. Because search is costly, a common prescription is for firms to focus on their endowments—the resources they already possess. However, is there a way for firms to somehow find value amongst the "vast reservoirs" of external resources? We review existing forms of resource search and then suggest an alternative. Extending arguments from biology, we develop the idea of a firm-specific search image and highlight how search images can reveal resources not obvious to others. The search image notion speaks to how firms might uniquely identify dormant resources, even in seemingly efficient factor markets. We conclude with a discussion of how our arguments pertain to the resource-based view and the origins of resources.

Managerial Summary: How do managers and entrepreneurs search, identify, and find assets and resources in relentlessly competitive markets? Existing arguments largely suggest that firms should *not* engage in costly and competitive "external" search—instead they should focus "inside," leveraging the endowments and resources they already possess. We argue that vast reservoirs of dormant resources are available, and that a particular form of external resource search offers a powerful alternative to the prescription to "look inside." Specifically, we highlight how a "search image" can enable entrepreneurs and

managers to search and see resources and value that is not obvious to others. In particular, the search for a functional need—and solution to a formulated problem—can help firms recognize and find dormant resources and create value.

KEYWORDS

factor markets, perception, resource search, resource-based view

1 | INTRODUCTION

Search has served as a powerful concept, tool and metaphor in the field of strategy (Kauffman, Lobo, & Macready, 2000; Levinthal, 1997), with direct application to one of the field's core theories—the resource-based view (henceforth RBV) (e.g., Ahuja & Katila, 2004; Csaszar, 2018; Denrell, Fang, & Winter, 2003). Strategy scholars have focused on the search for new resources, the search for resource complementarities, and the search for new resource uses and technologies (e.g., Adegbesan, 2009; Cattani, 2006; Clough, Fang, Vissa, & Wu, 2019; Lippman & McCardle, 1991; Lippman & Rumelt, 2003; Maritan & Peteraf, 2011; Mosakowski, 1998). One of the reccurring themes in the field of strategy is the need for firms to overcome locally bounded search, in order to access more distant or combinatorially novel resources not evident or available to others (e.g., Ahuja & Katila, 2004: p. 888; also see Gavetti & Levinthal, 2000; Gavetti, 2012; Kogut & Zander, 1992).

The search for novel resources, however, is inherently difficult and costly (Lippman & Rumelt, 2003). As noted by Denrell et al., while external resources and opportunities might be available and perhaps even abundant, they are "needles in a haystack of mistakes, and they are hard to locate" (Denrell et al., 2003: p. 981; Winter, 2000). This difficulty partly reflects the fact that the search for resources happens in a competitive environment where resources are likely to already be priced to reflect their underlying value (Barney, 1986; Leiblein, 2011)—leaving the search process with no free lunches (cf. Culberson, 1998). While strategic search has been compared to discovering a needle in a haystack, in reality it is far more complicated and difficult (see Rivkin, 2000). This is because—as vividly summarized by Herbert Simon—"the haystack of life is essentially infinite" (1978: p. 502).

How, then, can firms conduct resource search effectively? Is there some mechanism for searching and finding novel resources, even in seemingly competitive factor markets?

We argue that firm-specific "search images" can enable firms to identify new resources. While the broad idea of firm-specific search has certainly been raised before (e.g., Winter, Cattani, & Dorsch, 2007), we carefully work out the foundations of a particular form of this search, and describe how search images enable firms to identify new resources and resource uses. In the article, we first summarize how search pertains to a key puzzle of the RBV, namely, the identification of resources in competitive factor markets. We briefly review existing approaches to resource search and then develop our alternative. Our alternative builds on a key insight from biology, that is, the role of search images in guiding organism awareness and search. While many existing approaches to search focus on bounded rationality and various broader forms of environmental representation (whether partial or whole), search images offer a

different type of mechanism for search, one that enables firms to become aware of novel resources. Importantly, the resources and value recognized through search images may in fact be local rather than distant, thus offering an alternative path to resource discovery. Throughout the article, we offer examples of search images from biology, and in the context of relatively simple problem solving by humans. But we specifically apply, translate and extend this intuition to understand the emergence of economic novelty and the origins of new resources in the context of strategy. We conclude with a discussion of how our arguments link to existing work within the resource-based view and strategy. We especially focus on how search images offer a powerful way around the problem of factor markets—and a unique way to conceptualize the origins of new resources.

2 | ORIGINS OF RESOURCES: A BRIEF REVIEW

A central premise of the RBV is the idea that valuable resources cannot be easily found or purchased in markets (Barney, 1986). Denrell et al. call this the "bad news of the RBV"—namely, that "it is difficult to purchase things for less than they are worth" (2003: p. 977). According to resource-based logic, firms compete in markets to secure the necessary factors for implementing strategies and creating value (Chatain, 2011). Because of this competition, "the cost of the resources necessary to implement a strategy will approximately equal the discounted present value of that strategy once implemented" (Barney, 1986: p. 1238; also see Hoopes, Madsen, & Walker, 2003). These factor markets, wherein resources are purchased, are seen to function like auctions (Maritan & Florence, 2008; cf. Leiblein, 2011). Competition among many potential buyers—buyers who consider, scrutinize, evaluate and bid for these assets—ensures that any residual value is largely unavailable, reflected instead in the price of the factors and assets themselves (Arrow, 1986). Competitive dynamics like this play out for many types of factors and assets, including the market for technologies (Arora, Fosfuri, & Gambardella, 2004; Gambardella, Giuri, & Luzzi, 2007; Lippman & McCardle, 1991), as well as the market for companies (Maritan & Peteraf, 2011; Zajac & Bazerman, 1991).

Factor market efficiency, then, poses a distinct problem for the field of strategy and the resource-based view. If valuable assets or factors for implementing strategies cannot be purchased (or somehow secured from the outside)—because prices already capture their value (Denrell et al., 2003)—then what exactly are the origins of heterogeneity and valuable new resources?

The answer to this question provides a foundational premise of the RBV (Barney, 1986, 1991). That is, when resources cannot be purchased at prices below their use value, then *ex ante* endowments—resources already possessed by a firm—represent the key source of heterogeneity. Endowments are essentially resources but in dormant form, or at least partially dormant form. In terms of the origins of these endowments, they might be a function of a firm's pre-history, path-dependence and past experiences (Helfat & Lieberman, 2002), or embedded in the past skills and talents of managers (Castanias & Helfat, 1991).

The central point of the original formulations of the RBV (Barney, 1986; for further discussion, see Denrell et al., 2003) is that firms should focus on what they already possess, as they are likely to see limited (if any) returns from costly external analysis or environmental scanning to purchase or acquire external resources. Firms should focus inwards, on internal analysis, where they possess an informational advantage in understanding and leveraging the initial assets that they already happen to possess (Barney, 1995; cf. Cyert, Kumar, & Williams, 1993:

p. 51). In sum, the RBV "emphasizes the importance of resource *endowments* in creating sustained competitive advantage" (Barney, 1991: p. 116), resources that a firm already owns. And the most valuable endowments—among those owned by a firm—are those that meet the RBV's key characteristics of being valuable, rare, inimitable, and nonsubstitutable.

2.1 | Searching vast reservoirs of unpriced resources: Existing approaches

Despite the strong emphasis on endowments and factor market efficiency within the resource-based view, strategy scholars nonetheless have continued to raise the possibility that resources might somehow be secured at a bargain through various forms of external search. As Lippman and Rumelt point out, while factor markets may be relatively efficient, there still remains "a vast reservoir of unpriced resources and resource combinations" available for firms (Lippman & Rumelt, 2003: p. 1085; also see Denrell et al., 2003).

If this vast reservoir of underpriced resources exists, then the central question becomes: how do firms *uniquely* search and access it? How might firms conduct their search for resources in ways that "outsmart other [strategic factor market] participants and acquire underpriced [or even unpriced] resources" (Maritan & Peteraf, 2011: p. 1379)?

Scholars have proposed a variety of potential solutions to the problem of searching for resources. We *briefly* summarize some of the proposed approaches to search, specifically in the context of the resource-based view. However, due to space constraints, we do not cover this literature exhaustively. Rather, we specifically highlight the literature's insights surrounding how firms might search for and find new resources, and then propose and develop an alternative (though in part complementary) approach to understanding the process of resource search and the origins of new resources.

First, a key set of approaches within the resource-based view has focused on the "speed" with which firms search through potentially valuable resources. For instance, Lippman and Rumelt (2003) first highlight the plausibility of "vast reservoirs" of potential resources and then offer a simple model for how these resources might be searched and identified. In their search model, firms which have "smaller inspection costs" can cycle through and evaluate more resources and therefore identify valuable ones more quickly. Lippman and Rumelt also recognize that beyond the speed of search, the order or sequence in which resources are drawn for evaluation might profoundly shape the efficiency of this search. Broadly, similar intuition is readily evident in Van den Steen's (2017) model of strategy, where the "costs of investigation" of a strategic choice (and by extension, a resource) play a central role (also see Gans, Stern, & Wu, 2019). In a related vein, the environmental scanning literature also highlights capabilities that firms might have in identifying opportunities in their environments (Boyd & Fulk, 1996; Elenkov, 1997; Hambrick, 1982). And the dynamic capabilities literature is also of this same form, as it highlights the importance of routines that allow some firms to "constantly scan, search, and explore across technologies and markets, both local and distant" in search of value (Teece, 2007: p. 1322; for a review, see Schilke, Hu, & Helfat, 2018).

Second, firms may discover new resources through "strategic information acquisition," that is, the ability of firms to gather information and "research the value of a new resource" (Makadok & Barney, 2001; also see Maritan & Peteraf, 2011). Here, the central premise is that investments in information processing and information acquisition allow some firms to generate more accurate expectations about the value of a potentially new resource, and thereby secure resource bargains not available to others (cf. Barney, Ketchen, & Wright, 2011). This work builds on the assumption of ex ante heterogeneity in firms' capacity to do this research, that is, the assumption that "firms

differ in the efficiency with which they can gather information about the value of a new resource" (Makadok & Barney, 2001; p. 1623). However, this literature does not concern itself with how a firm might go about identifying, selecting or seeing a potentially valuable resource in the first place, among many possibilities. Rather, it begins with a given resource and focuses on the underlying inter-firm heterogeneity in being able to evaluate that resource.

Third, a firm's search for resources may be aided by a "superior representation of the environment" (Gavetti & Menon, 2016: p. 208; also see Csaszar & Ostler, 2020; Gavetti & Levinthal, 2000). This "representational view of strategy" has been directly applied to the resource-based view (e.g., Csaszar, 2018), suggesting that firms with better representations of their environments will accelerate valuable resource discovery. Perfect representation of course is not possible, though it serves as a background ideal or benchmark for the representational view. The presence of bounded rationality means that managers and firms develop "limited and imperfect cognitive representations that actors use to form mental models of their environment" (Gavetti & Levinthal, 2000: p. 113), which are then updated as the firm interacts with and learns about its environment (Csaszar, 2018). Representations are "mental models of the environment" and are simple, coarse, crude, and "of lower dimensionality than the actual landscape" (Gavetti & Levinthal, 2000: p. 121). But, in all, better environmental representations allow firms to see and search more efficiently, thus identifying resources and value.

Fourth and finally, firms and other economic actors may guide or filter their search by the unique resources they already possess, seeking complements to their existing resource endowment. While the resource complementarity literature does not generally use the language of "search," thinking about it in these terms can nonetheless be useful. The central idea here is that if firms indeed possess heterogeneous resource endowments, as suggested by the RBV (Leiblein, 2011), then they should also have heterogeneous patterns of complementarity or synergy with the vast reservoir of resources that surround them in strategic factor markets (Adegbesan, 2009; Lippman & Rumelt, 2003; Sirmon, Hitt, & Ireland, 2007). Firms can then search and look at their environment through the "lens" of their existing endowments and resources (cf. Winter et al., 2007). In fact, for many scholars the essence of strategic activity is building valuable competitive positions by assembling unique, complementary, or superadditive resource bundles (Amit & Schoemaker, 1993; Dierickx & Cool, 1989; Montgomery & Wernerfelt, 1988).

Without diminishing the role that any of the above approaches play in shaping the search for—and recognition or identification of—new resources, we suggest that resource search can also follow a very different path. Rather than sequentially searching through potential resources (or gathering information, building better environmental representations, or searching for complements), search may be quite firm-specific, targeted and focused. Our approach, then, builds on a novel way of thinking about search—an approach that is informed by biology. Biological models have strongly influenced strategy (Kauffman et al., 2000; Levinthal, 1997), and we think these models can offer further insights, especially for one of the field's key theories, the resource-based view.

2.2 | Exaptation and resource uses: A shared premise, different focus

Before proceeding, it is important for us to note that the approach we develop here shares a key premise with the exaptation literature in evolutionary economics, a literature that also builds on biology. However, while we share a key premise with this work, our central question and focus is different. Given its importance, we first discuss this shared premise, and then clearly

articulate our specific focus and contribution vis-à-vis the exaptation literature and its extensions into strategy.

The exaptation literature has offered a useful distinction between an object (whether an asset, technology or resource) and the unprestatable uses and functions that the object might possess. Exaptation is defined as "the process by which features acquire functions for which they were not originally adapted or selected" (Andriani, Ali, & Mastrogiorgio, 2017: p. 320; Oxford Dictionary). The central idea is that any particular biological feature or trait can be "pre-adapted" to surprising, new functions that enhance fitness and survival (for example, the swim bladder: Kauffman, 2014: pp. 5–7). This logic has been imported into economics and strategy from biology and has led to the recognition that any object—again, whether it be an asset, technology or resource—has indefinite uses and "latent functionality" (Andriani et al., 2017; Cattani, 2005; Cattani, 2006; for a recent review, see Porta, Pilotti, & Zapperi, 2020; also see Dew, Sarasvathy, & Venkataraman, 2004).

The logic of exaptation has powerful implications for how we think about resources and their uses and fungibility in the context of strategy as well (Eggers & Kaplan, 2013).[1] Namely, it suggests that given the vast realm of possible uses for any given resource, there is no way for markets to fully account for, exhaust, or price all of these possibilities (cf. Andriani & Cattani, 2016; Felin, Kauffman, Mastrogiorgio, & Mastrogiorgio, 2016). In this sense, strategic value can emerge through the process of identifying new uses for existing resources. The underlying assumption here is that these uses cannot meaningfully be anticipated and delineated, nor priced. Importantly, this idea of unidentified resource uses was also a central pillar of Edith Penrose's (1959) theory of the growth of firms. She argued that resources ought to be decoupled from their possible uses, highlighting how a resource can hold indefinite, surprising, and new "services" that will enable firms to grow and create additional value (Kor & Mahoney, 2004). While firms may extract certain uses and services from the resources they possess, any resource (including a resource others possess) also has "a range of potential productive services, *most of which will remain unused*" (Penrose, 1955: p. 534, emphasis added). And as further put by Penrose, "no firm ever perceives the complete range of services available from any resource" (1959: p. 86). It is this latent potential in resources that we seek to address, and specifically the search mechanisms that enable their identification.

Where our argument differs from the exaptation literature is that while exaptation focuses on asking how new uses might emerge for a *given* resource, our focus instead is on a type of search where the resource for which new uses are sought is not yet known to the actor searching. In other words, for us a known resource is *not* the beginning point of search (where we might search or consider possible uses or exploit our deeper knowledge or better access to information about the resource). Rather, our focus is on the resource as the *outcome* of the search process itself. This is a seemingly subtle but critical distinction. With an unknown resource as the outcome of the search process, we are able to more directly address Denrell et al.'s (2003) aforementioned "bad news" of the RBV, that resources cannot be acquired for less than they are worth (also see Lippman & Rumelt, 2003). And perhaps even more importantly, we provide a

[1]Penrose-type resource-based logic is also evident in a particular sub-domain of the RBV, namely, the resource fungibility or redeployability literature (Helfat & Eisenhardt, 2004). The specific emphasis in this work has been on discovering new uses for resources that firms already own, particularly in contexts of corporate strategy, acquisitions, or where firms are in declining industries (Anand, Kim, & Lu, 2016; Anand & Singh, 1997; Sakhartov & Folta, 2014). Resources possessed by a firm—as a result of, say, their path-dependence or past acquisitions—are seen as having fungible characteristics that might allow them to be utilized or redeployed in novel ways to create new value (e.g., in related diversification: Helfat & Eisenhardt, 2004).

firm-specific search mechanism that enables firms to, in a sense, "hack" seemingly efficient factor markets, to search and find new resources not evident to others. Importantly, we do *not* presume that firms that own a particular resource have preferential access to information about how to use that resource in novel and new ways. Rather, as we discuss, the value of the (initially latent) resource is conferred by a firm's ex ante specification of a search image—a concept we will develop more fully below. Instead of looking for how a given resource might be used in novel ways (also an important question), we focus on how the ex-ante specification of a function or use can lead to the identification of new resources—resources that are new to the firm searching for them.

3 | SEARCH IMAGE, RESOURCES, AND USES

We begin with the most basic form of our search argument, building on biology, using simple examples of organism and human search, and linking these to strategy. While our initial examples of search may seem relatively mundane, they are important to understand as they provide the underlying foundation and scaffolding on which we subsequently layer our argument about novel forms of search, along with discussing the associated implications for firms, resources, and the resource-based view.

3.1 | The power of a search image

Organisms are engaged in an ongoing process of interaction with their environments, scanning their surroundings and searching for food or resources. Organism-environment interactions can be seen as a generalized form of *search* (Simon, 1956). This search activity has been extended into numerous domains not just in biology (e.g., an organism's search for food or shelter), but as highlighted above, search has also been a central concept within economics and the organizational and strategy literatures (Kauffman, 1993; Levinthal, 1997). For example, search and organism-environment interactions are the central building block of the bounded rationality literature pioneered by Herbert Simon (1956; for a review, see Chater et al., 2018). Simon's most frequent examples of boundedly rational search included some form of organism and animal exploring and searching its environment (for a review, see Felin, Koenderink, & Krueger, 2017).

Biology has established that the way organisms perceive or "take in" their environments when searching is highly species-specific (cf. Tinbergen, 1963; for a history, see Burkhardt, 2005). An organism's perception of their environment—what they see and are aware of—cannot meaningfully be seen as some form of pictorial or holistic (or even partial) representation or map of the environment. Rather, what any given organism perceives and becomes aware of—the exact stimuli, cues or objects it recognizes or registers—is highly specific.[2] This specificity takes on several forms. At the most basic level it means that the visual (and other) organs of any given organism shape and structure what it sees and becomes aware of. For example, the human eye is able to see wavelengths within 380–750 nm, representing a vast array of colors. Horses on the other hand see a far smaller spectrum of colors, while butterflies

[2]As put by the biologist Uexküll, each organism exists in its own surroundings (what he called "Umwelt"), where certain species-specific factors are visible and salient to it: "every animal is surrounded with different things, the dog is surrounded by dog things and the dragonfly is surrounded by dragonfly things" (Uexküll, 2010: pp. 117).

are thought to have one of the widest visual spectra within the animal kingdom (Marshall & Arikawa, 2014; cf. Cronin, Johnsen, Marshall, & Warrant, 2014).

More importantly, this type of visual heterogeneity also applies to the set of objects that organisms perceive—the things organisms are (and are not) aware of in their environments. For example, some species of frog do not see or "recognize" their prey (say, a locust) even if it is right in front of them (and perfectly obvious to a human), *unless* it moves. Thus, the frog's perceptual apparatus is attuned to movement of a certain kind. This species specificity means that universal models of perception and search are not possible, given vast heterogeneity across organisms (Caves, Nowicki, & Johnsen, 2019).

Beyond this baseline difference across organisms in perception, there are also differences in what the *same* organism might see, perceive and become aware of in its environment. That is, organisms have "search images" (from the German word "Suchbild") that direct their moment-by-moment awareness toward specific cues, stimuli, and objects in their environments (Uexküll, 2010; cf. Tønnessen, 2018). At the simplest level, a search image can be defined as the image that an organism has in mind when it searches, that is, *what* the organism is looking for. What an organism is searching for determines what it sees, becomes aware of and recognizes. The search image determines what, in effect, "lights up" and becomes salient in its surroundings and environment.

To illustrate, day-to-day *human* perception highlights how search images shape what we see and become aware of. To offer a mundane example, if you have lost your car keys, you have a "key" search image in mind that helps you scan your surroundings—say the living room or your office—to find the keys. Note that the search for your keys is unlikely to be driven by any form of random or exhaustive search. When we search for our keys (or anything else for that matter), we do not pick up individual items that surround us, inspecting each of them and making a judgment about whether they are the keys or not. This type of item-by-item, exhaustive search would be far too time-consuming and costly (Culberson, 1998; cf. Wolpert & Macready, 1995). Instead, search images enable search to be highly targeted, radically simplifying the process. This is because search images do not demand costly environmental representation. What is represented in the search, instead, is the sought-after item, or its characteristics (as we discuss below), rather than the environment. This allows for us to efficiently find the keys with relatively minimal effort.

Importantly, a search image might also be coupled with a hunch or hypothesis about where we might have misplaced the item we are searching for. The search image therefore shapes *where* we look and which stimuli we become aware of. As shown by Simons and Chabris (1999), for the most part, humans ignore—and do not process, represent or even see—environmental stimuli or objects (even large ones) that are irrelevant to what we are searching for or focused on. While the fact that we miss stimuli or obvious objects right in front of us can be characterized as blindness (Chater et al., 2018), it also highlights how what we have in mind (as specified by the search image) shapes and determines our visual awareness. Perception, then, from the perspective of a search image, is not about taking in or processing environmental stimuli in camera-like fashion, nor is it about mapping the broad landscape, or evaluating that map based on how well it matches received stimuli (cf. Wolfe & Horowitz, 2017). Rather, perception is directed toward stimuli that match the search image. When searching for our lost car keys, key-like things or stimuli catch our attention, while non-key-like things are largely ignored.

Now, given its implications for strategy, it is important to note that search can further be simplified when one knows the *properties* of the searched-for item. To illustrate this, consider the popular needle-haystack search metaphor—frequently discussed in the context of strategy

(Agrawal, McHale, & Oettl, 2019; Bruderer & Singh, 1996; Denrell, Fang, & Liu, 2019; Fang, Kim, & Milliken, 2014; Simon, 1978; Winter, 2000).[3] The needle-haystack metaphor is meant to highlight the difficulty and seeming futility of finding something among abundant distractions. A needle is small and extremely hard to find, and the search is complicated by the fact that individual straws of hay might look needle-like. The crudest form of search might randomly begin somewhere in the haystack, with a sequential inspection of each individual straw of hay. Each straw might be picked up, examined and considered as a candidate solution, and then rejected if it is not the needle. This type of search-through process of course is extremely inefficient and costly, but it mimics a form of highly general serial processing or so-called brute-force, exhaustive search that provides the foundation of many models of search (Culberson, 1998; Rivkin, 2000).

A search image that specifies the properties of the searched-for item offers a way of solving the needle-haystack problem. That is, knowing the properties of the needle—that the needle is nickel-plated, made of high carbon steel wire, weighs one gram and is three inches long—enables us to find the needle more quickly. We might, for example, use a powerful magnet to aid in finding the needle. Or if the sought-after needle is made of something nonmagnetic (say, bone or gold), we might use alternative techniques to find it. For example, we might utilize our knowledge of the weight and size of the needle to hypothesize that search closer to the ground will prove most fruitful. Or we might compose some device or sieve to sift through the haystack, or perhaps simply burn the haystack, knowing that the object we seek is non-combustible. The central point here is: the thing we are searching for, in a teeming environment of distractions, "lights up" and is easier to extract, identify and find when armed with a search image and the associated knowledge of the properties of what we are looking for. This link—between the search image and the properties of the searched-for item—will in the next section provide a central insight for understanding the emergence of new resources as well.

3.2 | Search images: From mundane to novel search

Now, the search process in strategy of course is far more complicated than searching for some kind of known item—like a lost needle, car keys, or other common object. However, the underlying intuition behind mundane forms of search nonetheless provides a foundation for understanding and explaining the search for novelty as well, particularly in the context of new resources. What, then, is the specific "translation" and extension of the search image concept that will allow us to understand search in novel settings, especially when it comes to resources?

Search images yield novelty when the searched-for thing is not necessarily a specific item, but rather when search focuses on a need or function. The biologist Uexküll nicely describes this function-oriented extension of the search image concept as follows: "We do not look around for one particular chair, but for any kind of seating, that is, for a thing that can be connected with a certain function" (2010: p. 118).[4] Here, the sought-after item is replaced with a search to solve a problem—the need to sit down. Notice that the search for a function means

[3]The needle-haystack metaphor has also been discussed in other ways, including the idea of "satisficing" and looking for the sharpest needle (Simon & Kadane, 1975), or the idea of looking for the needle in the *right* haystack (Denrell et al., 2019). Here we take the most common form of the needle-haystack metaphor and point to some ways in which search might be foreshortened, with attendant implications for search and strategy more broadly.

[4]Uexküll (2010) extends his search image notion into the idea that objects have a "functional tone" or "search tone." To keep our arguments tractable, we simply use the search image label to include functional search as well. From our perspective it is important to ascribe the initiation of this type of search—and the resultant novelty and recognition of

that any number of potential objects in the surrounding environment now might visually "pop out" and become salient, providing the solution. The power of this function-oriented conception of a search image is that it opens up a vast set of possibilities in the environment, including highly novel ones (cf. Gabora, 2019). It provides a mechanism through which firms might identify the so-called "adjacent possible" (Kauffman, 2014)—a way of seeing local opportunities and resource uses that previously were not evident. Notice that it is the ex-ante specification of a functional need that opens up possibilities in the environment, and causes novel resources and uses—previously not obvious—to light up in the environment. We briefly offer some biological examples of this, and thereafter provide examples from the context of resource search in strategy and economic settings.

Organisms in nature have function-driven search images that direct their awareness and perception to novel possibilities in their environments (Bandini & Harrison, 2020; Fragaszy & Liu, 2012; Griffin & Guez, 2014). To offer an example of search images based on a functional need, consider a small animal or organism engaged in search. Say this organism is confronted with the problem of a predator attacking from overhead. The organism's search image now is constituted by a specific functional need: it searches for *anything* in its environment that might serve the shelter-function. This shelter-function might be provided by any number of items in the organism's environment, like a rock, a tree or leaf, or perhaps a small crevice in the ground. Put differently, armed with this functional search image, various items that might serve the shelter function—thus addressing the problem of the overhead predator—"light up" for the organism in question. The critical point here is that, *items in the environment become resources that service the need for shelter*. The specification of a functional need opens up novel possibilities in the environment.

Thus, we can imagine any number of functional needs that might shape the search and awareness of an organism, even in the same environment. An organism might engage in a search for something-to-hunt-with, something-to-distract with, something-to-throw, something-to-hide-under, something-to-open-with, something-to-camouflage-with, something-to-amplify-sound-with, something-to-mark-with, and so forth. These types of functional searches would yield salience to different objects and aspects of the environment. A large literature in biology, specifically on nonhuman tooling—on how organisms use tools in creative ways—offers many examples of this (e.g., Fragaszy & Mangalam, 2018; Sanz, Call, & Boesch, 2013). It is this type of functional search that contributes to the emergence of novelty in nature.[5]

Of course, in contexts relevant to strategy, the specification of a functional need or problem can be deliberate. That is, the aforementioned organism looks for shelter out of necessity, because of the overhead predator, while economic actors can deliberately shape and specify the functional needs or problems that shape their search for resources.

It is precisely this logic—that functional search enables the identification of novel resource uses in one's environment—that we generalize and extend into strategy-relevant economic settings as well. Note how this approach opens up possibilities even in seemingly efficient factor

value—to the organism itself, rather than assuming that objects themselves somehow intrinsically have obvious functional uses.

[5]In terms of related arguments, Felin and Kauffman (2021) discuss the role of functional search in the context of evolutionary economics and the literature on ecological rationality. However, their arguments are not directly focused on the resource-based view (or even strategy), which is the focus of this article. Felin and Zenger (2017) focus on the role that managerial "theories" play in search and strategy. While they focus on similar issues, particularly related to perception, their direct focus is not on resource search nor the resource-based view—again, which is the focus of this paper.

markets (Barney, 1986), because the delineation of all possible uses and functions for an object (a dormant resource, technology or asset) simply is not possible (Kauffman, 2014). The "environment"—the uses and possibilities afforded by objects within it—is not prestatable, even though this remains an underlying assumption behind market efficiency. Resource uses are not *inherently* obvious, even to those who might own the resources themselves. Rather, novel uses become visible in response to the ex ante specification of a search image and an associated functional need. Thus, the value of something (the recognition that "this object might serve as shelter") is revealed by the search image itself. Search images, tied to functions, provide a mechanism through which latent resources—available but by no means inherently evident—become visible.

To offer a brief example of this process from the context of science, consider the familiar story of Archimedes settling into a bathtub, while contemplating the king's challenge (cf. Bingham & Spradlin, 2011). The challenge was to determine whether an artisan who crafted the King's crown had stolen some of the gold, specifically by swapping lead for gold. The specific problem was therefore to figure out how to measure the volume of an irregularly shaped object. Archimedes presumably knew gold was denser than lead, and he used this knowledge to frame the "function" he was looking for. If he could somehow measure the volume of this irregular object, the volume would reveal if such a swap had happened. With this search image in mind, he settled into a bathtub one night and quickly recognized how the displacement of water could serve the function of measuring the volume and density of the irregular object. Archimedes had presumably bathed many times before, without recognizing this new resource use. What unveiled this novel resource was the specification of a functional search image.

3.3 | Resource origins: Search images and problem formulations

As readers may already have noted, there is a useful correspondence between the idea of a functional search image and the problem-solving literature (cf. Baer, Dirks, & Nickerson, 2013; Leiblein & Macher, 2009; Newell & Simon, 1972; Nickerson & Zenger, 2004). Fully vetting these linkages could be the basis of another article, particularly as the problem solving literature has not directly been applied to resource search, or even the resource-based view, in any meaningful way. Here we briefly discuss how our notion of a functional search image links to problem solving, but more importantly, reinforce the link between search images and the origins of new resources. In short, we think the process of identifying a functional need—a process that parallels the formulation of a problem—is critical in enabling firms to effectively search and identify new resources, even in seemingly competitive factor markets.

Specifying a functional need that defines a search image can be seen as emanating from a problem. Again, while problems are likely to be formulated out of necessity in biological contexts (like the aforementioned example of an organism looking for shelter), in strategic contexts managers and firms can engage in this activity in deliberate fashion. That is, if we recognize that search—and more broadly, what we are able to see and become aware of in our surroundings—is driven by search images, then the deliberate shaping of these search images is of paramount importance. The formulation of a problem provides precisely this type of mechanism, where the framed problem highlights a search image that *enables* seeing feasible solutions, in the form of new uses in latent resources. Humans, economic actors included, tend to see their surroundings in functionally fixed ways (Felin et al., 2016; James, 1890). But the

proactive specification of functional needs and formulation of problems enables economic actors to circumvent this functional fixedness and observe dormant value in the environment.

Consider how Steve Jobs and the Apple engineers formulated a problem from which a search image emerged—one that enabled them to see value where others did not see it. In the late 1970s, Apple sought to make a personal computer for everyday use, at a time when computing was focused on scientific, industrial, and large-scale office settings. Back then, personal computing was merely a hobby, one that required deep technological expertise in electronics and software engineering. But Apple's problem formulation was that if the computer could be made easier to use—by (somehow) simplifying how the average consumer interfaces with the device—then personal computers could become a mass-market product. Note that Apple's search image was for a needed function, rather than a search image for a specific technology. It is with this problem formulation and specific search image in mind that Apple recognized value in the technologies developed at Xerox Parc (see Isaacson, 2011; Rolling, 1998). Despite numerous observers seeing these very same technologies before—technologies which now are ubiquitously used (graphical user interface, bit-mapping, mouse)—it was the search for a specific functional need, solutions to a formulated problem, which enabled the recognition of the resources. Or to put this into the language of factor markets: Jobs and his engineers recognized dormant resources and value. The value of technologies at Xerox "lit up" for them, revealing value unseen by others, because in them they saw solutions to the problem they had formulated. In short, Jobs and his team recognized dormant value because they understood the rough *properties of the solution and use* they were searching for. Note that there were potentially many other formulations of the problem that Jobs and his team could have composed that would have revealed very different search images. And in fact, competitors of that era did compose the problem very differently and accordingly searched for resources that addressed different functions.

A central contribution of our approach, then, is to show how new resources are an outcome of firm-specific search images, as given by the specification of functional needs, often derived from unique problem formulations. Rather than take a given resource and search through its potential uses (Lippman & Rumelt, 2003)—or expend time gathering information and researching whether a given resource is valuable (Makadok & Barney, 2001)—resource value emerges from specifying, ex ante, a functional need or problem-related search image. This is a critical distinction, one that allows us to "circumvent" the factor markets problem central to the RBV (Denrell et al., 2003). Our conception of resource search suggests that firms are *not* scanning the environment for underpriced resources, sorting through an array of resources and assessing the value of possible new uses. This type of search simply is too costly, difficult, and staggering in scope (Rivkin, 2000).

But as a remedy to costly and exhaustive search, firms do not need to solely rely on looking inward at resources they already possess. Rather, we see firms as identifying a functional need or problem, hypothesizing about the attributes or properties of the needed solutions, and then searching, often externally, in a very focused manner to discover a resource that meets these attributes. It is this exercise that foreshortens search by causing particular resources to light up and become visible. Of course, it is intuitively obvious to everyone that resources feature indefinite uses, some that are common and some that are novel. But it is the exercise of actual problem-formulation that generates search images through which new, valuable, alternative uses of resources become salient and visible. Many of these resource uses may look plainly obvious in retrospect, once they have been identified. But like Archimedes' bathtub, prior to formulating the problems and attendant search images that reveal them, they simply are not.

We have offered a relatively linear and simple account of how the logic of a search image enables the identification of dormant value in resources. But in the context of strategy, not all search images and problems are simple in form, with solutions provided by a single resource. Rather, firms are likely to be engaged in many complex forms of search, where the overall bundle, architecture, and interdependence of assets and resources are critical. For example, to link this to the problem solving literature, many problems are complex and composed of many subproblems (Simon, 1973; also see Nickerson & Zenger, 2004). The exercise of problem formulation often involves decomposing larger problems into subproblems, such that solving subproblems is thought to solve the larger problem. The resulting search image may thus be multi-faceted, composed of several related subproblems. This reality only intensifies the importance of specifying a particular search image, to guide the search for potentially multiple resources (and attendant uses) that solve this hierarchy of subproblems. For instance, Michael Dell recognized that inventory holding throughout the value chain is an extraordinarily costly problem in an industry like personal computers, where components and parts are depreciating at rates measured in double digits (Magretta, 1998). His formulation of the problem suggested that solving this macro-level problem required solving several subsidiary problems, like how to flexibly manufacture PCs, how to sell direct and avoid retail distribution, and how to develop a trusted brand name. Resource search then becomes an exercise in searching with several distinct but related search images in mind.

4 | RESOURCE SEARCH: IMPLICATIONS

One of the initial, foundational premises of the RBV is that factor markets are efficient—largely void of opportunities for valuable resource discovery—and that the search for new value should focus on "looking inside," focusing on existing resource endowments that firms already possess (Barney, 1995).

In this article, we start with the premise that environments feature "vast reservoirs" of latent resources (Lippman & Rumelt, 2003; cf. Kauffman, 2016). We argue that external search within these environments holds significant opportunities for finding new resources and value. However, as recognized by many, the search exercise involved in discovering these new resources can be tremendously costly and overwhelming in scope (Denrell et al., 2003). Consequently, the search literature has focused on ways in which search might be rendered more tractable and efficient, highlighting how firms satisfice, or search for complements to existing resources, or accelerate and refine their search routines. As we have discussed, what is common to much of this external search literature is a focus on factors like environmental representation, or the process of sequentially searching through different resources (and possibly their uses) to identify potential resource bargains and value. In this article, we have proposed an alternative to these forms of search, highlighting the role that firm-specific search images play in the identification of dormant resources. Rather than starting with a resource itself and how it might be utilized differently, or generating better representations of the environment, we argue that firms can search with more targeted search images—in particular, search images that satisfy a particular functional need or problem that needs to be solved. It is this process that enables firms to identify and see dormant resources not obvious to others.

Others have, of course, discussed the need to focus on firm-specificity when it comes to search and resources, though without specifically addressing search images and associated functional search. For example, Denrell et al discuss what they deem to be an overly strong focus on

"turning inward" within the RBV and argue that there is also the "matter of *looking outward* at an unexplored environment *from* a *particular* vantage point on the frontier." They go on to say that "the more distinctive the view, the more likely such a view can encompass valuable opportunities not similarly visible to other firms" (Denrell et al., 2003: p. 988). We concur, and specifically focus on how search images enable this process of efficient search in external environments—a more distinctive and firm-specific view of search. Along similar lines, Winter et al. (2007) discuss search and the importance of a "firm-specific preferred direction" of search. Again, we concur that this type of firm-specificity to resource search is absolutely essential. Our aim in this article has been to work out what this firm-specificity of search means and actually looks like, particularly with respect to the identification of new resources, and the role that search images play in the process.

Our argument has implications for the literature on the "localness" or "globalness" of search. This literature highlights how firms often learn through local search, exploring technologies, and processes closely related to those they already possess (Helfat, 1994; March & Simon, 1958; Nelson & Winter, 1982). This localness of search and learning might be fueled by the requirement that firms possess the requisite absorptive capacity (Cohen & Levinthal, 1990). But at the same time, this search literature has also argued that "successful firms proceed beyond local search to enhance their resource positions" (Ahuja & Katila, 2004: p. 888). As Rosenkopf and Nerkar (2001) suggest, a capacity to search more globally may reflect a capacity to search in more combinative (Kogut & Zander, 1992), dynamic (Teece, 2007), or architectural ways (Henderson & Cockburn, 1994). We see the idea of a firm-specific search image as offering another way to think about the local–global search dichotomy, particularly when it comes to the *identification* of resources. We argue that search, whether it is local or global, benefits from having a search image that enables the recognition of valuable but dormant resources. That is, any form of successful search—whether local or global—requires some mechanism for recognizing something of value. Thus, even valuable local resources and opportunities are likely to be abundantly available. And the search image notion provides a mechanism for recognizing this value.

The search image concept also readily connects to the open innovation literature. This literature also focuses on search and the "potential value of *external resources* that are not owned by the firm in question, but may nonetheless create value for the firm" (Chesbrough & Appleyard, 2007: p. 60, emphasis added; West, Salter, Vanhaverbeke, & Chesbrough, 2014). This largely normative literature argues that firms alone cannot house all the resources and knowledge relevant for a firm, and thus prescribes that firms be more and more open to ideas, knowledge, solutions and technologies in their external environments (cf. Von Hippel & Von Krogh, 2016). However, being open is not a panacea, as search is costly and external resources are subject to competitive factor markets. Thus, one way to restate our argument is that openness requires the specification of *what* one (a specific firm) should be open to—and how one might uniquely recognize value in the external environment (in a particular technology or asset), beyond what others might see. We argue that a firm-specific search image provides a mechanism that allows firms to recognize resources not obvious to others. Thus the common open innovation notion of environmental scanning (Von Hippel & Von Krogh, 2016) might be replaced with (or at least augmented by) intuition developed in this article, which focuses on how firm-specific search images can enable firms to search and uniquely identify and see resources that are not obvious to others.

Finally, the literature in entrepreneurship—while not our direct focus in this article—is fundamentally concerned with related questions, such as whether the resources that fuel valuable opportunities are discovered by an alert entrepreneur or whether they are created through

actions performed by the entrepreneur (Alvarez & Barney, 2007; Baker & Nelson, 2005; Foss & Klein, 2012; Kaul, 2013). We see our search image logic as rather neutral in this debate. On the one hand, the possession of a search image enables entrepreneurs to see and discover what others have overlooked. On the other hand, developing the right search image often requires active cognitive effort on the part of the entrepreneur to, for example, identify and frame a problem and to define a function that will solve it. Thus, the underlying resources that emerge from search can be thought about as both discovered *and* constructed or created (e.g., in combination with other assets). Either way, this process of finding or creating resources can be enabled by a firm-specific search image, particularly in settings riddled with uncertainty—a premise that we share with the entrepreneurship literature (Kaul, 2013). Perhaps one point of distinction is that while some resource-based models of entrepreneurship explicitly focus on "resource-poor" or "depleted and penurious environments" (see Baker & Nelson, 2005), our starting point is the opposite. Namely, we see environments as featuring "vast reservoirs" of latent resources (Lippman & Rumelt, 2003; cf. Kauffman, 2016), and we address how a particular form of search can enable firms—whether they are entrants or incumbents—to identify specific resources within this reservoir.

By way of limitations, we certainly recognize that our search image-oriented approach to resources by no means offers a sure-fire tool or "rule" for finding resources and somehow magically generating value. After all, search images and associated problem formulations may prove to be poorly constructed, prompting a search that ultimately fails to reveal a valuable resource. But we argue that having a search image generally proves more efficient than varied forms of random trial-and-error or brute force search. For example, in the context of entrepreneurial firms, shortening the search process, even if it fails to deliver value, is highly productive as it then allows for better-informed "pivots" and re-specifications of subsequent search (Camuffo, Cordova, Gambardella, & Spina, 2020). Thus, search images offer a useful addition to the resource search and mobilization literature focused on entrepreneurial firms (Clough et al., 2019; Grossman, Yli-Renko, & Janakiraman, 2012).

That said, a persuasive alternative to any explanation of effective resource search—including ours—is simply luck or serendipity (Alchian, 1950; Von Hippel & Von Krogh, 2016; Winter, 2012, for a review, see Liu & De Rond, 2016). It might be that firms accidentally stumble onto proverbial $500 bills, that is, valuable resources and novel uses—resources and uses that markets have for whatever reason failed to see or value appropriately. There is no question that luck matters. But it is hard to develop any kind of meaningful, forward-looking theory of strategy with luck as the foundation, other than perhaps pointing to random trial-and-error. But more importantly, as noted by Porter, "there are often *reasons* why firms are lucky" (1991: p. 110)—or as put by Pasteur, "luck favors the prepared mind." Search images provide an apt example of this "prepared mind." To illustrate, we might say that Newton was lucky to have observed the apple falling. But others had observed the falling of apples and other items, *without* coming up with the same insights about the fundamental laws of nature. The reasons for lucky encounters or observations, from our perspective, then have to do with the *priors*—a specified search image (related to a function or formulated problem) that scientific and economic actors carry in their heads prior to search. Search images serve as a catalyst for what in retrospect appear to be lucky encounters. That is, search images and problem formulations enable the identification of novelty and value when it is encountered. This process, in retrospect, looks to be driven by luck. For example, we might label the geographic proximity of Apple and Xerox Parc as luck that helped facilitate critical resource discovery in the late 1970s. But it was not simply luck that enabled Jobs to recognize value in resources and technologies that many

others had seen. As we discuss above, it was the search image and problem formulation that enabled their discovery.

Finally, the arguments in our article are not just theoretical, but they also have practical consequences. Specifically, we see them as having important practical application for how entrepreneurs, managers, and firms might identify resources not obvious to others, a central question in strategy. The practical aspects of resource-based arguments are commonly taught in classrooms. The common prescription is for entrepreneurs and managers to "look inside" (Barney, 1995) to concentrate on endowments they already possess, particularly those that are valuable, rare, inimitable and nonsubstitutable (Barney, 1991). But we might add to this prescription a rather different, externally focused alternative. Entrepreneurs and managers can actively specify functional needs, formulate problems and compose firm-specific search images through which they "look outward" to identify resources—resources that are not obvious to others and often uniquely valuable to them.

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How to cite this article: Felin, T., Kauffman, S., & Zenger, T. (2023). Resource origins and search. *Strategic Management Journal*, *44*(6), 1514–1533. https://doi.org/10.1002/smj.3350