



# OPPORTUNITY ACKNOWLEDGEMENT AS A COGNITIVE PROCESS OF PATTERN RECOGNITION AND STRUCTURAL ALIGNMENT<sup>1</sup>

DENIS GRÉGOIRE

Ph.D., University of Colorado at Boulder, 2005

Now at Georgia State University, Atlanta, GA

## ABSTRACT

Noting a dearth of research on the cognitive processes that enable entrepreneurs to recognize, discover or even imagine potential opportunities, this dissertation develops and tests a model of opportunity acknowledgement as a cognitive process of pattern recognition, structural alignment and similarity comparison. More specifically, the dissertation reports the results of two studies conducted with experienced life-science and marketing-services entrepreneurs.

Using verbal protocols and content analysis techniques, Study 1 provides *qualitative* evidence that in their efforts to search for, acknowledge, and explain potential opportunities, experienced entrepreneurs effectively align a) the superficial features and structural capabilities of new technologies they learn about, with b) the superficial features and structural needs/problems of markets where they think of applying these new technologies. Interestingly, Study 1 also documents that entrepreneurs use their prior knowledge of markets to transcend the superficial features of the new technologies they learn about, and that to acknowledge opportunities that are not necessarily obvious at a superficial level, but that remain highly coherent at the structural level.

Using a within-subject experimental manipulation embedded in an online survey, Study 2 provides *quantitative* evidence that when presented with information about a new technology and a market where to possibly apply that technology, entrepreneurs' certainty that the information signals a potential opportunity a) augments with increases in the *superficial* similarity between technology and market, and b) augments with increases in the *structural* similarity between the two. Study 2 also demonstrates that, controlling for individual differences in human capital, motivation, self-construct, creative self-efficacy, metacognitive knowledge and overconfidence, entrepreneurs' reactivity to changes in superficial and structural similarity is enhanced with entrepreneurs' prior knowledge of technology.

Taken together, these findings show that entrepreneurs' acknowledgement of potential opportunities involve a cognitive process of structural alignment. Doing so, the dissertation results speak to the importance played by characteristics of opportunities that are cognitively meaningful, and that have an effect on opportunity acknowledgement that is conceptually and empirically distinct from the influence of prior knowledge and other individual characteristics. Seen in this light, the dissertation's model and findings contribute to expand research on the cognitive processes that underpin entrepreneurship, and particularly with respect to the identification, recognition and discovery of potential opportunities. In turn, the dissertation points to interesting avenues for future research, notably on the moderating role that individual differences in knowledge and other cognitive predispositions play in opportunity acknowledgement. Building on the theoretical and methodological framework it provides, the dissertation also has implications for future research in entrepreneurial cognition, in cognitive science, in strategic decision-making, and in entrepreneurship education.

Lastly, the dissertation has important implications for the practice of entrepreneurs, technology transfer officers, consultants and policy officials. More often than not, the most promising and valuable opportunities are those that are *the least obvious*. By studying the cognitive mechanisms that underpin opportunity acknowledgement, the dissertation points to how individuals can mobilize their expertise, prior knowledge and attention to literally transcend the superficial features of markets and new means of supply, and zero-in on the key structural dimensions that underpin sound opportunities. Seen in this light, the dissertation suggests pedagogical exercises to help entrepreneurs and technology transfer officials develop their abilities to acknowledge opportunities that are not necessarily obvious at a superficial level, but that remain highly relevant at a deeper, structural level. By extension, the dissertation points to communication strategies that could help technology transfer officers and policy officials increase the odds that someone will acknowledge those least obvious opportunities that may prove most valuable.

---

<sup>1</sup> This research was funded in part by the Ewing Marion Kauffman Foundation. The contents of this publication are solely the responsibility of Denis Grégoire.

# OPPORTUNITY ACKNOWLEDGEMENT AS A COGNITIVE PROCESS OF PATTERN RECOGNITION AND STRUCTURAL ALIGNMENT<sup>1</sup>

DENIS GRÉGOIRE

Ph.D., University of Colorado at Boulder, 2005

Now at Georgia State University, Atlanta, GA

## EXECUTIVE SUMMARY

What makes entrepreneurs recognize, discover or even create new opportunities?

Whether one talks about individuals starting new firms or existing organizations seeking to expand their offerings, entrepreneurship is affair of *seizing* opportunities. But before an opportunity can be exploited, it must first be perceived, identified, recognized, discovered, or even imagined. In other words, future entrepreneurs must first develop some sort of intuitive '*hunch*' that the potential for exploiting an opportunity is there.

Recent research on this topic has focused on what enables entrepreneurs to identify particular opportunities. By and large, this research points to the key importance of entrepreneurs' prior knowledge. Given a particular technology, for instance, entrepreneurs overwhelmingly tend to identify opportunities in markets that they know about, and have expertise in. By contrast, the same entrepreneurs thinking about the same technology tend to miss equally valuable opportunities in markets that they know less about. Seen in this light, it appears that what allows entrepreneurs to recognize or discover potential opportunities is tied to what they know about these opportunities in the first place.

But is individual knowledge all there is to entrepreneurs' abilities to acknowledge potential opportunities? What about the particular motivations and/or abilities of individual entrepreneurs? Do these play a role, over and above individual differences in knowledge?

---

<sup>1</sup> This research was funded in part by the Ewing Marion Kauffman Foundation. The contents of this publication are solely the responsibility of Denis Grégoire.

In addition, I must acknowledge the pivotal support offered by all those entrepreneurs who so generously accepted to participate in this research. I must also recognize the help and support of several directors of business incubators who supported my efforts vis-à-vis those entrepreneurs. To both groups: you have all my gratitude. If this sort of research is to mean anything, it becomes necessary that it be conducted with '*real-life*' experienced entrepreneurs. Your contribution and the insights you have given me are at the very heart of the findings reported here. I can only pray that others will follow in your footsteps, and kindly agree to participate in future research projects.

And what about the characteristics of these opportunities? Clearly, not all opportunities are alike. Even within a given field of application, some opportunities are more *'obvious'* than others – and that not because individuals know more about these opportunities and/or are better able to see them, but because the very characteristics of these opportunities make them so.

Manifestly, the question 'What makes entrepreneurs recognize, discover or even create new opportunities?' involves a number of variables. On one hand, one must consider all that an entrepreneur brings to the table – from his/her knowledge to his/her background, motivation and abilities. On the other hand, one must also consider the particular characteristics of potential opportunities. Yet, and from a research point of view, little is known about how these variables play in entrepreneurs' effort to search for, acknowledge, and explain potential opportunities.

Considering this issue, academics and consultants have suggested that at its most fundamental level, entrepreneurship rests on some form of *pattern recognition* – a mental process through which entrepreneurs develop their insights about potential opportunities. To date however, empirical research on such mental processes has been limited. While several theoretical papers have made interesting suggestions, there has been little empirical research focusing on how entrepreneurs may use these processes, and that in entrepreneurship-specific situations. As a result, academics, educators and consultants alike have little to offer when it comes to help entrepreneurs develop their intuitive hunches about potential opportunities. In other words, we need to know more about what makes entrepreneurs recognize, discover or even create new opportunities. The purpose of this dissertation is to explore these issues in more detail.

### **Modeling opportunity acknowledgement**

The dissertation develops and tests a model of opportunity acknowledgement as a cognitive process of structural alignment – a cognitive process shown to be particularly useful in drawing inferences about new information in learning and creative thinking. Stated succinctly, the core idea of the model is that entrepreneurs develop their hunches about potential opportunities by comparing what they know and learn about a 'demand side' (i.e., information about a market, its characteristics, needs and problems), and what they know and learn about a 'supply side' (i.e., information about new means of supply, say a new technology, its characteristics, and its capabilities).

Whereas this kind of mental comparison may take place at a sub-conscious level, without individuals being necessarily aware of it, cognitive research has demonstrated that the human mind makes great use of comparisons to understand the world, to learn about it, and to draw practically-useful inferences that can be used to decide what to do in a particular situation. In a

creative problem-solving task, for instance, an individual faced with a new problem may start thinking of problems that he/she has encountered in the past, and for which a solution is known to work. Comparing the old problems with the new one, the individual may identify an old problem that is similar enough with the new situation to suggest a potential solution. In terms of opportunity acknowledgement, this suggests that entrepreneurs may develop their intuitive hunches about potential opportunities by comparing – more or less consciously – what they know and learn about new means of supply (be it a new product or a new service), with information they know and learn about markets where to apply/use these new means of supply. In other words, the acknowledgement of potential opportunity may involve some sort of ‘*matching*’ or ‘*alignment*’ between market demand problems, and supply-side solutions.

But cognitive science has demonstrated that this kind of comparison-based reasoning takes place at two levels, each underpinned by distinct cognitive ‘*mechanisms*’. On the one hand, the human mind focuses on comparing *superficial* features. The central idea of these *superficial features* is that they correspond to basic descriptive information: the objects themselves, along with their characteristics. In terms of opportunity acknowledgement, *superficial features of the demand side* include the consumers in a market, and the characteristics of these consumers. Conversely, the *superficial features of means of supply* include products and services that are offered, the components of these products and services, the characteristics of these products and services, the companies that offer these products/services, their characteristics, etc.

On the other hand, cognition research has demonstrated that the human mind distinctly considers a second type of information, that considering the *structural relationships* between superficial features. In a typical market situation, for instance, consumers (a superficial object) *use* a particular product (a second superficial object). Formally speaking, the verb ‘use’ represents a connection between the two superficial objects. Cognitive scientists label this kind of connection as a *structural relationship*. By extension, a whole hierarchy of structural relationships would be necessary to represent a full market situation. For instance, people in a market use particular products to achieve some particular ends – say some goals or needs, or to solve a particular problem. Likewise, the relationships between the components of a new technology (or of a new service) translate into particular capabilities to achieve certain ends – cause-effect relationships so to speak.

Again, what cognitive scientists have shown is that the mental processing of such higher-order relationships-between-relationships is cognitively distinct from the processing of superficial information. Yet the two categories of superficial features and structural relationships are considered in mental comparisons – and thus influence the kind of inferences that may be drawn.

In terms of opportunity acknowledgement, this implies that entrepreneurs' insights about potential opportunities may be influenced by two kinds of similarity: *superficial similarity* between the features of market and a new means of supply, and *structural similarity* between the goals, motives and needs of a market, and the particular capabilities of new means of supply.

In practice, this means that when both the superficial features and structural capabilities of a new means of supply correspond to the superficial features and structural goals, motives and needs in a market, opportunities should be seen as relatively obvious. Entrepreneurs considering information about such matching of means of supply and market conditions should be relatively certain that this information does indeed signal an opportunity. Conversely, entrepreneurs considering information about means of supply and market conditions that *do not* correspond to one another, neither superficially nor structurally should be relatively certain that this information does signal a non-opportunity.

By contrast, however, one could also encounter information about a new means of supply – say a new technology – that shares a number of superficial features with a given market, but no structural parallel. In such cases, for instance, the components of the technology, the material it uses, the object it produces, or even, the originator of this new technology are very much in line with the superficial features of a market one knows. On this account, then, the match between the technology and this market begins to make some sense. But if the structural capabilities of the new technology do not directly correspond the structural goals, motives and needs of the market, doubts could linger about the opportunity. Accordingly, entrepreneurs should be relatively unsure that the information under consideration signals a potential opportunity.

Yet, entrepreneurs could also encounter situations where a new technology shares few superficial features with market that one knows, but where the two still share strong structural parallels. In such cases, for instance, the components of the technology, the material it uses, the object it produces, or even, the originator of this new technology bear little superficial resemblance with the superficial features of a market one knows. At the same time, however, the same technology has structural capabilities that are highly relevant for that market, capabilities that could solve problems or needs that are poorly addressed under current conditions. Because of the mismatch in superficial features, however, such opportunity would be much less obvious than the pure matches considered above, where both the superficial features and structural capabilities of a technology corresponded to the superficial features and structural needs of a market. And indeed, past research suggests that in general, only those entrepreneurs with extensive knowledge of both the technologies and markets under consideration are able to

acknowledge such non-obvious opportunities. Yet, these non-obvious opportunities are likely to be the most valuable ones, precisely because they are not obvious to would-be imitators.

Taken together, these observations from cognitive research on pattern recognition and structural alignment have important implications for a model of opportunity acknowledgement: over and above individual differences in motivation, abilities and other predispositions, entrepreneurs' insights about potential opportunities may be influenced by the superficial and structural similarities between the means of supply and market conditions involved.

### **Results from two experiments with experienced entrepreneurs**

To test this model of opportunity acknowledgement, I conducted two different experiments with experienced entrepreneurs. Each experiment used a different technique, and focused on a different kind of data. At the same time, both experiments made use of documented cases of real-life technological opportunities. Because the material for the experiments was based on real cases, however, it became important that the entrepreneurs who voluntarily took part in the studies be unlikely to know much about the technologies in questions, the companies involved, and the actual opportunities being pursued by these companies. Given that the material consisted of engineering-based technologies, I conducted the two studies with entrepreneurs operating businesses in the areas of life-science, medical and biological technologies, and in the domain of marketing services.

The first experiment consisted of an opportunity acknowledgement exercise. The exercise presented experienced entrepreneurs with short descriptions of new technologies, and asked them to *'think out-loud'* as they answered the question "what business opportunity(ies) could you pursue with that technology?" Having recorded and transcribed what entrepreneurs had spontaneously thought about in their attempts to identify potential opportunities for these technologies, I was able to study the kind of links, parallels and connections that entrepreneurs made between new technologies, and markets where to potentially apply these technologies.

What this first study revealed is that in their efforts to search for, acknowledge and explain potential opportunities, experienced entrepreneurs use both superficial and structural information. Both dimensions are illustrated in the following sequence – an actual quote from one of the entrepreneurs who participated in the study. The technology under consideration consists of a simulation tool developed by NASA to improve the concentration skills of its Shuttle pilots.

*“You know, given the fact that NASA is interested obviously, there probably are a lot of professions where this could be very important, like for airline pilots*

*Perhaps, flying into space is an area where you would need to be able to have absolute control over your thought process, better than one might without this kind of training.*

*Certainly in NASCAR driving and, anything that requires intense focus, and the ability to control, control your focus so that you can blank out everything that’s going out around you.*

*So there are probably lots of places, like sports training....*

*In fact just think about sports training, look at the, I would argue that... Again, I just happened to go, I’m not a basketball fan but I got invited to the (Denver) Nuggets basketball game on Friday or Saturday night – it’s been a long time since I sat in sort of an NBA professional game.*

*And what was surprising to me was how good the talent on the Nuggets team are, yet, they only applied it about 30% or 20% of the time.*

*And that’s all mental, there’s nothing to it that’s physical: it’s all mental.*

*And yet, if they were able – they won the game – but where they were able to apply, that intensity, for the entire 100% of the game, they would have blown the opposing team out.*

*So I think there are lots of things, I mean sports, school, certainly academics, high intensity activities like, flying in outer space, high speed...”*

What the sequence shows is that at first, the entrepreneur used the superficial features of where the technology had been developed (NASA) and who was using the technology (Shuttle pilots) to think of a market with the same superficial elements (airplane, pilots) and structural needs (need to stay concentrated while flying). But almost immediately, the same entrepreneur began ‘transferring’ his insights to market applications that were progressively less and less *obvious*, at least at a superficial level. Clearly, the superficial similarity between Shuttle pilots and airline pilots is greater than with NASCAR drivers, and then much greater than with professional basketball players. But at the same time, all these markets share the same structural needs for developing individual abilities to stay concentrated.

As the sequence suggests, superficial similarities may provide some basis for entrepreneurial insights. But across all the entrepreneurs who took part in this study, the consistent observation was that entrepreneurs spontaneously emphasized the structurally-relevant similarities between the capabilities of a technology, and the needs and problems that are left poorly addressed in a market. The following excerpts illustrate this emphasis in reference to the same NASA-developed technology.



*“I think about the kind of problems and the kind of needs that are out there and well, you know... certainly, there’s a lot of people that struggle with staying focused and staying concentrated.”*

*“I would like to have this because, when I’m concentrating, skiing down the hill... and I would rent a helmet, that had this neurofeedback that showed me when I’m concentrated or not, because I ski so much better when I’m concentrating on being on the mountain, versus when I’m skiing thinking about work.”*

In sum, this first experiment provides qualitative evidence that in their efforts to search for, acknowledge and explain potential opportunities, experienced entrepreneurs spontaneously consider the alignment between the superficial features of new technologies and markets where to apply these technologies, but eventually place greater emphasis on aligning the structural capabilities of new technologies with the latent goals, motives and needs of these markets.

The second experiment took place within an on-line survey. Experienced entrepreneurs were presented with short paragraphs describing 1) a market with a particular problem, and 2) information about a newly developed technology that could address this problem. Entrepreneurs were then asked to rate how certain they were that the information they had read signaled a potential opportunity – or a non-opportunity. By carefully varying the descriptions of different technologies, the experiment presented entrepreneurs with various combinations of superficial and structural similarities between the technologies and associated markets. After rating four such cases, entrepreneurs in the survey completed a questionnaire asking about their background, education, and demographic characteristics. The questionnaire also captured information about different dimensions of participants’ entrepreneurial motivations, self-characterization, and various cognitive predispositions. All these dimensions were used as control variables in the statistical analyses.

What this second experiment showed is that entrepreneurs’ rating of potential opportunities is consistently influenced by the degree of *superficial similarity* between new technologies and markets where to apply them, as well as by the degree of *superficial similarity* between the two. The more a new technology has *superficial features* that are similar to those of a market where this technology could be applied, the more certain entrepreneurs are that applying this new technology in that market constitutes a potential opportunity. Likewise, the more a new technology has *structural capabilities* that are aligned with the *structural causes* of a latent need/problem in a market, the more certain entrepreneurs are that applying this new technology in that market constitutes a potential opportunity.

Unlike the results from the first experiment, however, there was no evidence here that one effect was dominant over the other, and that structural considerations came to be more important than superficial ones. In practice, the interesting observation is that within the limited-information conditions of the experiment, opportunities that were high on superficial but low on structural similarities were not rated differently than opportunities that were low on superficial, but high on structural similarities. Both types of opportunities were seen as uncertain. What's interesting, however, is that in practice, the latter type of opportunities (low on superficial but high on structural similarities) is shown to be the most promising ones, the ones where real-life businesses were founded around. In turn, this finding points to an important challenge for entrepreneurs: that of acknowledging opportunities that are less obvious than others.

### **Implications for practice**

Before an opportunity can be exploited, entrepreneurs must first develop their hunch that an opportunity is there to be seized. But not all opportunities are alike. Seen in this light, one of the most practical implications of the dissertation is to draw attention to cognitively meaningful reasons *why* some opportunities are less obvious than others, and that over and above individual differences in knowledge, motivation, abilities and other characteristics. This is particularly the case for opportunities where the means of supply involved share high levels of *structural* similarity with the markets where they could be used, but low levels of *superficial* similarity. Because these opportunities are not necessarily obvious, at least at a superficial level, they may be particularly hard to acknowledge. Yet, their non-obviousness may also be what gives them some particularly high value, in that they may prove particularly difficult to imitate. Given this particular challenge, the dissertation has practical implications for three groups of individuals: educators and consultants, technology transfer officers, and entrepreneurs themselves.

From an education and training standpoint, it first appears relevant to consider whether the acknowledgement of less obvious opportunities could be facilitated by the development of particular abilities. In this regard, one could use the material developed for the dissertation to create opportunity-acknowledgement case studies, exercises and other training material. In turn, educators, consultants and other assistance programs staff members could use this material to draw the attention of potential entrepreneurs to the particular challenges of opportunity acknowledgement – and notably the difficulties of acknowledging opportunities across markets and means of supply that share little superficial similarities, but high levels of structural similarity. In addition, it has been suggested that some individuals may be more competent than others in their abilities to reason beyond considerations of superficial similarity. On that basis,

tools could be developed not only to develop the opportunity acknowledgement skills of would-be entrepreneurs, but also, to measure those skills among individuals interested in entrepreneurship. In turn, this could help educators, consultants and other program officials to better assess the needs of their audience, and thus tailor their efforts to those needs.

Over and above the implications of the dissertation for business educators and consultants, this challenge of acknowledging opportunities characterized with low levels of *superficial* similarity may be particularly acute in contexts of technology transfer. Seen in this light, it appears that even before entrepreneurs manifest interest for newly developed technologies, it is technology transfer officers who must face this cognitive challenge. Day in day out, these officers must sift through several new technologies developed by academics and other inventors, only to make a judgment about which technologies they should concentrate on in their licensing efforts. To the extent that they may be less familiar with the technologies, or with all the various markets where these technologies could be applied, technology transfer officers may pay more attention to superficial than to structural considerations. As a result, they may fail to acknowledge the potential of technologies in markets with which they share low levels of *superficial* similarity, but that would still be highly relevant from a *structural* point of view.

By drawing attention to these particular issues, the dissertation may ultimately help technology transfer officers in their efforts to better assess the various technologies they are presented with. To this aim, pedagogical means could be developed to introduce technology transfer officers to these notions, as well as to help them develop their structural alignment abilities. Here again, the dissertation's experimental framework implicitly suggests case studies and exercises that could be developed to teach relevant dimensions of opportunity acknowledgement in general, and of structural alignment in particular.

In addition, the very nature of technology transfer suggests another practical implication. If indeed the acknowledgement of potential opportunities between technologies and markets that share low levels of *superficial* similarity is no small cognitive achievement, then a question arises as to what technology transfer officers could do about it. For instance, does it matter how technology transfer officers communicate information about newly developed technologies that they offer for licensing? In other words, can the content of licensing announcements limit – or expand – the range of market applications that can intuitively be considered for a new technology? By framing an announcement in certain ways, say by emphasizing where a technology comes from and what its first laboratory application had been (superficial cues so-to-speak), technology transfer officers could inadvertently narrow the field of markets that could be considered by potential entrepreneurs. Conversely, messages that would emphasize the

capabilities of a technology – and that across several domains – could effectively encourage the kind of *‘mental leaps’* that characterize non-obvious yet-relevant opportunities. Seen in this light, the results from the dissertation draw attention to how technology transfer officers can communicate information about newly developed technologies. More specifically, the dissertation suggests that technology transfer officers might consider how they frame their licensing announcements to simultaneously downplay superficial information about the technologies, and emphasize its structurally-relevant capabilities.

In the end, however, it is entrepreneurs that must bear the brunt of these challenges. Like technology transfer officers, entrepreneurs could *‘walk past’* promising opportunities, and that not because these entrepreneurs are not as knowledgeable, motivated or able as they should be, but because the very similarities between means of supply and markets make these opportunities cognitively hard to acknowledge. By drawing attention to these issues, the dissertation encourages entrepreneurs to *‘think outside the box’* to think *beyond* the superficially obvious.

Already, the discussion above suggested how case studies, exercises and other education means could be developed to help entrepreneurs develop their abilities to acknowledge opportunity matches characterized by low levels of *superficial* similarity, but high levels of *structural* similarity. In addition, discussing technology transfer officers’ efforts to license newly developed technologies drew attention to the form in which information about new technologies was communicated. By extension, one could surmise that entrepreneurs face similar challenges when communicating their ideas to eventual financial backers, suppliers, partners and/or consumers. If indeed, the characteristics of particular opportunities make these opportunities cognitively difficult to acknowledge, entrepreneurs could face significant difficulties in their efforts to communicate their business ideas, and generate interest for it. Along the lines developed above, the results from the dissertation suggest that in their interaction with eventual financial backers, suppliers, partners and/or consumers, entrepreneurs could be well advised to emphasize the structural parallels underpinning the opportunities they wish to pursue.

In the end, the dissertation’s most potent impact lies in drawing scholars’ and practitioners’ attention to characteristics of opportunities which, over and above individual’s resources in prior knowledge, expertise, motivation and other abilities, may contribute to make promising opportunities more (or less) obvious. Seen in this light, the dissertation highlights the particular cognitive challenge that entrepreneurs face in their efforts to search for, acknowledge, and eventually communicate their ideas about valuable opportunities. Ultimately, the dissertation’s results suggest concrete means to help entrepreneurs face this important challenge.