



Learning asymmetries and the discovery of entrepreneurial opportunities

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Abstract

Discovering entrepreneurial opportunities requires that individuals not only possess some form of prior knowledge, but that they also have the cognitive abilities that allow them to value and exploit that knowledge. This article builds upon and extends this line of inquiry by examining the relationship between opportunity identification and learning. Based upon an experimental task and other data collected from 380 technology professionals, the article defines a relationship between how individuals acquire and transform information and experience (i.e., learning) in order to identify opportunities. After analyzing the empirical data, the article develops the concept of learning asymmetries and explains how the manner in which people learn may affect their ability to identify entrepreneurial opportunities.

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1. Executive summary

Discovering opportunities to develop a product “not-yet-in-existence” and subsequently creating a venture is a multifaceted endeavor. Current theoretical and empirical work in entrepreneurship suggests that the study of cognitive mechanisms and their interactions

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with an individual's existing knowledge base are important pieces in the puzzle of opportunity identification. This study builds upon this base by exploring the relationship between opportunity identification and the learning process.

Augmenting the extant research on knowledge with an investigation of how learning affects opportunity identification is important because, depending on how individuals use their knowledge, it can be either a bridge on the road to entrepreneurship or a detour that takes them on a fruitless path (Ward, 2004). As such, and with an understanding that individuals can acquire and transform information and knowledge in distinctly different manners (Allinson and Hayes, 1996; Kolb, 1984), this article investigates the effect these differences in learning have on the discovery of opportunities. Building on theory borrowed from psychology, the study shows that an individual's ability to identify opportunity is dependent not just upon knowledge (Shane, 2000), but also upon the *process* through which individuals acquire and transform their information and knowledge (i.e., learning).

The results of the paper provide support for previous theoretical arguments regarding learning and opportunity (Corbett, 2005) and extend existing empirical work on prior knowledge. Perhaps most importantly, just as Shane's (2000) work illustrated the role that knowledge asymmetries play in the opportunity recognition process, this article demonstrates that learning asymmetries also affect the discovery of opportunities.

Beyond scholarship, this article has implications for practitioners in the field. The findings of this study suggest that the manner in which learning affects opportunity identification has implications for how we should view the entrepreneurial process, how entrepreneurial teams are built, and how human resource managers make decisions with regard to internal ventures. The implications of these findings for entrepreneurs, corporate intrapreneurs, investors, and other stakeholders associated with the process of bringing new products and services into being are discussed.

2. Introduction

The identification of opportunities that initiate entrepreneurial ventures is the key to the engine that starts new businesses; opportunity recognition is the progenitor of both personal and societal wealth (Venkataraman, 1997). While the effects of opportunity identification can have a broad impact on society, it is an issue that requires study from an individual level due to its inherent reliance on individual cognition (Mitchell et al., 2002; Shane and Venkataraman, 2000; Shaver and Scott, 1991).

Since the move away from focusing on the traits of the entrepreneur and towards the entrepreneur's behavior (Gartner, 1988), researchers have made great progress in identifying the cognitive factors and behaviors most relevant to entrepreneurship. Knowledge (Ardichvili et al., 2003), expert scripts (Mitchell et al., 2000), alertness (Gaglio and Katz, 2001), intentions (Shepherd and Krueger, 2002), cognitive mechanisms (Baron, 1998), and cognitive infrastructure (Krueger, 2000) are just a handful of the important triggers that have been identified within the process of entrepreneurship.

The exemplary contributions these scholars have made by linking cognition and entrepreneurship belie the fact that little empirical work has appeared in peer-reviewed

journals investigating cognition and opportunity identification (Busenitz et al., 2003; Gaglio, 1997). In addition, research examining learning and entrepreneurship is at a preliminary stage (Agndal, 1999; Minniti and Bygrave, 2001) and the research on learning's impact on opportunity identification is scant (Corbett, 2005; Ravasi and Turati, 2005).

The current study addresses this breach by empirically investigating how individuals acquire and transform information (i.e., learn) and how this process interacts with an individual's existing knowledge (human capital) to affect the discovery of opportunities. The goal of this paper is to extend entrepreneurship research by examining the relationships between how an individual's preference for information acquisition, preference for information transformation, and knowledge are related to opportunity identification. After a brief review of the opportunity literature, experiential learning theory is explored and then used to build hypotheses related to opportunity identification. This is followed by an explanation of the methodology, analysis and results, and finally, a discussion of the implications of this work.

3. Opportunity identification

Opportunity identification is central to the domain of entrepreneurship research. At its core, entrepreneurship revolves around the questions of “why, when, and how opportunities for the creation of goods and services in the future arise in an economy. . .” (Venkataraman, 1997). Gaglio and Katz (2001) argue that understanding the opportunity identification process is one of the primary questions within the province of entrepreneurship. This awareness of the importance of opportunity to entrepreneurship has spurred numerous investigations of one's ability to identify opportunities.

Over the past decade, researchers have examined opportunity identification with respect to creativity (Hills et al., 1998), motivation (Kuratko et al., 1997) alertness (Gaglio and Katz, 2001), risk (Mullins and Forlani, 2005), and financial reward (Shepherd and DeTienne, 2005). Of most importance to the current study, a few researchers have conducted empirical investigations of the relationship between opportunity and knowledge (Shane, 2000), opportunity and human capital (Davidsson and Honig, 2003; Dimov and Shepherd, 2005), and opportunity and learning (Dimov, 2003).

Shane's (2000) results confirm theoretical speculation (Ardichvili et al., 2003; Hayek, 1945; Venkataraman, 1997) that different types of prior knowledge will affect the manner in which one identifies opportunities. Shane shows that an individual's knowledge about existing markets, how to serve that market, and knowledge about customers' problems will influence the opportunities one discovers. Davidsson and Honig (2003) demonstrate the importance of using specific human capital to exploit opportunities. Dimov and Shepherd (2005) demonstrate that general human capital is related to the exploitation of opportunities. Dimov's earlier work on learning (2003) examined the identification of opportunities. In this study, he suggested that while knowledge and human capital are important, how that knowledge is applied is perhaps more important. Dimov's research, which consisted of a small sample of graduate students, provides an excellent platform from which to conduct a larger study. His study, taken together with recent work theorizing

about the potential linkages between experiential learning theory and opportunity (Corbett, 2005), demonstrates a need for a large scale empirical study that examines learning and opportunity identification.

4. Experiential learning theory

Kolb (1984) explains that learning is grounded in experience and that learning occurs and new knowledge is created when an individual acquires information and transforms it with existing knowledge. He states that it is often tempting to think about an individual's mind as a blank slate but, in fact, all learning is actually re-learning, because knowledge already exists within the mind. Kolb argues that the process of experiential learning consists of three distinct elements: (1) the existing knowledge, (2) the process through which individuals acquire new information and experiences, and (3) the manner in which individuals transform new information and experiences into new knowledge.

In the experiential learning process, new knowledge is created when information is first grasped through the *apprehension* of a concrete experience or the *comprehension* of an abstract conceptualization (Kolb, 1984). The concept of prehension refers to two different modes in which an individual can acquire information in the world—either through direct experience or through a recreation of experiences. Kolb (1984) uses the example of what you are doing right now—reading—to illustrate the differences in these two learning modes.

If you put down this book, get up from the chair, and leave the room, your apprehensions of that situation will vanish without a trace (substituted for, of course, by new apprehensions of the hallway or whatever new immediate situation you are in). Your comprehension of that situation, however, will allow you to create for yourself and communicate to others a model of that situation that could last forever. (1984:43)

Once an individual has acquired new information or experiences, Kolb (1984) explains it must then be transformed via *intention* or *extension*. Kolb describes intention as a process of internal reflection, whereas extension can be seen as a manipulation of the external world. He explains that individuals who rely more on intention to transform their experiences tend to be oriented to “intellectual operations” and they are less concerned with the external objective reality. Conversely, individuals who tend toward extension are keen to “behavioral actions” and are outwardly oriented, sociable and comfortable with interpersonal relations. Kolb notes that these two styles of transforming are akin to the concepts of introversion and extraversion (1984:52).

In the next section, the hypotheses that will be tested are developed based upon the three elements of Kolb's experiential learning theory (existing knowledge, acquisition, and transformation) and their relationship to opportunity identification. Fig. 1 provides a representation of the model.

Opportunity recognition has been defined as the ability to identify a good idea and transform it into a business concept that adds value and generates revenue (Lumpkin and Lichtenstein, 2005). Since experiential learning theory examines the different manners in which individuals acquire and transform new information, it provides a cogent theoretical

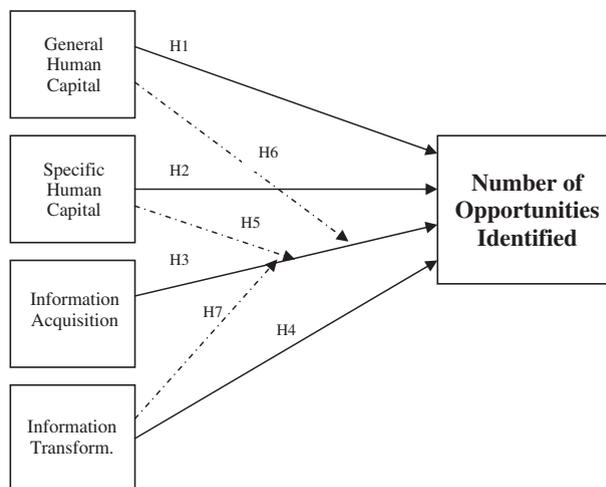


Fig. 1. The process of learning and the discovery of opportunities.

platform for investigating individual variance within the process of opportunity identification.

5. Experiential learning theory and opportunities—hypothesis development

The primary tenet of experiential learning theory is that learning occurs when new information or experience is acquired and transformed with an existing knowledge base. Kolb notes that “the figurative grasp or operative transformation alone is not sufficient. The simple perception of experience is not sufficient for learning... (1984: 42).” Therefore, hypotheses representing each of these constructs—knowledge, acquisition, and transformation—are developed below.

5.1. Knowledge and human capital

Becker’s (1964, 1993) theory of human capital extended microeconomic analysis to a wide range of human behavior and suggested that knowledge can increase cognitive ability and lead to more effective activity. When identifying opportunities for entrepreneurial ventures, one’s existing knowledge base is crucial to opportunity identification because it serves as a base for interaction with new experiences (Kolb, 1984) and we use it as a foundation to interpret and understand new stimuli (Cohen and Levinthal, 1990).

Many scholars have examined the influence of human capital within the process of entrepreneurship (Brüderl et al., 1992; Cooper et al., 1994; Dahlquist et al., 2000; Davidsson and Honig, 2003; Greene and Brown, 1997). Greene and Brown (1997) put forth propositions regarding the varying need for human capital across different types of entrepreneurs. A number of the studies examine the effect that human capital has on the failure, survival, and the possibilities for high growth of new ventures (Brüderl et al.,

1992; Cooper et al., 1994; Dahlquist et al., 2000). Davidsson and Honig (2003) measured the relationship between both human and social capital to nascent entrepreneurial activities and eventual exploitation of opportunities.

Given all of this previous research on human capital and entrepreneurship it might appear that another test of human capital would only provide confirming results. However, as Davidsson and Honig (2003) point out, while previous research seems to support a relationship between human capital and entrepreneurship, the results have not been consistent. Additionally, only a few studies have examined the specific relationship between human capital and the identification of opportunities (Ardichvili et al., 2003; Davidsson and Honig, 2003; Shane, 2000).

In a conceptual article, Ardichvili et al. (2003) provide four detailed propositions regarding human capital and its relationship to opportunity recognition. The authors propose that (1) special interest knowledge and general industry knowledge; (2) prior knowledge of markets; (3) prior knowledge of customer problems; and (4) prior knowledge of ways to serve markets will all increase the likelihood of successful entrepreneurial opportunity recognition.

Shane's (2000) empirical investigation of prior knowledge and entrepreneurial discovery investigates the last three of the propositions put forth by Ardichvili and his colleagues. Shane's investigation of a 3-dimensional printing (3DP) process patented by MIT faculty illustrates how different individuals recognized different opportunities based on the same technical innovation. By corroborating case studies from eight entrepreneurs with archival data detailing their process of recognizing and attempting to exploit the 3DP technology, Shane provides evidence for Ardichvili et al.'s proposition regarding the necessity of prior market knowledge, knowledge of customer problems and the importance of knowing ways to serve a market that are both crucial to opportunity recognition.

Davidsson and Honig's (2003) results were mixed. They showed support for a relationship between both education and start-up experience and the nascent activity of opportunity search. However, a relationship between finding opportunities and successfully exploiting them was non-existent. In attempting to place their findings in line with other results, these authors suggest that different types of human capital may be more or less effective at different stages of the entrepreneurship process. Fortunately, others have already made these distinctions.

Both Brüderl et al. (1992) and Cooper et al. (1994) defined human capital more specifically, delineating it into general human capital (basic skills) and specific human capital (industry-related or technically related skills). The current study follows these works by examining these two constructs during the initial phase of the entrepreneurship process—opportunity identification. The first hypothesis investigates the general human capital construct.

Hypothesis 1. There will be a positive relationship between an individual's level of *general human capital* and the number of opportunities identified.

Recall from above that Ardichvili et al.'s work theorized a relationship between special interest industry knowledge and the discovery of opportunities. However, this proposition was outside of the scope of Shane's study. Therefore, Hypothesis 2 is offered to investigate

the relationship between the more specific industry- or technology-related knowledge capital and the discovery of opportunities.

Hypothesis 2. There will be a positive relationship between an individual's level of *specific human capital* and the number of opportunities identified.

5.2. Acquiring information and experiences

Kolb (1984) theorizes that the learning process begins when an individual first acquires new information or experience. He explains that individuals acquire this new experience through one of two ways—apprehension or comprehension. Recall that apprehension is a reliance on the tangible, felt qualities of immediate experience. Conversely, comprehension refers to a reliance on conceptual interpretation and symbolic representation of experiences.

It is this reshaping of information and experiences inherent within comprehension that has primacy for opportunity identification. When individuals acquire information through comprehension, they are relying on their ability to think through abstract concepts and reinterpret prior information. When individuals acquire information through apprehension, they rely on their feelings to digest the direct, concrete occurrence that they are currently experiencing. Based on these contrasting modes, the current study posits that differing abilities to discover opportunity result partially from the fact that individuals tend to rely on one or the other of these modes (Kolb, 1984). While the process of apprehension develops unique personal knowledge, this mode is more restrictive than comprehension. Those who rely on comprehension have a forward-looking schema that uses past knowledge to help make sense of newly acquired information (Kolb, 1984). Their more critical eye leads to the third hypothesis.

Hypothesis 3. Individuals with an information acquisition preference that tends more toward *comprehension* will identify more opportunities than individuals with an information acquisition preference that tends more toward *apprehension*.

5.3. Transforming information and experiences

According to Kolb (1984), after information or experience is acquired, it is then transformed and combined with existing knowledge through either intention or extension. He explains that individuals who favor *intention* are primarily concerned with avoiding failure. These individuals have a “willingness to sacrifice opportunities” and are “socialized to avoid ‘irresponsible’ errors” (p. 56). When transforming information via intention, individuals search for the one “best” answer. Conversely, those who favor *extension* disregard the notion of failure and are only concerned with maximizing success. These individuals examine many alternatives and recognize the possibility for more than one answer.

These two dimensions of intention and extension are aligned with previous entrepreneurship research that examined entrepreneurs use of either a promotion or prevention mindset (McMullen and Shepherd, 2002). These scholars show that

entrepreneurs tend to be *promotion* focused; that is, they tend not to think about failure and instead see the potential success in a multitude of opportunities. Non-entrepreneurs tend to have a *prevention* focus that is more concerned with avoiding failure and not identifying as many opportunities. As such, it is hypothesized here that individuals who tend toward extension are likely to find more opportunities than those who favor intention.

Hypothesis 4. Individuals who transform information via *extension* are likely to identify more opportunities than individuals who transform via *intention*.

5.4. Concomitance

Whereas the current study posits that each of the constructs of general human capital, specific human capital, information acquisition and information transformation has a direct relationship to opportunity identification, the theory from which these hypotheses are derived proposes that there is a concomitance of learning as well. Experiential learning theory suggests that an individual's mode of acquiring information does not act in isolation from his or her knowledge or transformation preference (Kolb, 1984).

Additionally, Cohen and Levinthal (1990) remind us to be cognizant of the recursive nature of one's existing knowledge and ability to acquire new information. Their concept of absorptive capacity tells us that one's ability to acquire new information is dependent upon one's existing knowledge base. As such, hypotheses with interaction effects between information acquisition and both of the human capital constructs are offered. Hypothesis 5 theorizes that an individual with a high level of specific human capital will be additionally aided in his recognition abilities by an information acquisition preference of comprehension. When this individual's critical schema is applied to his high level of specialized knowledge, the result should be an ability to recognize many more opportunities than someone with the less-critical mode of apprehension. Hypothesis 6 examines general human capital in the same manner. The formal statement of these hypotheses is below.

Hypothesis 5. Increased levels of *specific human capital* will moderate, in a positive manner, the relationship between the *comprehension information acquisition* and the number of opportunities identified.

Hypothesis 6. Increased levels of *general human capital* will moderate, in a positive manner, the relationship between the *comprehension information acquisition* and the number of opportunities identified.

The final hypothesis examines the interaction of information acquisition and information transformation. Experiential learning theory tells us that those who acquire information through comprehension are more interpretive than those who use apprehension. Additionally, the theory explains that those who favor extension look at many pathways to create new meaning, whereas those who favor intention often search for one specific "right" answer.

Therefore, it is hypothesized that when the open-minded, global perspective of extension is combined with the interpretive behavior of comprehension, more entrepreneurial opportunities will be identified.

Hypothesis 7. An *extension transformation* preference will moderate, in a positive manner, the relationship between an individual's *comprehension acquisition* preference and the number of opportunities identified.

6. Methodology

When developing an empirical investigation of opportunity identification, care must be taken to avoid the problems and conflicting results of previous research (Busenitz, 1996; Gaglio and Katz, 2001). Eckhardt and Shane (2003) assert that longitudinal studies, experiments, or simulations are all appropriate techniques for empirical investigations of opportunity. Gaglio and Katz (2001) instruct scholars to consider qualitative methods and to use approaches that require individuals to think, as opposed to just recalling past experiences. As such, the current study employs a survey with an embedded quasi-experiment that requires individuals to identify entrepreneurial opportunities.

6.1. Sample

A random sample of 1,592 founders, owners, top management team members, engineers, and researchers of technology-based firms was used in this study. The sample frame for this study came from the 1,559 usable listings for Colorado-based businesses in the 2002 Rocky Mountain High Technology Directory. Each of 1,559 records contained multiple contacts for each company (for example, the founder, CEO, manager, engineer, etc.) and yielded 3,184 contacts. The instrument was mailed to a computer-generated, random selection of 50% of the individuals listed in the sample frame. The sample frame was created to include various technical professionals from all levels of organizations to ensure heterogeneity in the human capital variables.

6.2. Descriptive statistics

The total number of usable returned instruments was 380. With 83 others returned due to incorrect addresses, this equates to a response rate of 25.2%. The firms represented four primary classifications of industries. Engineering/R&D firms made up 35% of the sample, while computer hardware firms represented 24% of the sample. Software firms and technical equipment manufacturers comprised 20% and 21% of the sample, respectively. Annual sales for each firm ranged from less than \$100,000 to over \$3,000,000,000, while the number of employees in each firm ranged from 1 to more than 20,000. Nearly a third of the individuals in the sample (31.3%) were original founders of the firm, while just over half (51.8%) were at least part owners of the firm, with a mean ownership stake of 43.2%.

The sample was predominantly male (84%) and highly educated (with 85% holding at least a bachelor's degree).

6.3. Independent variables

In this study, four independent variables (general human capital, specific human capital, information acquisition preference, and information transformation preference) are measured in relation to the dependent variable (number of opportunities recognized). Since the study examines individual-level phenomenon it controls for firm level and industry effects (firm age, firm size, and industry).

6.3.1. General human capital

Becker (1964) states that experience and job training are the two most important aspects of general human capital. Other studies have stressed the importance of age (Cressy and Storey, 1995) and experience (Cooper, 1981; Westhead, 1995) to the construct of general human capital. In accordance with these works, general human capital was captured in this study using an index of each individual's age, job level, years in their current job, years with their current firm, and years in their current industry.

6.3.2. Specific human capital

Previous entrepreneurship research has argued that specific human capital can be defined as an individual's level of industry or technical related knowledge or skill (Brüderl et al., 1992; Cooper et al., 1994). The quasi-experiment in this study focuses on the Bluetooth protocol. As such, specific human capital was measured through a series of questions regarding experience and familiarity with Bluetooth. A seven point Likert scale was used.

6.3.3. Learning acquisition mode

This variable was captured by using a normative version (Geiger et al., 1993) of Kolb's Learning Style Inventory (1985). The 24 independent statements regarding one's preferred manner of information acquisition were scored on a 7-point Likert scale to determine a preference for either apprehension or comprehension. Previous studies have supported the high reliability, validity, and internal consistency of this version of Kolb's Learning Style Inventory (Pickworth and Schoeman, 2000; Willcoxson and Prosser, 1996).

6.3.4. Information transformation

The Cognitive Style Index (CSI) measures how individuals transform information and experience (Allinson and Hayes, 1996; Messick, 1984; Sadler-Smith and Badger, 1998). Dozens of samples across numerous studies support the reliability and construct validity of this instrument (Allinson and Hayes, 1996; Armstrong, 2000; Murphy et al., 1998). Using 38 questions, the CSI measures the dimensions of transformation by capturing whether an individual transforms in (1) a focused, constrained, formal manner based on mental reasoning and detail, or an (2) expansive, unconstrained, informal manner based on feeling and an adoption of a global perspective. The former maps Kolb's construct of transforming via intention and the latter matches the process of extension.

6.4. Dependent variable

Prior studies (Hills and Shrader, 1998; Singh et al., 1999a,b) that isolated the number of opportunities an individual can identify required subjects to recall the number of opportunities they identified in the past. Methodological designs such as this have inherent flaws due to biases of recall and retrospection (Goodwin, 1998) and the problem of the “good subject” (Orne, 1962). As such, Gaglio and Katz (2001) instruct scholars to use approaches that require individuals to think, as opposed to using procedures that rely on recall.

Taking this direction, the quasi-experiment designed in this study asked each respondent to list as many new business or product opportunities as he or she could, based upon a description of the Bluetooth wireless protocol (Fig. 2 shows the quasi-experiment). Although the entire sample came from high technology professionals, the range of familiarity and knowledge of Bluetooth (specific human capital) ranged from none to significant, due to the fact that respondents came from various high technology fields, not just telecommunications or computing. Three expert raters, all of whom have technological entrepreneurship experience, judged the ideas that the respondents listed. The process required the principal investigator to transcribe all these handwritten ideas, develop a rating form to allow independent experts to rate each idea, and then perform an inter-rater reliability procedure to ultimately construct a dependent variable for each respondent.

6.4.1. Preparing the data for judgment

After the data was entered for all variables, the principal investigator created a spreadsheet and entered the ideas listed from the 380 respondents. Detailed instructions

Finding New Opportunities

In this section we would like to examine your ability to find new potential business opportunities. After reading the passage below on a new emerging technical protocol, take a few minutes to list any potential business opportunities based on this protocol that come to mind. The ideas you list may or may not be related to your current business.

Please note: It is extremely important for the validity of this survey that you take a few minutes to think creatively and try to answer this question as fully as possible. **The remaining questions will only ask you to tick boxes or provide one-word answers.** After taking a few minutes on this one question you will be done with this survey shortly. Thank you again for your consideration.

A wireless technology is currently being developed that operates over radio waves. This technology will allow all electronic devices to “talk” with one another without cable connections. One example of a business opportunity that has come from this technology is now your can connect to the internet on a portable computer wherever you are without being connected to a cable.

17. Use the following space to list any ideas for new products, services, or business opportunities based on the above technology. List all ideas that come to mind and list each separately as #1,#2, and so forth.

Fig. 2. Experiment on identifying opportunities.

and coding sheets for each respondent were then created so that each expert rater could judge each idea by answering basic questions. Prior to the rating, each rater was briefed on the objective of the task before they were given the detailed instruction sheets and examples. Each rater was also taken through a number of examples to confirm what was expected of him. Each rater was given 794 pages of material, which consisted of 1,454 ideas listed by 380 respondents.

6.4.2. Inter-rater reliability

Upon the return of the coding sheets from the experts, the principal investigator then compared the 2400 pages of judgments. The process of determining inter-rater reliability was followed according to protocols established by previous research (Armstrong et al., 1997; Robinson, 1998; Sandberg, 1986). The judgment of the three raters had an initial inter-rater reliability of 89.1%, which is well within the acceptable range. Subsequently, the raters further discussed the items that were in disagreement until they reached 100% agreement.

7. Analysis and results

Correlation analysis and results from the regression analysis are reported in Tables 1 and 2. Multicollinearity diagnosis was applied and the variance inflation factors (VIF) for each of the variables were all below 1.5, which is well within acceptable ranges (Hair et al., 1998).

Table 2 shows the results for the base model (control variables), the independent effect model, and the full interaction effect model. Before proceeding to a discussion of the regression analysis, one important note should be clarified with regard to the information acquisition measure and its correlations. The CSI provides each individual with a score ranging from 0 to 76. A score of zero is at the extreme end of the “extension” scale, whereas a score of 76 is the other theoretical extreme (“intention”). Due to the manner in which the CSI is scored, the lower one’s score, the more he or she tends toward extension and conversely, the higher one’s score, the more one tends toward intention. As such, any negative statistics in this measure represent a tendency toward the extension manner of transformation. For example, the $-.111$ correlation between information transformation and opportunities recognized means that the more

Table 1
Descriptive statistics and correlations

| | Mean | S.D. | 1 | 2 | 3 | 4 |
|-----------------------------|-------|------|--------|--------|---------|--------|
| 1. Opportunities recognized | 3.79 | 2.64 | – | | | |
| 2. General human capital | 17.07 | .699 | .045 | – | | |
| 3. Specific human capital | 1.87 | .974 | .182** | .022 | – | |
| 4. Info transformation mode | 38.01 | 12.8 | –.111* | .001 | –.156** | |
| 5. Info acquisition mode | 3.19 | 7.91 | .105 | .152** | –.303 | .438** |

* $p < .05$.

** $p < .01$.

Table 2
Regression analysis of opportunities recognized

| | Base model | Independent effects | Full model |
|-------------------------|------------|---------------------|------------|
| Equipment manufacturer | .029 | .020 | .041 |
| Software development | .118* | .059 | .051 |
| Hardware manufacturer | .128* | .088 | .074 |
| Firm age | .152** | .155** | .155** |
| Sales | .101* | .075 | .073 |
| General human capital | | .071 | .098 |
| Specific human capital | | .128** | .146** |
| Info acquisition mode | | .178*** | .166** |
| Info transform mode | | −.164** | −.155** |
| Info acq*specific HC | | | .121** |
| Info acq*general HC | | | −.076 |
| Info acq*info transform | | | .134** |
| R ² | .051*** | .105*** | .129*** |
| ΔR ² | | .054*** | .024*** |

* $p < .10$.

** $p < .05$.

*** $p < .01$.

one tends toward an extension style, the greater the number of opportunities one will recognize.

Accepted statistical procedure (Aiken and West, 1991; Cohen and Cohen, 1983) states that the results from the full model should be used to interpret both the direct effects and the interaction effects when the results show a contribution above and beyond the main effects model. This is the case in the current study, as the model shows a contribution above and beyond the main effects model so that the entire model explains approximately 13% of the variance. By following this procedure and examining the last column of Table 2, the data provides statistical support for two interaction effects (Hypotheses 5 and 7), while finding support for all main effects except Hypothesis 1 (general human capital).

Hypothesis 5 states that specific human capital will moderate the relationship between an individual's comprehension information acquisition preference and the number of opportunities identified. The standardized regression coefficient for the interaction of information acquisition and specific human capital is statistically significant (beta = .121, p value of .043); thereby supporting the presence of the interaction. Similar to Hypothesis 5, Hypothesis 7 tested the combined effect that the comprehension information acquisition preference and the extension information transformation preference would have on one's ability to recognize opportunities. Again, like Hypothesis 5, the standardized regression coefficient for this Hypothesis 7 shows that this interaction is statistically significant (beta = .134, p value of .023).

7.1. The nature of the interactions

In accordance with the procedures for interpreting interaction effects (Baker and Cullen, 1993; Cohen and Cohen, 1983), each of the relationships was plotted by calculating “high” and “low” points for each of the variables (plus and minus one standard

deviation from their mean) using the standardized regression coefficients reported in Table 2. Following this procedure, each calculation yields four points for each interaction effect that can then be plotted on a standard x - y axis.

The plot for the interaction effect of Hypothesis 5 is shown in Fig. 3. Information acquisition is graphed with two lines: the solid line represents the preference for apprehension and the dotted line represents the preference for comprehension. The result shows that individuals with higher levels of specific human capital will recognize more opportunities than those with lower levels of specific human capital, as Hypothesis 2 posited. This result only tells part of the story, however. Fig. 3 shows that the manner in which one acquires information has a large interaction effect on specific human capital within the context of opportunity recognition. The solid line representing the apprehension preference shows very little interaction effect with specific human capital. However, the dotted line representing the comprehensive preference shows a dramatic difference in the number of opportunities recognized. Succinctly stated, individuals with high levels of specific human capital will recognize many more opportunities if they also use a comprehension information acquisition mode as opposed to an apprehension mode.

Similar to the plot for Hypothesis 5, Fig. 4 represents the plots for Hypothesis 7, with number of opportunities on the y -axis and cognitive style on the x -axis. Again, information acquisition is graphed with two lines: the dotted line represents the mode of comprehension and the solid line represents the mode of apprehension.

In this instance, the strength of the interaction lies in the effect on those who have a preference for apprehension. The plot shows that those who employ an extension transformation style recognize more opportunities than those who employ an intention style as predicted by Hypothesis 4. The interaction with information acquisition again demonstrates a dramatic shift though not in the manner predicted by Hypothesis 7. If one acquires information through comprehension the interaction effect of transformation is negligible. However, the solid line shows that individuals with an apprehension learning mode will recognize significantly fewer opportunities if they also employ a preference for transforming via intention. The results corroborate the finding that extension is the preferred information transformation process for identifying opportunities and suggest that

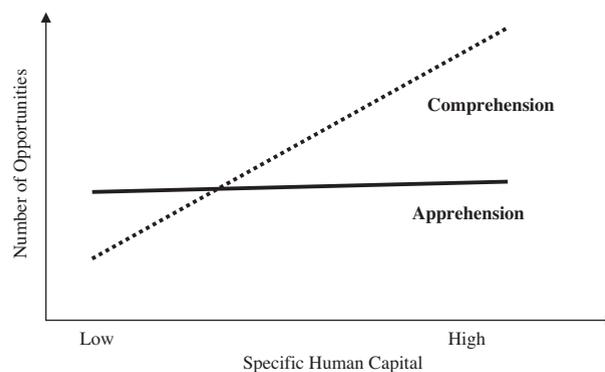


Fig. 3. Interaction of information acquisition preference and specific human capital on number of opportunities recognized.

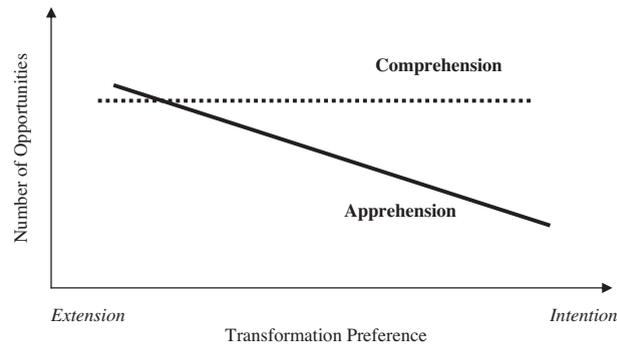


Fig. 4. Interaction of information acquisition and information transformation on number of opportunities recognized.

it is the information acquisition preference that is responsible for much of the difference in ability to identify opportunities.

8. Discussion

The analysis shows support for three of the four direct hypotheses, two of the three proposed interactions, and provides evidence for the importance of learning in the opportunity recognition process. Below, these results are put into context with the extant literature in order to illustrate what they mean for both researchers and practitioners.

8.1. Human capital and learning during the opportunity identification and exploitation process

Shane's (2000) work illustrates that an individual's existing knowledge about a market, how to serve that market, and knowledge of problems of customers in that market are related to one's ability to identify an entrepreneurial opportunity. Extending Shane's work, the current study shows that an individual's specific human capital also affects the discovery of entrepreneurial opportunities. When put in the context of other research, the study also shows that different forms of human capital may be more or less useful during different parts of the entrepreneurship process as Davidsson and Honig suggest.

Hypothesis 2 illustrates that an individual's technical knowledge—his specific human capital—is directly related to his ability to recognize opportunities. The uncoupling of general and specific human capital in this study is important because while previous research seems to support a link between human capital and entrepreneurial endeavors, conflicting results abound (Davidsson and Honig, 2003). For instance, Davidsson and Honig's results stress the importance of specific human capital for exploitation of an initial nascent opportunity. Recently, however, in Dimov and Shepherd's (2005) study examining human capital variables and initial public offerings, it is shown that general human capital is best for exploitation while specific human capital has no significance. The results of the current study might seem to add to this confusion, since general human capital had no

relationship with opportunity recognition, while specific human capital was significantly related.

However, when examined together, a pattern begins to emerge about the usefulness of different forms of human capital during different phases of the entrepreneurship process. Davidsson and Honig (2003) asked the question directly, wondering whether “different types of human capital may be more appropriate at various stages in the entrepreneurial process.” When added to the existing base of research, the results of this study suggest that the answer to this question is likely to be “yes.” The current study suggests that when initially identifying an opportunity, specific human capital is important, and certainly more useful than general human capital. However, as the entrepreneurial endeavor matures, general human capital becomes more important as the entrepreneur and his investors attempt the ultimate exploitation when exiting the venture (Dimov and Shepherd, 2005). It appears that as the entrepreneur and his opportunity emerge, grow, and mature over time, learning when to rely on specific or general human capital is crucial.

The results from Hypothesis 5 also support the speculation stated above regarding the importance of learning and human capital. Hypothesis 5, the interaction between specific human capital and information acquisition, shows that it is not just what one knows (specific human capital) but also the process through which one acquires new information that matters with respect to identifying opportunities. As Ward (2004) states, all prior knowledge is not created equal; what matters is what you do with the knowledge. Do you learn from it? The results of this study bear out Ward’s thesis. If only the knowledge construct was examined, one would expect two individuals with high levels of specific human capital to recognize a similar number of opportunities. However, the interaction with information acquisition mode (Fig. 3) shows that this is not necessarily true, because those with high specific human capital and a comprehensive preference far outperform those with high specific human capital and an apprehensive preference.

This finding has implications for scholars because it extends Shane’s work by demonstrating that while knowledge is important, the mode in which one acquires new information and learns is also significantly related to opportunity recognition. Additionally, it opens up a potential line of inquiry with respect to the results of Davidsson and Honig and Dimov and Shepherd. How much more could we as a community understand about the process of entrepreneurship if studies were to be conducted examining the concomitance of learning and human capital in the later phases of the entrepreneurship phenomenon?

8.2. Information transformation, learning and opportunity

In much the same way that specific human capital and information acquisition affect the discovery of opportunities, the results from Hypotheses 4 and 7 show that the manner in which an individual transforms new information and combines it with existing knowledge also affects opportunity identification. For nearly two decades, scholars have been theorizing about the importance of the entrepreneur’s mental make-up and the unity between cognitive psychology and entrepreneurship (Baron, 1998; Mitchell et al., 2002; Shane and Venkataraman, 2000; Shaver and Scott, 1991; Venkataraman, 1997). The current study supports some of this conjecture by providing empirical evidence that

suggests that differences in the transformation of information and experiences do matter with regard to opportunity identification.

Shane and Venkataraman (2000) theorize that in order to discover opportunities one must have not just a strong knowledge base, but must also possess the “cognitive properties necessary to value it” (2000: 222). Baron (2004) asks directly why some individuals recognize opportunities when others do not and suggests an answer may be found by exploring the individual’s cognition. Baron and Ward (2004) ask whether those who are successful at identifying opportunities have different knowledge structures and a preferred processing style or heuristic. The results from this study provide a partial answer to these questions by demonstrating that individuals that have a preference for transforming information via extension do indeed outperform those with a preference for intention.

Additionally, the results of Hypothesis 7 again illustrate the importance of information transformation, this time in its interaction with information acquisition (see Fig. 4). While Hypothesis 4 shows the effectiveness of an extension preference, Fig. 4 illustrates that those with an intention preference can be just as effective as long as they also have a comprehensive preference for acquiring information. The results show that it is not just one’s knowledge but how one concurrently acquires, processes, and learns from that knowledge that matters with respect to opportunity discovery. This result gives ammunition to Sarasvathy’s (2001) work championing effectuation and entrepreneurial contingency.

Sarasvathy (2001) hypothesizes that nascent entrepreneurs seeking opportunities may be better served by a process of effectuation as opposed to causation. When contrasting causation and effectuation, she states that causation processes work better in static, linear environments where the actor can focus on predictable aspects of an uncertain future. Causation relies on the actor exploiting his existing knowledge. By contrast, effectuation allows the actor to use his abilities to discover and exploit various contingencies. Results from this study affirm Sarasvathy’s work by demonstrating that nascent entrepreneurs who implement an extension preference for transformation along with a comprehensive preference for acquisition allow for the investigation of many contingencies and will outperform individuals who rely on a more straightforward exploitation of their current knowledge base (the intention and apprehension preferences).

Taken in sum, the results of this study demonstrate that while specific types of knowledge are important, the process of learning also plays an important role in the discovery of entrepreneurial opportunities.

8.3. Not just knowledge asymmetries, but learning asymmetries

With few exceptions, knowledge-based entrepreneurship research either ignores learning or implicitly assumes that the learning function is inherent within broader knowledge and cognitive constructs. Within the domain of opportunity research, the number of studies examining knowledge is relatively large when compared to the few examinations of learning. However, knowledge is a static concept (Best, 1992), whereas learning is an active process (Hebb, 1949). And process, as Aldrich and Martinez (2001)

remind us, must be included in our studies of entrepreneurship if we are to make progress understanding the phenomenon.

This study directly addresses the process of learning and shows that learning asymmetries—the different manner in which individuals acquire and transform information—have important implications for the discovery of opportunities. By introducing Kolb's concept of experiential learning to opportunity recognition research, this study amplifies Shane's work (2000).

Shane argues that all people are not likely to find the same opportunity because there is a difference in the prior distribution of information in society (Hayek, 1945) which results in knowledge asymmetries between individuals. The current study extends Shane's research by providing additional insight into *why* these knowledge differences might exist. Results from the current study suggest that knowledge asymmetries exist because learning asymmetries exist! By acquiring information and transforming information in fundamentally different ways, the resulting product is a difference in the knowledge that each of us can use to uncover opportunities.

8.4. Implications for entrepreneurship theory

The recent proliferation of cognition-based entrepreneurship research has focused attention on developing a cognitive theory of entrepreneurship (Mitchell et al., 2002). As explained above, this article supports much of this work by providing empirical evidence that sustains the work of Baron, Mitchell, Sarasvathy, Shane, Venkataraman and others. Perhaps more importantly, this study may open up new theoretical avenues by shifting the focus from static concepts, such as knowledge, to also include process (learning).

Including process in the equation is important (Aldrich and Martinez, 2001) but to date, theorists have been relatively silent regarding the potential significance of the learning process within opportunity identification and the entrepreneurial process (Agndal, 1999; Corbett, 2005; Minniti and Bygrave, 2001; Ravasi and Turati, 2005). The results of this study should encourage theorists to continue to investigate other aspects of the learning process with respect to opportunity identification and the entire process of entrepreneurship.

8.5. Limitations, future research, and practitioner implications

When digesting this study, it is important to consider the context in which it was conducted. All of the participants in this study were technologists working in a high technology sector. As such, the environments in which they worked were characterized by high uncertainty, much ambiguity, and constant change. Therefore, generalizing these results outside of a highly dynamic and technology-dependent environment may be inappropriate. Additionally, it must be stressed that this study focused on only one part of the process of entrepreneurship—the initial identification of opportunities. At the same time, these limitations may also be seen as areas for future exploration. Researchers have the opportunity to extend this study by examining similar phenomena in other non-high tech environments and by extending the examination of learning asymmetries beyond opportunity identification and into the process of opportunity exploitation.

There are also many implications for practitioners. For entrepreneurs themselves, the results of this study can help them understand their own learning preferences and how these preferences may affect their ultimate success and survival. This study and previous literature suggest that the learning and cognitive styles necessary to identify, launch, and run a successful venture vary at different times during the process. Recognizing this, entrepreneurs may want to work on their ability to toggle between styles. Research tells us that while we all have a preferred learning approach, we can and should utilize all styles in order to be a maximally effective learner (Mainemelis et al., 2002). In other words, while recognizing that learning asymmetries exist, entrepreneurs should attempt to stretch out of their comfort zone and try to learn in new ways. This also means that when building their teams, entrepreneurs should focus on surrounding themselves with team members whose learning style is complementary.

With respect to corporate entrepreneurship initiatives, human resource officers and managers undertaking new ventures could use the tools from this study to aid in their selection process, specifically with regard to specialists versus generalists. Results here suggest that individuals with high levels of specific human capital and a preference for comprehension and extension may be needed early in the process. However, these folks will need to be assisted by generalists with different approaches as the time comes to exploit and run the venture.

In this study, investors of all types will also find verification for their often-stated refrain of “betting on the jockey, not the horse.” The results of this study support the importance these arbiters put on the individual, not necessarily their original idea. Angel investors and venture capitalists know that the venture that is finally launched is often very different from the idea described in the original business plan. This is due to changing environmental conditions, resource fluidity, and the cognitive limitation of the entrepreneur (Baron, 1998). As such, it is the opportunity that is *eventually* identified that is of most importance. This study elucidates the importance of the learning that occurs as the entrepreneur identifies new opportunities during the evolution of his ideas.

9. Conclusion

The predominant contribution of this article is the new light it sheds upon one of the most elemental, yet unresolved, questions in the entrepreneurship literature. Nearly a decade ago, Venkataraman asked why some individuals are better at recognizing opportunities for entrepreneurial activities than others. Since that time, he and others have suggested that these differences may be the product of the differing cognitive abilities of various individuals. Many researchers theorized about the importance of cognitive processes within the entrepreneurial process. Some empirically examined cognitive processing within the entrepreneurship realm; however, no one had conducted a large scale empirical investigation that focused on the *learning processes* of opportunity identification.

The current study fills this void. Jung (1977) tells us that all individuals learn differently and these differences ultimately affect each individual’s ability to function and perform certain tasks. This study tests his assertion within the entrepreneurship domain by

investigating the learning antecedents to opportunity identification. The results suggest that learning asymmetries not only exist, but they have a profound effect on why some individuals discover entrepreneurial opportunities while others do not.

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