

## Prior Knowledge and Entrepreneurial Cognition

The ability to identify opportunities is among the most important skills successful entrepreneurs have (Ardichvili et al. 2003), thus making this topic particularly important for entrepreneurship research. For instance, Gaglio and Katz (2001: 95) argued that “understanding the opportunity identification process represents one of the core intellectual questions for the domain of entrepreneurship.” Additionally, research on the resource-based view of the firm has recently begun exploring opportunity identification as a resource that can result in competitive advantage through the process of exploitation (Alvarez and Busenitz 2001). As can be expected, researchers are rather interested in understanding why, when, and how certain individuals are able to recognize opportunities whereas other individuals either cannot or do not (Shane and Venkataraman 2000). In particular, studies have found that knowledge—“a fluid mix of framed experience, important values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information” (Davenport and Prusak 1998: 4)—plays a crucial role in the entrepreneurial process. How do individuals’ prior knowledge and knowledge acquired through external sources impact the opportunity-recognition process? Which type of knowledge matters for which type of opportunities? And which cognitive processes during opportunity recognition does knowledge trigger? In this chapter, we investigate the relationship between knowledge, cognitive processes, and entrepreneurs’ opportunity recognition.

## PRIOR KNOWLEDGE AND OPPORTUNITY RECOGNITION

Thus far, entrepreneurship research has largely taken an Austrian economics perspective centered on the notion of prior knowledge. Austrian economics scholars suggest that differing levels of prior knowledge allow some individuals to identify certain opportunities while others fail to do so (Hayek 1945; Venkataraman 1997). Prior knowledge, which denotes the unique information a person has on a particular topic, enables that person to recognize particular opportunities (Venkataraman 1997; Shane 2000). Individuals obtain prior knowledge, for example, from their education (Gimeno et al. 1997) or experience at work (Evans and Leighton 1989; Cooper et al. 1994). Prior knowledge is often gained through experiential learning, either intentionally or unintentionally, via direct experience, the experiences of others (vicarious learning), and/or second-hand experience (Huber 1991). As an example, Ed Pauls, the inventor of the NordicTrack, is a prime example of how prior knowledge facilitates opportunity recognition. A mechanical engineer passionate about cross-country skiing, Ed was often frustrated when he was not able to go skiing due to severe weather. From this frustration, he identified an opportunity and used his engineering knowledge and skills to develop an indoor cross-country ski machine.

Previous studies on cognition have argued that increased knowledge within a specific field can lead to important advantages for individuals. For example, individuals become increasingly efficient as they gain more knowledge about a task through experience—namely, they begin to focus their attention on crucial dimensions of the task, generally dimensions that contribute the most variance to decision outcomes (Choo and Trotman 1991). Additionally, those who have more knowledge seem to draw more on intuition and thus make decisions in a more automatic way as opposed to going through more mindful methodical processing (Logan 1990). Automatic processing and the resulting decisions are generally quicker than the more methodical processing.

Busenitz and Barney (1997) showed that entrepreneurs—compared to managers—tend to depend on heuristics to increase the speed of their decisions. Without these heuristics, entrepreneurs would often miss out on opportunities as the window of time to act on opportunities tends to close quickly. Furthermore, general human capital, which refers to prior knowledge gained through education, helps individuals accumulate and

integrate new knowledge, which in turn opens up a wider opportunity set (Gimeno et al. 1997). Indeed, Davidsson and Honig (2003) found that the number of years of education an individual has positively influences that person's likelihood of identifying new opportunities. Applying the literature on prior knowledge to the recognition of opportunities, those with more prior knowledge (compared to those with less prior knowledge) will pay more attention to the most important aspects of the available information and will then process this information more efficiently, thus facilitating the recognition of more opportunities. Beyond their focus on key information dimensions and enhanced information-processing efficiency, knowledgeable individuals develop stronger, more, and richer connections between mental concepts (Gobbo and Chi 1986), which in turn enhance their capabilities to recognize innovative opportunities.

Researchers have also shown that prior knowledge is an important element of creativity. According to Amabile (1997: 42), relevant knowledge or expertise “can be viewed as the set of cognitive pathways that may be followed for solving a given problem or doing a given task—the problem solver's network of possible wanderings.” Further, in their study on absorptive capacity, Cohen and Levinthal (1990: 130) highlighted why pertinent prior knowledge can increase the number of innovative ideas: “the prior possession of relevant knowledge and skill is what gives rise to creativity, permitting the sorts of associations and linkages that may have never been considered before.” Thus, prior knowledge seems to increase individuals' ability not only to produce more opportunities but also to enhance those opportunities' level of innovativeness. For example, in one study, my (Dean) colleague and I (Shepherd and DeTienne 2005) found that more prior knowledge about customer problems leads to the recognition of a greater number of opportunities. In addition, the opportunities higher-knowledge individuals identify tend to have high levels of innovativeness. These results are in line with the arguments presented by researchers who study entrepreneurship through the lens of Austrian economics as well as with the literature on cognition. However, these results may not be applicable to other types of prior knowledge, and they may not represent a clear-cut blessing.

Studies in the expertise literature (e.g., Fiske and Taylor 1991) have shown that as individuals gain experience, their thoughts can start to become channeled in such a way that they fall into mental ruts. For instance, when an individual has prior knowledge of ways to serve the

market, his or her thoughts may be channeled along known pathways. In turn, creative thought becomes more difficult and unlikely, thus making the recognition of innovative opportunities more challenging. Such mental ruts also tend to make it increasingly difficult for seasoned decision makers to identify new variables or recognize environmental change (Tversky and Kahneman 1974), and they limit individuals' ability to think "outside the box," which can make recognizing more innovative opportunities difficult. Whether this limited creativity and constrained ability to identify opportunities help or hurt firm performance seems to be determined by the task at hand in relation to the knowledge comprising the particular individual's expertise (Shanteau 1992). As such, entrepreneurship scholars who explore the connection between prior knowledge and opportunity identification must carefully differentiate between types of prior knowledge.

Both of these perspectives could be possible—namely, that prior knowledge leads people to recognize more opportunities that display themselves higher in innovativeness but that some individuals may become entrenched in mental ruts as they gain more experience. Indeed, this relationship could be curvilinear such that there is an early increase in the number and innovativeness of opportunities until a plateau is reached, which is then followed by a decline. These are just expectations, however; additional research is needed to fully understand these relationships.

Moreover, it is likely that prior knowledge and opportunity identification are related in a more complicated way than a clear-cut main-effect-only explanation. Through our more in-depth analysis, we found that the relationship between individuals' prior knowledge of customer problems and their ability to recognize an opportunity varies depending on—at least to some extent—differences in the financial reward they receive for completing the task (Shepherd and DeTienne 2005; see also Csikszentmihalyi 1975, 2000; Maheswaran and Sternthal 1990). While it is valuable to explain why certain individuals (and not others) recognize opportunities based on the prior knowledge they have, the mechanisms underlying how prior knowledge facilitates opportunity recognition remain largely unclear to date. Interestingly, a better understanding of the relationship between prior knowledge and opportunity recognition may come from focusing on specific potential opportunities, namely,

those that enhance the natural and communal environments, to which we now turn.

### PRIOR KNOWLEDGE AND OPPORTUNITIES THAT SUPPORT AND ENHANCE NATURAL AND COMMUNAL ENVIRONMENTS

Known as “a source of resources and services for the utilitarian life support of humankind” (Costanza et al. 1997; Daily 1997), the *natural environment* includes the *earth*, *biodiversity*, and *ecosystems* and the phenomena that constitute the physical world (Parris and Kates 2003). Numerous individuals and groups have noted the importance of protecting the natural environment for fear of threats to the existence of many species, including humans, if the natural world is damaged. The Global Scenario Group, for example, encouraged the world’s population to protect the “beauties of the earth,” while others have emphasized how important it is to safeguard open green spaces and natural resources (Boston Indicators Project 2007).

Referring to the communities in which people live, the communal environment consists of a complex network of relationships between people with common history, norms, meanings, values, and identity (Etzioni 1996). Unique to communities are their specific *culture*, *groups*, and *places*. In case these distinguishing elements are threatened, the community faces decline and even collapse. Culture, in particular, plays a central role in the communal environment as “human beings have a right to culture—not just any culture, but to their own” (Margalit and Halbertal 2004: 529). Thus, the ability to conserve a culture as an element of the larger society enables community members to develop and secure their personal identity.

#### *Knowledge of Natural and Communal Environments*

Individuals’ prior knowledge about natural and communal environments is likely to influence their ability to identify possible opportunities to protect and/or maintain those environments. Knowledge of air- and water-pollution sources in developing economies, for instance, facilitated individuals’ recognition of opportunities for ovens that considerably lessen particle pollutants in households as well as opportunities for inexpensive

methods to convert polluted water to drinking water (Prahalad 2007). Furthermore, knowledge about specific cultures has uncovered opportunities to sustain those cultures (Foley 2003). For example, Peredo and Chrisman (2006: 322–323) introduced:

[community-based enterprise as] an adaptive and socially innovative response to macro-economic social, legal, and political factors with economic, social, environmental, political, and cultural fallout for already impoverished communities. The effectiveness and energy ... of community reaction to these factors may be facilitated by local community culture, which taps into ancestral values, practices, and collective learning from previous community mobilizations. The energy of a local response fosters a cycle between culture and action: local culture encourages community action, but, at the same time, community action reinforces local culture and entrepreneurship.

Indeed, individuals who do not have this type of knowledge about the environment and/or culture may be too uninformed to even question whether any changes take place in these phenomena and whether such changes affect the life of human beings (Patzelt and Shepherd 2011). Thus, it is unlikely that such individuals will identify opportunities to protect natural and communal environments.

Differences in people's prior knowledge about natural and communal environments can be explained—at least partially—by variation in their education, life experiences, and cultural and social backgrounds. Individuals specializing in chemistry, for example, have the scientific knowledge needed to understand the chemical processes underlying ozone-layer damage, air pollution, and wastewater treatment. Similarly, individuals with a specialization in biology have the knowledge needed to comprehend pollution's biological impact on aquatic habitats. Moreover, individuals' social and cultural backgrounds may affect their prior knowledge and ability to identify opportunities. For instance, opportunities to maintain a threatened culture are often identified by members of that particular culture (Foley 2003).

Heterogeneity in prior knowledge can also help explain variation in how people direct their attention toward certain characteristics of natural and communal environments and thus their ability to identify opportunities that protect those environments (consistent with Shepherd and Patzelt 2011). In other words, individuals are much more likely to pay attention to sustain-

ability opportunities that relate to their prior knowledge about a particular part of the environment (consistent with Shane 2000). For instance, while reducing greenhouse gas emissions and conserving the rain forest both counter climate change to a degree (Tilman et al. 2002), when beginning to think about opportunities to offset climate change, individuals with a background in chemistry will likely identify different opportunities than individuals with a background in biology. Chemists are more likely to focus on developing new chemicals that can substitute for greenhouse gases, whereas biologists are more likely to focus on protecting the rain forest by developing, for example, alternative materials for producing furniture so as to reduce the use of tropical woods.

### *Prior Knowledge of Societal Problems*

Prior knowledge about societal problems often enables individuals to identify opportunities to develop economic and non-economic gains for disadvantaged people (Patzelt and Shepherd 2011). People can acquire this type of prior knowledge from a variety of sources, including education, work experience, personal experience, and social experience. Differences in prior knowledge about societal problems are likely to at least partially explain why some people and organizations pay attention to particular aspects of developing economic and non-economic gains for society, whereas others pay attention to other aspects. Identifying opportunities to assist disadvantaged others by creating economic and non-economic gains is often easier when individuals can take others' perspective and "put themselves in their shoes." By attempting to take another person's perspective, the individual tries to understand that person's thoughts by cognitively positioning him- or herself in the other person's situation to obtain information about his or her development needs. Depending on their prior knowledge of societal problems, individuals will process and use this information in different ways and will focus on different methods to develop people and society.

### *Entrepreneurial Knowledge: Bringing It All Together for Action*

In addition to having knowledge about natural and communal environments and about societal problems, having prior *entrepreneurial* knowledge is often imperative in identifying possible opportunities. Individuals'

entrepreneurial knowledge likely impacts how much their prior knowledge of natural and communal environments facilitates their identification of opportunities that protect or sustain those environments (Patzelt and Shepherd 2011). For instance, Ibrahim Abouleish—founder of the Egyptian company Sekem—realized that reduced pesticide use and the introduction of organic agricultural methods could help protect the natural environment in this country. Abouleish was able to identify this specific opportunity due to his in-depth knowledge of the pharmaceutical market, which he gained throughout his career in the pharmaceutical industry. Based on this unique knowledge, Abouleish formed the opportunity belief that organic food and herbs can be grown and commercialized in national and international food and pharmaceutical markets. Thus, Abouleish complemented his knowledge about organic agriculture with entrepreneurial knowledge in order to protect the environment, and this complementarity increased the effect of Abouleish’s prior knowledge on his development of a sustainability opportunity belief (Seelos and Mair 2005; as described in Patzelt and Shepherd 2011).

#### KNOWLEDGE, ENTREPRENEURSHIP, AND OTHERS’ HEALTH

Health plays an inarguably important role in people’s lives, so it is unsurprising that scholars are interested in investigating this topic. Although there is some entrepreneurship research focusing on health (e.g., the impact a career as an entrepreneur has on people’s psychological [e.g., Tetrick et al. 2000] and physical [Boyd and Gumpert 1983] well-being or research on startups in the biopharmaceutical industry that develop new drugs [e.g., Evans and Varaiya 2003; Deeds et al. 1999; Patzelt et al. 2008]), there are many opportunities left to substantially grow this research stream and thus contribute to our understanding of entrepreneurial phenomena (and, hopefully, people’s lives) (Shepherd and Patzelt 2015). When we use the term “health,” we are referring to both physical health (“the physiological and physical status of the body”) and mental health (“the state of the mind, including basic intellectual functions”) (Ware et al. 1981). Additionally, to ensure the scope of our task is feasible, we limit our discussion to *personal* health as these health-related aspects “end at the skin” and therefore have a clearly defined boundary (Ware et al. 1981).



Those who have prior knowledge about the health problems of others are likely to be the individuals who identify opportunities to improve these others' health. Many individuals personally deal with health-related problems or gain familiarity with such problems by caring for loved ones. By directly or indirectly experiencing a particular health problem, an individual not only develops a strong understanding of the specifics of the problem but also gains in-depth knowledge of existing treatments and how those treatments fall short. In turn, this knowledge can lead the individual to recognize latent demand. For instance, Han Pham was infected by bacteria from a mishap with a dirty vaccination needle. Later, while in graduate school for design, Pham recognized an opportunity stemming from her needlestick injury and developed the YellowOne Needle Cap, which is a yellow cap made of plastic. The cap turns cans for soft drink into a safe receptacle for discarded needles by preventing the needles from coming back out ([www.designtoimprovelife.dk](http://www.designtoimprovelife.dk)).

While individuals who directly or indirectly experience health problems may recognize an opportunity for someone, they may not have the knowledge required to personally act on the opportunity (McMullen and Shepherd 2006). Acting on an opportunity to develop a new product to overcome a health problem, for instance, might require knowledge of marketing, production, and management in the particular health sector as well as the resources to do so. Take the example from above again: Pham's invention of the YellowOne Needle Cap ultimately resulted from the design knowledge she gained in graduate school. Acting on an opportunity to overcome health problems could be an especially significant context in which individuals who create and use innovations to solve their own health problems begin a process (perhaps unintentionally) that results in the development and exploitation of the health opportunity. It appears that studies on this process could build on the concept of user innovation (Shah and Tripsas 2007; von Hippel 1988). This perspective might be useful to develop the field of health entrepreneurship.

While they have different knowledge from individuals who have directly and indirectly experienced health issues, people who have not experienced problems with their own health may also possess knowledge that leads to the identification and exploitation of health-improving opportunities. For instance, some people have a deep understanding of technologies with the potential to become health solutions, such as engineer Dean Kamien. Kamien realized that many people who live in third-world countries do

not have access to clean drinking water. This lack of clean water represents a significant health problem since drinking water that is of bad quality is full of microbial pathogens. These pathogens, in particular when combined with bad sanitation and poor hygiene, contribute to more than 1.7 million deaths every year (Ashbolt 2004). Kamien's goal was, in his words, to "solve the biggest world problem" by using his inventing and engineering knowledge to develop the Slingshot. The Slingshot is a system that is portable and requires little power but purifies water to an acceptable quality for humans ([www.slingshotdoc.com](http://www.slingshotdoc.com)).

Professionals in the field of medicine have particularly comprehensive knowledge about health problems across many different people, which makes them particularly capable of identifying opportunities that may address (some of these) problems (Simmons 2002). Studying patent data from the American Medical Association, Chatterji, Fabrizio, Mitchell, and Schulman (2008: 1532) discovered that "20% of the medical device patents filed in the United States during 1990–1996" came from doctors. However, while medical doctors may be in the position to identify opportunities for someone, they may ultimately feel they lack the knowledge necessary to exploit those opportunities, thus concluding that entrepreneurial action is infeasible (we address motivational issues in Chap. 3).

### PRIOR KNOWLEDGE AND OPPORTUNITIES THAT ALLEVIATE OTHERS' SUFFERING AFTER A DISASTER

Many situations can lead to human suffering. Natural disasters, however, are particularly frequent occurrences that cause suffering of many individuals. The International Federation of Red Cross and Red Crescent Societies reports that in 2010, 406 natural disasters (not counting, e.g., epidemics and wars) occurred throughout the world (Armstrong et al. 2011). The damages these events caused amount to more than \$123 billion, and the people killed in these events amount to more than 304 million (Armstrong et al. 2011). Overall, 2010 was the year with the greatest number of people affected by natural disasters; however, the data show that natural disasters regularly lead to significant human suffering (Armstrong et al. 2011). For the individual, *suffering* involves "the experience of pain or loss that evokes a form of anguish that threatens an individual's sense of meaning about his or her personal existence" (Dutton et al. 2006: 60; see also Sutcliffe and Vogus 2003).

Many organizations step in after natural disasters to aid victims and help the affected area recover. While these organizations do help many individuals, frequently they cannot address all victims' urgent needs, so suffering continues (e.g., Schneider 1992; Van Wart and Kapucu 2011). However, my (Dean) colleague and I (Shepherd and Williams 2014; Williams and Shepherd 2016) found that in this context—namely, when there are numerous outside resources after a disaster but established organizations are ineffective at alleviating suffering—local venturing is often successful. More specifically, local ventures are very effective at recognizing opportunities to organize abundant resources (generally provided by sources that are not harmed by the disaster). These ventures are also effective in the fast delivery of resources to those in need. This type of entrepreneurial action works well since it is locally driven, rapid, and customized to the urgent needs of those suffering.

Before investigating prior knowledge's role as a resource, it is important to understand how a disaster changes other resources. Disasters considerably reduce the amount of material, or *tangible*, resources in an area, such as *infrastructure, shelter, water, food, and physical health*, thus often worsening people's suffering. Disasters can ruin people's homes, including their houses, clothing, and belongings; devastate community infrastructure; kill or injure animals; destroy businesses, including business buildings, equipment, and inventory; and injure or kill community members.

While disasters cause significant damage at the local level, especially damage to much-needed resources, several non-physical, or *intangible*, resources are crucial for compassion venturing to ease victims' suffering (Shepherd and Williams 2014). Intangible resources constitute the community's social architecture. After a disaster, community members often maintain these non-physical resources. Moreover, sometimes they try to even improve them. For instance, after the Black Saturday bushfire disaster in Australia, "localness" or "being local" was influential in driving entrepreneurial actions, and an important factor of this localness was local knowledge (Shepherd and Williams 2014).

Referring to location-specific information, local knowledge includes a community's terrain, history, social networks, community members' skills, and available resources. After Black Saturday, local knowledge played a key role in facilitating collaboration among locals (individuals and organizations). Moreover, local knowledge triggered the cooperation between locals and non-locals and enabled more rapid delivery of customized solu-

tions that helped address the victims' suffering. Local knowledge was primarily informal and tacit as it was generally not documented and was frequently challenging to transmit to others (Shepherd and Williams 2014).

## INTERNATIONAL KNOWLEDGE AND OPPORTUNITIES TO GO ABROAD

International knowledge constitutes a critical intangible resource for entrepreneurship in an international context. However, due to liabilities of newness and foreignness, it can be difficult for individuals and organizations to obtain this knowledge. Contrary to arguments based on absorptive capacity, entrepreneurial firms' management teams (TMTs) having little international experience tend to capitalize on external sources providing international knowledge, such as venture capital organizations, alliance partners, and other firms in close proximity (Domurath and Patzelt 2016; Fernhaber et al. 2009).

International entrepreneurship comprises the "discovery, enactment, evaluation, and exploitation of opportunities across national borders to create future goods and services" (Oviatt and McDougall 2005). A majority of international entrepreneurship research has focused on new ventures (Zahra and George 2002), particularly on such ventures' need to address substantial limitations stemming from their newness and smallness as a prerequisite for internationalization (Knight and Cavusgil 2004). To become international, a venture must have a competitive advantage as a basis for dealing with the added costs of foreign business operations and succeed in doing business abroad (Dunning 2000; Rugman 1981). These tasks require resources. While many firms tend to leverage resources that are tangible when they enter international markets, resources that are intangible are frequently more likely to yield competitive advantage because they are difficult for competitors to replicate (Kotha et al. 2001). Researchers have shown that international knowledge, particularly for new ventures, constitutes a crucial intangible resource for internationalizing business operations (Bloodgood et al. 1996; Carpenter et al. 2003; Reuber and Fischer 1997).

Most scholarly work on international entrepreneurship has concentrated on the international experience of entrepreneurial TMTs as the main source of international knowledge. Because prior knowledge and experience enable individuals and firms to more readily identify opportunities (Shane 2000; Wiklund and Shepherd 2003; Patzelt and Shepherd

2011; and discussed above), new ventures that have more international knowledge based on their TMTs' prior experience will recognize a larger number of opportunities in foreign markets and therefore internationalize to a greater extent than ventures without such knowledge. New ventures may further utilize their TMTs' international experience to attract alliance partners from the international business arena and thus build credibility in foreign markets. Moreover, many firms whose TMT has international experience are able to internationalize more quickly than their counterparts (Reuber and Fischer 1997). This faster internationalization facilitates such firms' integration of international considerations into their organizational structure and processes sooner, thus speeding up growth in international markets (Autio et al. 2000) and yielding higher efficiency (Oviatt et al. 1995). Moreover, earlier internationalization can lead to a higher share of foreign sales of total sales (Reuber and Fischer 1997).

While prior research on international knowledge acquired internally through TMTs' previous experience has provided important insights into new venture internationalization, scholars have failed to adequately investigate international knowledge that comes from outside new ventures. This research gap is surprising given the important role the external environment plays in new venture internationalization (e.g., Coviello 2006; Johanson and Vahlne 2003) and entrepreneurs' assessments of opportunities in foreign markets (Domurath and Patzelt 2016), especially for overcoming liabilities of newness and foreignness. Most new ventures depend on knowledge sources that are external to the organization in order to confirm they are operating effectively and to enhance their overall chance of high performance (McGrath and MacMillan 1995). Internationalizing firms are likely to have a similar reliance on outside knowledge sources to learn how to effectively enter into foreign markets (Domurath and Patzelt 2016). While the internationalization process of new ventures can be influenced by their TMTs' prior international experience, the international business environment constantly changes (Hitt et al. 1998), making the value of TMTs' experience decline over time (Anand et al. 2002) and increasing the need for outside knowledge sources.

### *Alliance Partners*

Strategic alliances are cooperative inter-firm agreements with the purpose of creating competitive advantages for all parties involved (Das and Teng 2000). These alliances represent an important formal relationship which

provides entrepreneurial ventures with access to the resources they need for growth (Baum et al. 2000). In addition to gaining access to important resources, new firms are also likely to learn from the knowledge they obtain through these partnerships (Johannisson 2000; Haeussler et al. 2012). For instance, by interacting with alliance partners, entrepreneurial firms could access business intelligence or learn about new opportunities. Indeed, as Hite (2005: 113) contended, an entrepreneurial firm's partners provide the "conduits, bridges and pathways through which the firm can find and access external opportunities and resources." Scholars have also argued that strategic alliances provide the best access to new ideas and innovation (Dyer and Singh 1998) and are an important source of tacit knowledge about markets (Anand et al. 2002); these assets are indispensable for entrepreneurial ventures' growth and survival.

Thus, strategic alliances are a key external source of knowledge for entrepreneurial ventures. Accordingly, a strategic partner's level of business operations in or engagement with foreign markets likely affects to what extent the new venture's recognized opportunity and knowledge resources are international. Previous theoretical work has suggested that there is a positive link between new ventures' development of strategic partnerships and internationalization (Coviello and Munro 1995). The transmission of international knowledge influences this association to some degree (Johanson and Vahlne 2003), with higher levels of international knowledge among alliances having a larger influence on new ventures' efforts to internationalize. Numerous studies back this notion. Through surveying new ventures, Coviello and Munro (1995) found that 64% of the ventures' initial entry into international markets and the entry mode chosen stemmed from opportunities that were revealed to them by their alliance partners as opposed to the ventures' own opportunity-identification efforts. Similarly, Chen and Chen (1998) contended that alliance partnerships lead to higher levels of direct foreign investment and that smaller firms generally depend on such partnerships when internationalizing to a greater extent than larger firms. This higher dependence on alliances is likely the result of a lack of options and decreased information for decision making among small firms. Unsurprisingly, entrepreneurial firms are typically smaller than older firms (Hanks et al. 1993). Thus, forming alliances with firms that have higher levels of international experience in addition to a strong presence in an international market can greatly

aid the ventures hoping to internationalize through enhanced knowledge of the local market (Fernhaber et al. 2009; Lu and Beamish 2001).

### *Venture Capital Firms*

Building relationships with venture capital firms is another crucial way for new ventures to grow their knowledge base for recognizing new business opportunities (Fernhaber et al. 2009). Existing research has suggested that venture capital firms often provide entrepreneurial ventures with more than just financial resources (Sapienza 1992). These firms add value to entrepreneurial ventures by providing reputations (Chang 2004), granting access to expertise in business management (Baum and Silverman 2004; Ruhnka et al. 1992), assisting the ventures in finding and recruiting qualified personnel (MacMillan et al. 1989), and helping entrepreneurs formulate an appropriate strategy for their firm (Fried et al. 1998; MacMillan et al. 1989). An additional way venture capital organizations might be valuable to entrepreneurial ventures is by sharing knowledge related to foreign market entry, which likely occurs as a result of the managerial influence venture capitalists have over the entrepreneurial firms in their portfolios.

Venture capital firms generally take an active management role in their investees (Baum and Silverman 2004; Ruhnka et al. 1992); some even believe that they contribute directly to a venture's human resources (Florin et al. 2003). High levels of involvement are rooted in the risks venture capital firms take on when financing new ventures. Moreover venture capitalists not only desire to safeguard their invested capital but also to guarantee a high return on it (Fried et al. 1998). Sometimes, a venture capital firm's investment in a new venture can lead to the replacement of individuals in certain management positions (even the founder in some cases), participation in the board of directors, and continual monitoring of the investee's performance (Carpenter et al. 2003; Fried et al. 1998). That is, because venture capital organizations own part of their investees and provide them with access to limited finance, they often have numerous possibilities to affect what strategic decisions their investees take.

An examination of the existing literature shows that venture capital has become a global practice. Venture capitalists make widespread investments outside domestic markets (Wright et al. 2005). It is likely that a new firm will be encouraged to internationalize when the venture capital firm

financing it has a high level of international knowledge/expertise. Along these lines, prior studies have investigated how greater ownership among external investors results in higher rates of ventures' activities in foreign markets (George et al. 2005). We build on these studies by suggesting that venture capital firms aid in the internationalization process of entrepreneurial ventures by providing them with international knowledge. Of course, the impact of venture capital firms' knowledge in this context varies depending on the extent of their international experience (Fernhaber et al. 2009).

### *Proximal Firms*

Research on knowledge spillovers has argued that firms can profit from other firms' knowledge through informal interactions. This research has highlighted the importance of geographic proximity to one another for effective knowledge transfer to occur (Audretsch and Feldman 1996). As Saxenian (1990: 97) explained, people "meet at trade shows, industry conferences, and the scores of seminars, talks, and social activities organized by local business organizations and trade associations. In these forums, relationships are easily formed and maintained, technical and market information is exchanged, business contacts are established, and new enterprises are conceived." A particularly good illustration of the value of knowledge spillovers can be seen in industries characterized by intense research and development (R&D). Many multinational corporations, for instance, have built their R&D labs in specific locations based on the likelihood that spillovers of knowledge occur (Feinberg and Gupta 2004). The degree to which knowledge from one firm spills over to other firms is partially determined by the presence (or lack) of the relevant industry in the firm's specific geographic area. For instance, while Silicon Valley is the most renowned area for the development of new software, other top tech regions in the United States, such as San Francisco, Boston, and Austin, also represent regions in which knowledge spillovers can advance entrepreneurial firms depending on their industry presence. The notion of knowledge spillovers is usually associated with technological knowledge; however, knowledge spillovers are likely to also occur for international knowledge (Fernhaber et al. 2009). If many of the firms physically surrounding a new venture are international, the likelihood of international knowledge from these firms spilling over and influencing the new firm is greater (Fernhaber et al. 2008).



### *Internal and External Sources of Knowledge About International Markets*

As we addressed above, alliance partners, venture capital firms, and proximal firms can provide entrepreneurial ventures with international knowledge. This knowledge is not usually an element of a formal exchange of resources per se; instead, it is a secondary benefit a new venture can exploit from this relationship. While we believe these external international knowledge sources will directly influence new ventures' international activities, it is also probable that the international knowledge possessed by the TMT of an entrepreneurial firm will impact the degree to which the firm accepts and capitalizes on these knowledge sources from outside.

One may assume that new ventures that have TMTs with greater international experience are more capable at identifying the worth of their networks' international knowledge and applying that knowledge when internationalizing. However, my (Dean) colleagues and I (Fernhaber et al. 2009a, b) found that new ventures having TMTs with limited or lacking international knowledge are more likely to take advantage of external knowledge sources. More specifically, new ventures generally have a "high ratio of assumption to knowledge" (McGrath and MacMillan 1995: 4), often motivating them to find external sources to confirm they are taking the right course of action and enhance their odds of success. These external knowledge sources are valuable because they compensate for—and sometimes even replace—new ventures' limited collection of internal knowledge sources. Indeed, as Stinchcombe and March (1965) described, new ventures' dependence on social networks for survival is one of the main elements of the liability of newness. This notion implies that when new ventures have inadequate internal international knowledge, they must depend on external international knowledge sources more heavily when making strategic decisions. That is, new ventures with limited knowledge about foreign markets are more likely to be motivated to seek out and actively exploit this knowledge in the outside environment. Entrepreneurial ventures that have TMTs with more international knowledge, on the other hand, will to a limited extent rely on outside knowledge sources (even though they will still benefit from these sources) for recognizing new opportunities in international markets.

Neo-institutional theory corroborates these assertions, demonstrating that during times of uncertainty, firms are more likely to seek out and compare themselves to similar firms in their environment to understand

their own situation and adjust their behavior if necessary (Haunschild and Miner 1997). In general, uncertainty can be connected to being new and/or lacking experience (Shepherd et al. 2000). For instance, studying how Japanese firms make decision about their mode of foreign entry, Lu (2002) showed that experience moderates the impact of firms' isomorphic behavior on their mode of entry decision. Firms with weaker experience in foreign entries generally draw to a greater extent on other firms' previously used entry modes. Similarly, entrepreneurial firms with weaker international experience tend to confront higher uncertainty and thus to a greater extent depend on outside firms' international knowledge for opportunity recognition.

In addition, entrepreneurial ventures' TMTs with weaker international experience tend to profit more from outside international knowledge sources since they have a larger knowledge gap that needs to be filled. Indeed, new ventures sometimes deliberately choose to exploit external knowledge when seeking international opportunities because they recognize a shortage in their own knowledge. However, this exploitation can also occur inadvertently. For instance, a new venture may enter international markets because its partners wanted to or because a particularly valuable opportunity required such entry. An absence of international experience often increases the TMT's awareness of and openness to accept knowledge from outside sources. Indeed, in my (Dean) study on new venture internationalization with colleagues (Fernhaber et al. 2009), we showed that the association between the international knowledge of an entrepreneurial firm's external knowledge sources and the firm's internationalization is more positive when there is less international knowledge within the TMT than when there is more international knowledge within the TMT.

## KNOWLEDGE, COGNITIVE PROCESSES, AND OPPORTUNITY IDENTIFICATION

Previous research has shown that when firms perceive discrepancies between their prior assumptions and environmental signals, a "trigger" is activated that concentrates their attention on the interpretation of the signals and prompts the development and pursuit of a response by the organization (Dutton and Jackson 1987). However, while we know what factors influence managerial perceptions of environmental signals within

organizations (Kaplan 2008; Ocasio 1997), our understanding of perceptions of opportunities is incomplete. That is, compared to perceptions of threat, we know less about the processes individuals use to identify opportunities. However, we do know, as Baron (2006: 104) argued, that opportunity identification requires pattern recognition, or the ability to “connect the dots between changes in technology, demographics, markets, government policies and other factors.” Indeed, Baron and Ensley (2006) found that experts’ opportunity prototypes show higher complexity levels than prototypes of novice entrepreneurs and highlight different characteristics of both the opportunity and the business.

Although these studies are a considerable step toward understanding opportunity identification, numerous conceptual issues and empirical difficulties still hinder research in this area. Some studies, for example, investigate opportunities that were identified in the past, thus leading to limitations caused by biases due to retrospection and success (Golden 1992; Huber and Power 1985). Consequently, it continues to be challenging to uncover precisely how attention to environmental signals fosters opportunity identification (Ocasio 1997; Shepherd et al. 2007, 2017); what the perceived features of the signals are (Jackson and Dutton 1988; Julian and Ofori-Dankwa 2008); what information-processing abilities individuals have (Kuvaas 2002; Milliken 1990); what crucial resources, resource slack, or strategies firms have (Chattopadhyay et al. 2001; Thomas and McDaniel 1990); or how prior knowledge (Dimov 2007b; Shane 2000; Shepherd and DeTienne 2005) and other capabilities and resources at the individual or organizational level are utilized (Barnett 2008; Cattani and Ferriani 2008). Thus, numerous unanswered questions remain surrounding *what* factors facilitate opportunity recognition as well as *how* and *why* these factors are so crucial.

To shed light on these issues, my (Dean) colleagues and I (Grégoire et al. 2010) explored the reasoning strategies individuals utilize to identify opportunities. More specifically, the study investigated two previously unaddressed questions: *what cognitive process facilitates individuals’ opportunity recognition*, and *what particular role does the individual’s prior knowledge play in this process?* To this end, we created a model of opportunity identification as a cognitive process of structural alignment (Gentner 1983, 1989). Next, we carried out exercises with founders to document their think-aloud articulations during their attempts to identify new technological opportunities. An analysis of these articulations determined the degree to which entrepreneurs utilize structural-alignment processes when

identifying new technological opportunities as well as the impact prior knowledge has in these processes.

These findings of structural-alignment processes have broader implications for research on organizations. Crossan et al. (1999) showed that for organizational learning, opportunity recognition is based on mechanisms at the inter-individual, team, organization, and society levels (Davidsson 2003; Dimov 2007a); however, there are also many poorly understood individual processes at the center of this multilevel phenomenon. Moreover, opportunity recognition is a prerequisite to opportunity evaluation and pursuit by both individuals and organizations (McMullen and Shepherd 2006). Thus, individual opportunity-recognition processes are crucial not only for entrepreneurial firm foundation but also for learning, adaptation, renewal, and strategy formulation more generally within organizations (Crossan and Berdrow 2003; Zott and Amit 2007).

There is a recurrent discussion among scholars about the ontological nature of opportunities. That is, do opportunities come into being as objective artifacts waiting for predisposed individuals to “discover” them, or do they come into being out of these individuals’ subjective interpretations and creative behavior? This discussion has received a great deal of attention (Davidsson 2003; McMullen et al. 2007), but it is our opinion that in its current form, this debate has led to a stalemate that impedes research on one of the most relevant phenomena for organization scholars; that is, it impedes research on the processes individuals and organizations use to identify and then exploit potential opportunities (Grégoire et al. 2010; McMullen and Shepherd 2006; Shepherd et al. 2007; Shepherd 2015).

Rather than focusing on the philosophical foundations of the nature of opportunities, it may be more beneficial to examine research suggesting that opportunities stem from changes, such as changes associated with new organizational or individual knowledge, changes in the actions of important players in the economy (e.g., customers, suppliers, competitors), or widespread changes in the macro-environment (e.g., new regulations, economic cycles) (Grégoire et al. 2010; see also Shepherd et al. 2007, 2017). However, while changes like these may make existing routines and processes less optimal, they do not represent opportunities in and of themselves. As an example, take an inventor developing a new technology. While this new technology may create an objectively distinguishable environmental change, he or she does not already “have” an opportunity. Further, the new technology itself does not signify an

opportunity because opportunities are associated with action targeted at reaping benefits from these changes (Grégoire et al. 2010; Grégoire and Shepherd 2012). In the entrepreneurial context, for example, new technological opportunities would stem from *applying* the technology in a specific market context (see Venkataraman and Sarasvathy 2001: 652; Eckhardt and Shane 2003).

Yet, the appropriateness of using a new technology in a specific market context is uncertain from the beginning (Knight 1921; McMullen and Shepherd 2006) due to unbalanced knowledge diffusion (Hayek 1945) and restrictions to the rationality of the person (Simon 1957), including narrow attention (Ocasio 1997; Shepherd et al. 2007, 2017); this appropriateness can only be examined in hindsight. Thus, we can conclude that the opportunity-identification process has both objective and subjective dimensions: there is the objective reality of an individual's environment and then his or her subjective interpretation of this environment and of his or her role in that environment before any objective facts become available (McMullen and Shepherd 2006).

As such, research has focused on the difference between two interdependent phases of entrepreneurial action (McMullen and Shepherd 2006; Shepherd et al. 2017). The first phase deals with the emergence of subjective individual beliefs about the existence of an opportunity for somebody who possesses the capabilities/skills necessary for exploitation (2006: 137). The second deals with individuals' assessment of the opportunity for themselves or their organization—namely, whether they have the capabilities and motivation necessary for exploitation. Thus far, the majority of work on opportunity identification has either not distinguished between the two opportunity-process phases (e.g., Baron and Ensley 2006) or has concentrated on the assessment phase (e.g., Chattopadhyay et al. 2001; Krueger and Brazeal 1994; Sarasvathy 2001; Thomas and McDaniel 1990). Yet, to advance knowledge of the underlying mechanisms that lead individuals and organizations to pursue potential opportunities, research has also focused on the first phase—the process of identifying opportunities or

efforts to make sense of signals of change (e.g., new information about new conditions) to form beliefs regarding whether or not enacting a course of action to address this change could lead to net benefits (for instance, in terms of profits, growth, competitive jockeying and/or other forms of individual or organizational gains). (Grégoire et al. 2010: 415)

### *Structural Alignment Connecting the Novel to the Known*

We believe that the solution to this puzzle lies partly in examining the cognitive processes people use to make sense of new information. It is well documented that individuals mentally compare new information to their prior knowledge in order to understand it. With this perspective, being able to identify opportunity-relevant patterns requires individuals to put forth cognitive effort to see “resemblances” between what happens in the world (such indications of possible environmental changes) and their mental models of circumstances that are pertinent to understanding the new information as well as to (in the case of opportunity identification) recognizing a plan to potentially benefit from these changes.

However, how does this comparison and sensemaking occur in the real world? What cognitive processes do individuals use to evaluate resemblances between new information and their prior knowledge? This issue of resemblance is the focus of cognitive research on perceptions of similarity and the utilization and outcomes of similarity considerations across a large variety of reasoning tasks (cf. Holyoak and Thagard 1996). Research in this area emphasizes that similarity perceptions regarding two or more items of interest depend on individuals’ alignment of mental representations of these items (Day and Gentner 2007; Keane et al. 1994). Following on this research stream, the cognitive process of *structural alignment* (Gentner 1983, 1989) can serve as a valuable foundation to explore opportunity recognition. Structural alignment represents a cognitive “tool” individuals use to compare objects. Based on this comparison, the individual then derives implications or generates new insights. When individuals come across a new object, for example, they tend to instinctively question if anything in the new object is similar to anything they have encountered previously. Based on identified similarities, individuals then make efforts to more fully make sense of the new object. As cognitive scientists have illustrated, these considerations and the associated structural-alignment mechanism take a vital role in how individuals understand new information, learn novel ideas, and create new categories (see Holland et al. 1986). These processes include scientific innovation, the development of new product ideas, strategy development (Gavetti and Rivkin 2005, 2007), and other tasks that require creativity (Dahl and Moreau 2002; Ward 1995).

A main finding of this literature is that alignment occurs at two levels. One level centers on *superficial features*, while the other level centers on

*structural relationships* (Gentner 1983, 1989). Specifically, superficial features are a mental representation's basic "parts" in addition to its characteristics and attributes (Gentner et al. 1995: 271). Structural relationships, on the other hand, are the links connecting various superficial features as part of a mental representation. Further, research has found that there are two types of *structural* relationships. The first type are first-order structural relationships, which denote one-to-one functional relationships between superficial features. These superficial features can include direct effects and action verbs. The second type are higher-order relationships, which are "relationships between relationships" and are therefore more abstract. Higher-order relationships include goal statements, causal chains, and conditional rules (Gentner et al. 1993; Holyoak 1985).

To illuminate the difference between superficial features and structural relationships, my (Dean) colleagues and I (Grégoire et al. 2010: 416) used an example of a new technology which had been developed at MIT—namely, the 3DP™ discussed in Shane (2000). We illustrated the differences between superficial features and structural relationships as follows:

Examples of superficial features of the technology include who developed the technology (mechanical engineers at MIT), the components of the technology (mechanical arm, print head), the material it uses (ceramic powders), and what the technology produced in the lab (e.g., ceramic filters, casting molds, etc.). Examples of first-order structural relationships include how the technology operates (e.g., [mechanical arm (moves) print head]; [print head (deposits) powder]). Higher-order structural relationships include more abstract capabilities of the technology (e.g., [how the technology operates] causes [fabrication of tridimensional objects with high level of automation and precision]).

Structural-alignment processes are a significant aspect of individuals' sensemaking efforts regarding new information. When individuals are presented with a new stimulus, they evaluate how its features and relationships align with those of a pertinent "source" (Gentner 1989; Holland et al. 1986). For example, this source could be a related object, or it could be a more intangible framework including a category or theoretical model the individual holds. Yet, more frequently such a related object is a mental representation of a situation that informs the individual's understanding of the new information. This comparison of new information with a related model, object, or situation (i.e., the determination of whether a target's superficial features and structural relationships align with those of

a source) enables individuals to detect patterns that convey meaning. Based on these patterns, the individuals can derive useful conclusions.

However, research on structural alignment has also shown that different sets of cognitive structures and dynamics are required to process superficial features and structural relationships (Gentner 1989; Keane et al. 1994). Consequently, these two aspects of structural alignment are likely to impact opportunity-identification efforts in different ways. On the one hand, superficial features affect how individuals search for and retrieve information from their memory (Gentner 1989; Gentner et al. 1993). Thus, a new stimulus's superficial features (e.g., the material required for operating a new technology) may trigger individuals' recollection of comparable features of an important source (e.g., a market offering the material referenced in the previous example). The source the individual recalls from memory is often shaped by his or her previous experiences or familiarity with specific features. Alternatively, it can be shaped by his or her environment or current situation (e.g., a feature may be salient for a person because of particular events in his or her life). This shaping limits the number of superficially related domains one instantly (and unconsciously) accesses (Keane et al. 1994) when scanning for pertinent references for alignment. Structural relationships, in contrast, are intertwined in a more direct manner with higher-order processes of reasoning (Keane et al. 1994). As an example, the processing and alignment associated with structural relationships affect individuals' formation of categories (Namy and Gentner 2002), solving of problems (Catrambone and Holyoak 1989, 1990), and learning (Loewenstein and Gentner 2005).

Superficial features and structural relationships can both impact people's interpretations. However, scholars have demonstrated that structural relationships are especially crucial when individuals make inferences about a stimulus that is novel and/or ambiguous (Day and Gentner 2007; Gentner 1989). As such, my (Dean) colleagues and I (Grégoire et al. 2010) theorized that people's attempts to identify opportunities are likely to stress their use and alignment of structural relationships. There are two notions underlying this stress. First, individuals are likely to draw on structural relationships when stimuli are encoded in a deep and rich way. For example, such deep and rich encoding happens when one performs a cognitively demanding or emotionally challenging task (Blanchette and Dunbar 2001; Catrambone and Holyoak 1989). The opportunity-identification task fulfills both these conditions as information required is typically ambiguous and difficult to interpret. Similarly, these tasks are



usually emotionally engaging largely due to the possible outcomes they may yield for entrepreneurs and their firms (Cardon et al. 2012; Ireland et al. 2003).

Second, scholars have found that from a neuro-cognitive perspective, the brain is activated more when individuals perceive alignment of structural relationships than when they notice alignment of superficial features (Holland et al. 1986; Keane et al. 1994). Based on this partiality for the alignment of structural relationships, individuals are better able to identify and compare meaningful patterns. These patterns might include superficial similarities (but not necessarily). Indeed, researchers from several fields have documented individuals' use of structurally based "mental leaps" (Holyoak and Thagard 1996). Such mental leaps occur, for example, when individuals think creatively and/or attempt to solve scientific problems (e.g., Dahl and Moreau 2002; Dunbar 1993; Ward 1995). In the context of strategic decisions, Gavetti and Rivkin (2005) reported how Andrew Grove (the former Intel CEO) realized the risk of deserting the low-end microprocessor segment. Instead of considering the context of computer or electronic products, he related Intel's situation to what occurred in the steel sector after Nucor and mini-mills were introduced. While reinforcing bars and microprocessors do not share many comparable characteristics, Nucor's entrance and success in the steel business was very similar to Intel's entrance and success in the microprocessor sector. Thus, Grove was able to formulate a strategy that prevented Intel from experiencing a similar future because he had knowledge of the history and decline of established US steel companies. The discussion above implies that when trying to identify opportunities, individuals tend to pay more attention to the alignment of structural relationships than to the alignment of superficial features. Along these lines, my (Dean) co-authors and I revealed that the opportunity-identification process requires higher levels of cognitive effort (i.e., attention) for the alignment of structural relationships than for the alignment of superficial features (Grégoire et al. 2010).

### *The Role of Prior Knowledge in the Structural-Alignment Process*

As mentioned earlier, scholars have shown that since knowledge is not evenly distributed throughout the population, prior knowledge provides at least a partial explanation as to why some people are able to identify specific opportunities that other people miss (e.g., Corbett 2005; Dimov

2007b; Shane 2000; Shepherd and DeTienne 2005). Overall, work in this area has argued that prior knowledge serves as a foundation for the interpretation and use of new information; however, most studies on this topic have not delineated the cognitive mechanisms by which prior knowledge affects individuals' opportunity recognition. We believe that prior knowledge likely triggers individuals' consideration of structural relationships. For instance, domain experts often find reasoning in terms of structural relationships easier because they can draw on deeper mental representations (Chi et al. 1981). Such experts are particularly good at solving problems characterized by low levels of superficial similarity but high levels of structural similarity (Keane 1988). Additionally, research has demonstrated that when people fail to solve particular problems, "failure indices" are frequently left in long-term memory. Following Seifert et al.'s (1994) "opportunistic-assimilation hypothesis," these indices remain inactive until one has an encounter with a stimulus related to addressing the problem. At that point, failure indices "serve as signposts that guide subsequent retrieval processes back to stored aspects of the problematic situation" (Seifert et al. 1994: 87). That is, prior experience with a problem can enhance an individual's attentiveness to stimuli that are relevant for finding a solution (Dimov 2004). What these perspectives demonstrate is that prior knowledge enables individuals to notice structural similarities between new information and relevant contexts although superficial connections between the two are missing.

In line with the reasoning above, my (Dean) colleagues and I (Grégoire et al. 2010) revealed that in the opportunity-recognition process, individuals' dependence on higher levels of prior knowledge requires more cognitive effort (i.e., attention) for the alignment of structural relationships than for the alignment of superficial features. The results uncovered were in line with a structural-alignment model of opportunity identification, suggesting that these cognitive processes are vital to identifying opportunities. My (Dean) colleagues and I (Grégoire et al. 2010) showed that when entrepreneurs came across information related to a novel technology, they focused on the parallels between this information and contexts in which it could be useful. Further, the structural-alignment process involves various types of similarities, each having different outcomes, and some of these similarity considerations encompass the superficial features of technologies and markets. In line with studies in cognitive psychology (e.g., Gentner 1989; Keane et al. 1994), the findings imply that these

features direct individuals' early attempts to look for contexts that serve as a point of reference for assessing the significance of the stimulus (which in our example includes the identification of markets that may align with the technology). Yet, most attempts to make sense of new information and determine whether the technology and the market fit in a way that they constitute a possible opportunity primarily depend on considering and aligning structural relationships (Grégoire et al. 2010).

Most importantly, the study found that perceiving similarities between higher-order relationships seems to be a vital part of the opportunity-identification process, a notion that is supported by three additional lines of evidence. First, when participants made verbalizations highlighting similarities between the superficial features of technologies and superficial features of markets, they allocated a significantly higher amount of attention to the alignment of the structural relationships between technologies and markets, and in doing so they emphasized high-order structural relationships. Moreover, several times the entrepreneurs came up with opportunities when there were numerous structural relationships that were shared by technologies and markets but when technologies and markets had few common superficial features. Said differently, entrepreneurs' ability to notice the alignment of structural relationships enabled the transfer of technologies across domains and thus formed opportunity beliefs that were not overtly evident. Third, when the entrepreneurs placed more emphasis on a stimulus' superficial features rather than on its structural relationships, they had greater difficulty thinking of possible opportunities. Similar challenges surfaced when other matters inhibited the entrepreneurs' ability to consider structural relationships (e.g., when one participant concentrated on assessing the viability of obtaining intellectual property protection for the technology or when another participant focused on time limits). As a whole, the three lines of evidence highlight that while superficial features may direct individuals' initial thinking about new information, reasoning based on the aligning structural relationships is a vital part of opportunity recognition.

### *Differences in the Nature of Opportunities and the Structural-Alignment Process*

The discussion above concentrated on the factors that enable some individuals or organizations to identify and act upon promising activities (cf. Gruber et al. 2010; Plambeck and Weber 2009; Short et al. 2010). Although there has been sustained interest in and theorizing about the nature and sources of opportunities (e.g., Alvarez and Barney 2010; Jackson and Dutton 1988; McMullen et al. 2007), scholars have paid less theoretical and empirical attention to the impact of differences across opportunities, particularly in regard to initial opportunity identification. However, my (Dean) colleague and I (Grégoire and Shepherd 2012) created and tested an opportunity-identification model focusing on the effects of differences across potential opportunities. Expanding the assumptions outlined above, opportunity beliefs form as a result of cognitive efforts to understand possible “matches” between new ways of supply (e.g., new services, products, technologies, or business models) and the markets in which these new means of supply can be introduced. Thus, in the context of technology transfer, the formation of opportunity beliefs hinges on the consideration entrepreneurs give to the structural alignment between new technologies and markets (as described above and specified in Grégoire et al. [2010]).

### *The Effects of Convergent and Divergent Variations in Alignment*

When thinking about structural alignment, we need to take into consideration that superficial and structural similarities can differ independently of one another. From a modeling perspective, the question thus arises as to whether the effects of superficial and structural similarity are merely additive or whether these two forms of similarity interact with one another. To answer this question, my (Dean) colleague and I (Grégoire and Shepherd 2012) tested for a possible interaction between the two dimensions (as detailed below). However, when trying to understand the challenges associated with recognizing potential opportunities, it becomes especially important to explore the meaning and influence that differences across forms of alignment may have on the development of opportunity beliefs. This issue is particularly relevant when the superficial and structural similarities of a technology-market combination are at odds with each other.

While new technologies are often depicted as only being appropriate for specific applications (i.e., how the technology was utilized “in the lab”), entrepreneurs frequently envision other uses for technologies in entirely different markets than the inventors (or those in charge of the commercialization) originally had in mind. Indeed, Shane (2000) described how the opportunities envisioned for the technology he investigated were frequently “non-obvious” even to entrepreneurs trying to exploit other opportunities *for the same technology*. Explanations for this “non-obviousness” have generally emphasized the role of entrepreneurs’ unique knowledge resources in this context. More specifically, due to their greater knowledge and understanding of particular markets and industries compared to many technology inventors, some entrepreneurs are able to recognize market applications that the inventors never could have imagined (Gruber et al. 2008, 2012; Shane 2000; Ucbasaran et al. 2009).

Over and above entrepreneurs’ prior market knowledge, a complementary explanation for opportunity identification is focused attention on the distinct influence of superficial and structural similarity in the development of opportunity beliefs. In the context of our model (Grégoire and Shepherd 2012), the seeming non-obviousness of opportunities appears to be caused by divergences stemming from the low levels of superficial similarities shared between markets and technologies even though they share high levels of structural similarities.

Cognitive science researchers have found that the human mind prefers reasoning involving higher-order structural relationships when interpreting ambiguous stimuli in uncertain contexts (Gentner 1989; Holland et al. 1986). For example, when making predictions about new objects, people generally prefer predictions that proceed from a comprehensive causal system as opposed to predictions that—while equally conceivable—are not part of such a system (Clement and Gentner 1991). Similarly, studies have shown that structural matches usually lead to more brain activity compared to superficial matches because the former activate more neuronal connections (Keane et al. 1994). The implication here is that when individuals think about entrepreneurial opportunities, they are likely to be more cognitively “aroused” when they notice commonalities between a new technology’s structural features and the causes of latent demand in a market than when they notice superficial similarities between the technology and the market.

Despite the mind's preference for structural similarities, recognizing and processing structural similarities without superficial parallels are especially demanding cognitive activities (cf. Catrambone and Holyoak 1989). As a result, the absence of superficial similarities characteristic of some technology-market combinations can make opportunity ideas less apparent even when a technology's capabilities correspond to the causes of latent demand in a market. In turn, individuals may feel less certain or less positive about the resulting opportunity beliefs than they would in the case of high superficial similarity. Students often experience this challenge, for example, they often have a difficult time transferring the content and solutions they learn in one domain with specific superficial elements (e.g., math problems that use particular objects or units) to other domains with logically similar problems but different superficial features (e.g., physics problems focusing on different objects and units) (cf. Bassok and Holyoak 1989; Novick and Holyoak 1991). Ultimately, the absence of superficial similarities often makes knowledge transfer more challenging.

On the other hand, a dominant focus on superficial similarities can at times result in flawed reasoning premises, such as when there are superficial similarities present without structural similarities. For example, strong similarities between a technology's superficial elements and a market could potentially offset the detrimental effects of structural discrepancies between the technology's capabilities and the causes of latent demand in the market. When this occurs, individuals' opportunity beliefs are likely to be less negative than they would have been without such strong superficial similarities.

As a whole, these observations could explain why casual observers find it difficult to identify opportunities comprising technologies that share low levels of superficial similarity but high levels of structural similarity with markets. Again, while the human brain favors making inferences based on structural relationships, identifying and processing such relationships when superficial parallels are lacking are cognitively demanding. Nevertheless, cognitive researchers have shown that low superficial/high structural reasoning is vital to making inferences that enhance knowledge in highly uncertain contexts (Holland et al. 1986) and to making creative "mental leaps" (cf. Holyoak and Thagard 1996), such as when scientists, engineers, designers, and strategists come up with imaginative solutions to complex problems (Dahl and Moreau 2002; Dunbar 1993; Gavetti and Rivkin 2005).

Based on these observations regarding superficial/structural similarities and individuals' ability to recognize non-obvious opportunities, my

(Dean) colleague and I (Grégoire and Shepherd 2012) explored the degree to which beliefs about technology-market matches with low superficial similarity levels and high structural similarity levels differ from beliefs about technology-market matches with other similarity configurations. The study found that the human mind clearly prefers reasoning involving structural relationships such that opportunity beliefs about a novel technology-market match with low superficial similarity levels but high structural similarity levels are more positive than beliefs for new technology-market matches with high superficial similarity levels but low structural similarity levels, and—rather obviously—they are also more positive than beliefs for new technology-market matches with low levels of both superficial and structural similarity. Unsurprisingly, the most positive opportunity beliefs for new technology-market matches have high levels of both superficial and structural similarities.

Thus, as we have argued, differences across possible opportunities are relevant. That is, individuals' cognitive abilities and resources are not the only factors that matter in the formation of opportunity beliefs; information differences about opportunities' underlying elements play an important role in this process as well. Consideration of the ways differences in opportunities impact structural alignment's effectiveness in generating opportunity beliefs complement studies recognizing the role these differences play in opportunity exploitation. For example, Samuelsson and Davidsson (2009) showed that the effects human and social capital have on new ventures' development activities are substantial for ventures going after *innovative opportunities* but not for ventures going after *imitative opportunities*. Further, Dahlvist and Wiklund (2012) validated an opportunity newness measure and revealed that newness correlates with intellectual property protection and patent application. By shifting the focus away from the performance effects of exploitation-relevant differences to the inherent traits of opportunity beliefs for new supply-demand combinations, researchers can more successfully differentiate between the effects of differences across possible opportunities and the effects of individuals' motivations, resources, and capabilities.

## CONCLUSION

In this chapter, we illustrated how individuals' prior knowledge impacts the opportunity-recognition process. While higher levels of knowledge (education) seem to facilitate opportunity recognition generally, different

types of knowledge trigger the recognition of different types of opportunities (e.g., knowledge related to problems of nature can trigger the identification of environmental opportunities, and knowledge related to international markets can facilitate the identification of opportunities abroad). Knowledge related to opportunity recognition can be internal to the entrepreneur but can also be provided by external sources, such as venture capital investors. Moreover, it appears that entrepreneurs' prior knowledge plays an important role in the cognitive process of structural alignment that "connects the known with the unknown" and, in doing so, can facilitate opportunity recognition. In the next chapter, we explore how entrepreneurs' motivation, independently and conjointly with knowledge, impacts entrepreneurial cognition.

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