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NEW VENTURE STRATEGIC ADAPTATION: THE INTERPLAY OF BELIEF STRUCTURES AND INDUSTRY CONTEXT

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We adopt an information processing perspective to investigate how the interplay of belief structures and industry context shapes new venture strategic adaptation in a sample of 104 publicly traded new ventures founded between 1996 and 2006 in several technology-intensive industries. Results highlight that distinct espoused belief structures attributes (complexity, centrality, proactive causal logics) and industry growth combinations predict diversity, frequency, and speed of new venture strategic actions. We contribute to prior literature on early firm strategic adaptation by providing an elaborated understanding of the role of espoused belief structures in interpreting and translating industry signals into new venture strategic action. Further, we highlight the role of belief structures in facilitating the fast, diverse, and frequent organizational actions typically associated with continuous adaptation.

INTRODUCTION

What are the drivers of new venture strategic adaptation? This question is of central concern to those interested in understanding the basis for new venture success (Bhide, 2000; Robinson and McDougall, 2001). Much of the research directed toward understanding heterogeneity in new venture performance and growth has focused on the relationship between the firm and its environment and, in particular, on how (or the degree to which) firms identify and exploit opportunities (i.e., take actions) in order to address the shifting nature of their external environments (e.g., Eisenhardt and Schoonhoven, 1990; Tripsas and Gavetti, 2000).

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While prior research has identified a variety of factors, both external and internal to the organization, that influence new venture strategic action, our understanding of the processes associated with new venture strategic adaptation has been hampered by the tendency for this work to take either a deterministic or a choice perspective. Most deterministic models are rooted in population ecology and focus on liability of newness and smallness as mechanisms of firm selection (Carroll, 1983; Freeman, Carroll, and Hannan, 1983; Stinchcombe, 1965). Research rooted in industrial organization economics is also deterministic in the sense that industry and firm level factors are seen as the main drivers of new venture action and performance (e.g., Feeser and Willard, 1990; Sandberg and Hofer, 1987). The choice perspective, on the other hand, emphasizes the important role of the entrepreneur and his/her beliefs or interpretation for organizational actions and builds on the idea that new ventures adapt and grow by altering

the environments in which they compete through proactive actions that shape the environment (Baum, Locke, and Kirtpatrick, 1998; Bhide, 2000; Lumpkin and Dess, 1996; Miller *et al.*, 1996; Nicholls-Nixon, Cooper, and Woo, 2000).

Because the deterministic and choice perspectives each focus on a different set of explanations for why some new ventures engage in strategic actions and others do not, we lack a unified explanation of new venture strategic adaptation. In this paper, we begin to address these weaknesses in prior work by adopting an information processing perspective and developing and testing a model of new venture strategic adaptation that integrates the deterministic and the choice perspectives and ties the *combined* influence of industry and new venture belief structures to strategic actions. In doing so, we build on prior research that highlights the role of espoused belief structures in organizational adaptation (Bogner and Barr, 2000; Calori, Johnson, and Sarnin, 1994; Dutton, Fahey, and Narayanan, 1983; Kiesler and Sproull, 1982; Nadkarni and Narayanan, 2007; Walsh, 1988) and predict that differences in new venture strategic actions are driven by different belief structure attributes-industry growth combinations.

Results based on a sample of 104 new ventures that operate in high-technology industries (pharmaceutical preparations, medical instruments, semiconductors, and computers) suggest that specific attributes of new venture belief structures play a critical role in new venture strategic adaptation by providing the mechanism necessary to identify and interpret the myriad signals emanating from fast-paced entrepreneurial environments and translate those signals into appropriate actions.

Our study makes several contributions to the literature on firm strategic adaptation. First, it answers calls in the literature to investigate *early firm strategic adaptation* through complex models that simultaneously take into account environmental signals and the role that subjective interpretations play in translating those signals into firm action (e.g., Grégoire, Barr, and Shepherd, 2010; Hitt *et al.*, 2001; Sandberg and Hofer, 1987) and provides a bridge between the deterministic and the choice perspectives that have been previously adopted. Second, it focuses on specific belief structure attributes and examines their distinct role on a variety of new venture strategic actions, thereby highlighting their role in early capability development. Third, by focusing on diversity, frequency, and speed of firm actions typically associated with continuous adaptation (Brown and Eisenhardt, 1997) , we also contribute to the broader research on organizational adaptation as we begin to uncover the role played by cognitive mechanisms in continuous adaptation processes. Finally, from an empirical perspective, by employing a larger cross-industry sample, we extend prior simulation and case-based research (e.g., Gavetti, Levinthal, and Rivkin, 2005; Tripsas and Gavetti, 2000) and research that has examined the influence of cognitive mechanisms in firm reaction to significant environmental jolts (e.g., Barr, Stimpert, and Huff, 1992; Eggers and Kaplan, 2009) to a larger, more diverse group of firms.

THEORY AND HYPOTHESES

New venture strategic adaptation as an information processing process

New venture strategic adaptation may be viewed as an activity that involves choices and commitments, implementation, execution, and refinement of actions (Choi and Shepherd, 2004; Foss, Lyngsie, and Zahra, 2013; March, 1991; McMullen and Shepherd, 2006). These actions are taken in an effort to more closely link the activities of the firm to the often evolving demands of the environment in which the new organizations operate.

Information processing (IP) is the means by which individuals and organizations seek to make sense of and operate effectively within their environment(s). The process involves three basic operations: noticing, interpretation, and action (Daft and Weick, 1984). In the first stage, noticing, the environment is scanned for data that provide signals as to the nature of the environment. In the second stage, interpretation, these data are given meaning, and cognitive theories about the environment are developed. The third stage, action, involves "putting cognitive theories into action" (Daft and Weick, 1984: 286); actions are undertaken that are consistent with beliefs held about the environment.

Adopting an IP perspective of strategic adaptation has implications for both the types of actions that new ventures will undertake and the cognitive mechanisms (interpretive processes) at work. Prior research suggests that new firms attempting to define their initial competitive position or strategy typically engage in deployment of multiple

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complementary investments and assets that are materialized in a variety of actions that firms undertake on several important dimensions such as product, production technology, or markets (e.g., Choi and Shepherd, 2004; Foss *et al.*, 2013). Consistent with an IP perspective, research also suggests that in settings characterized by continuous change, such as those characteristic of high-technology new ventures, firms engage in a series of trial-and-error actions over relatively short periods of time, iterative and purposive actions aimed at probing both the environment and the organization. (e.g., Brown and Eisenhardt, 1997; Miller *et al.*, 1996; Nichols-Nixon *et al.*, 2000). In particular, firms are observed to engage in fast, frequent, and diverse actions to develop a better understanding of the environment and of subsequent firm actions required for competitive success. Building on these two important insights, we suggest that new venture information processing efforts associated with strategic adaptation will result in their firms' engaging in similar forms of activity.

Belief structures (also called dominant logics, strategic schemas, cognitive maps, or strategy frames) are a key component for information processing. They are cognitive structures that represent organized knowledge about a given concept or circumstance, such as the firm and its environment, contain both attributes of the concept and the relationships among the attributes, and are used by a firm's top managers when making strategic decisions (Daft and Weick, 1984; Fiske and Taylor, 1991). Prior research suggests that there are strong links between managerial belief structures and organizational actions (e.g., Barr, Stimpert, and Huff, 1992; Fahey and Narayanan, 1989; Nadkarni and Barr, 2008; Nadkarni and Narayanan, 2007). This may be particularly true in small, entrepreneurial firms where founders are still present and top management teams are relatively small and enjoy high levels of discretion (Forbes, 2005; Powell, Lovallo, and Fox, 2011).

How concepts are ordered and linked in belief structures is of particular interest for the present study because it influences the ability to (quickly) notice a wide array of signals, to differentiate, integrate, and synthesize concepts (Calori *et al.*, 1994), as well as the ability to generate effective solutions to problems (Marek, Griggs, and Koenig, 2000). Three attributes in particular—belief structure complexity, centrality, and causal logics—have been associated with differences in the timing and content of adaptive actions in settings characterized by continuous change (Fahey and Narayanan, 1989; Nadkarni and Barr, 2008; Nadkarni and Narayanan, 2007) and are the focus of the present study.

Industry signals, belief structures, and new venture strategic actions

Information processing is directed toward activities that occur in one's environment and provide the raw material for interpretation and subsequent action. For new ventures seeking to adapt, that environment is typically defined as the firm's operating environment or the industry in which it competes. *Industry growth is* a characteristic of particular importance for new venture strategic action. An industry's growth rate is widely considered by both scholars and venture capitalists to be the most critical aspect of market attractiveness for new ventures (McDougall *et al.*, 1994; Miller and Camp, 1985; Porter, 1980). It is also often regarded as an enabling rather than a causal variable in the realization of high performance (Keats and Hitt, 1988) with firms targeting a higher percentage of their resource base, and associated actions, toward the pursuit of growth (Heeley, King, and Covin, 2006). This makes it a particularly relevant environmental aspect for our study.

Although a high level of industry growth may be favorably associated with initial market entry, because it has lower entry barriers and it provides access to a higher and more diversified pool of resources, it also poses unique interpretation challenges. New ventures must make sense of and respond to a high number of new entrants and existing players that use increasingly sophisticated tactics and competitive strategies, constantly evolving customer preferences, high rates of technological change, and higher rates of innovation (Audretsch, 1995; Eisenhardt and Schoonhoven, 1990; McDougall *et al.*, 1994). From an IP perspective, new ventures will respond to these challenges by noticing and interpreting signals from the environment, thereby translating signals into indicators for action. We argue that certain belief structure attributes are likely to facilitate the translation process and thus new venture strategic action. We explore these influences in the following sections.

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Industry growth, belief structure complexity, and new venture strategic actions

Belief structure complexity captures the breadth and variety of knowledge embedded in the belief structure and is represented as the total number of strategic concepts that appear in a belief structure and the number of links between those concepts (Calori *et al.*, 1994; Eden, Ackermann, and Cropper, 1992). Complex belief structures emerge through repeated exposure to complicated situations that require a multidimensional approach and call for advanced symbolic, affective, behavioral, and perceptual responses (Kolb and Fry, 1975). Managers with complex belief structures have the ability to differentiate and integrate various concepts that lead to understanding an issue from a variety of perspectives and to "synthesize aspects of these perspectives in an appropriate response" (Bartunek, Gordon, and Weathersby, 1983: 275). Prior research suggests that complex belief structures translate into superior information processing capabilities—as managers perceive a larger number of contextual dimensions, they spend more time interpreting information, and they draw on complementary and competing perspectives when formulating various courses of action (Dollinger, 1984; Levy, 2005).

We expect that complex belief structures facilitate the translation of industry signals into diverse and frequent actions. Prior research suggests that the use of simple belief structures to interpret new and unfamiliar stimuli is associated with failure to recognize and interpret critical environmental changes Kiesler and Sproull, 1982). Complex belief structures, on the other hand, have been identified as a mechanism that promotes strategic flexibility through broad scanning and simultaneous consideration of strategic alternatives (Dutton *et al.*, 1983; Nadkarni and Narayanan, 2007). Thus, new ventures where managers hold complex belief structures are better able to recognize and discern among an abundant and varied set of industry signals and engage in a broader and more diverse set of organizational actions.

Managers with complex belief structures are also more likely to be engaged in dynamic learning processes characterized by frequent changes in various areas of their firm when seeking to determine how to best position their firm (Miller *et al.*, 1996). By facilitating the absorption and processing of new and diverse information, complex belief structures encourage new insights and may lead to managerial openness for strategy reformulation (Bartunek *et al.*, 1983; Nicholls-Nixon *et al.*, 2000). This may manifest not just in the diversity of actions that new ventures take along distinct dimensions of their organization, but also in a greater frequency of organizational actions (Evans, 1991).

In sum, managers with complex belief structures are better able than those with simpler belief structures to engage in broad scanning and discern among varied sets of signals and develop new insights, including an increased awareness of new technological and product-market opportunities associated with their environments, all of which suggest more frequent actions along a more diverse set of organizational dimensions.

Hypothesis 1: As industry growth increases, higher levels of belief structure complexity are associated with more (a) diverse, and (b) frequent new venture strategic actions.

Industry growth, belief structure proactive causal logic, and new venture strategic actions

Managers' beliefs about the nature of the causal relationship between environment and strategy have been investigated in the managerial cognition literature and have been found to affect issue framing (Barr and Huff, 1997; Eden *et al.*, 1992; Fahey and Narayanan, 1989) and to influence the timing and nature of firm-level action (Barr *et al.*, 1992; Fahey and Narayanan, 1989; Nadkarni and Barr, 2008). Of particular interest is the direction of this causal relationship. Proactive logics refer to causal structures that reflect the belief that strategy (action) influences the environment. Deterministic logics represent the belief that environment influences strategy (Fahey and Narayanan, 1989). In organizations where managers hold proactive causal logics, extensive time and resources are not expended in efforts to understand environmental events prior to undertaking an action because action is viewed as influencing environment, rather than being determined by it. Instead, organizational action is used as a sensemaking device; action is undertaken and the results are used as the basis for assessing the need for additional or different actions (Daft and Weick, 1984; Nadkarni and Barr, 2008).

The results of this work suggest that new venture managers with high levels of proactive causal logics are more likely to view industry signals (coming

from both peers and competitors) as opportunities for action that will shape the emerging environment rather than threats that must be resolved. As industry growth increases, the number and variety of signals emanating from the environment is also likely to increase as a result of the myriad of changes in competitors, competitive strategies and tactics, customer preferences, and technologies, etc., that often accompany growth. New venture managers with high levels of proactive logics emphasize the effect of action on environment and view these signals as opportunities for action that influence the nature of the environment in their favor and increase their likelihood of success (Eisenhardt and Tabrizi, 1995). They are therefore more likely to engage their firms in a greater number of organizational actions (Fahey and Narayanan, 1989) and in multiple/frequent iterations and realignments of already implemented actions and existing products (Eisenhardt and Tabrizi, 1995) than will new venture managers with lower levels of proactive causal logic.

Hypothesis 2: As industry growth increases, higher levels of proactive causal logic are associated with more (a) diverse, and (b) frequent new venture strategic actions.

Industry growth, belief structure centrality, and new venture strategic actions

Belief structure centrality refers to the extent to which belief structures are centralized around a limited number of core concepts (Eden *et al.*, 1992; Nadkarni and Narayanan, 2005, 2007). Conceptually similar to network centrality, which captures the degree to which a small number of firms or individuals serve as the nexus of relationships between other members of the network, belief structure centrality captures the degree to which the concepts in the model are causally connected, directly or indirectly, to a few focal concepts (Nadkarni and Narayanan, 2005). The concepts and relationships in belief structures with high levels of centrality are organized hierarchically with clear and logically sequenced relationships between concepts (Eden *et al.*, 1992). Belief structures with high levels of centrality also clearly distinguish core and peripheral sets of concepts and relationships, with the peripheral sets playing a supporting role for the core sets (Eden *et al.*, 1992; Lyles and Schwenk, 1992).

It has been suggested that belief structures characterized by high centrality facilitate information processing and knowledge application in various problem-solving situations. Prior research suggests that centralized belief structures of a given domain facilitate the storage, recall, and interpretation of data specific to that domain (Walsh, 1988). They also facilitate accurate and effective problem solutions by channeling managerial attention to the appropriate combination of hypotheses (Hong and O'Neil, 1992; Marek *et al.*, 2000; Nadkarni and Narayanan, 2005; Newstead and Griggs, 1992).

By facilitating the recall and interpretation of data and the use of focused and logical reasoning processes, high centrality belief structures allow new venture managers to efficiently process a broad collection of environmental, strategic, and organizational concepts, avoid information overload and redundancy, and use only relevant information for the swift implementation of organizational actions. This suggests that new venture managers with higher levels of belief structure centrality will be able to quickly recognize important changes in the environment that are related to their central subjective representations of that domain and interpret the implications of those changes for action (Fiol and O'Connor, 2003; Forbes, 2005; Nadkarni and Barr, 2008) leading to new venture action in high growth industries that is faster than that of new ventures led by managers with lower levels of belief structure centrality.

Hypothesis 3: As industry growth increases, higher levels of belief structure centrality are associated with faster new venture strategic actions.

METHODS

Sample selection criteria

The guidelines used to collect the data were based on a review of existing research in entrepreneurship (e.g., Hmieleski and Baron, 2008; Mishina *et al.*, 2004) and managerial cognition literatures (e.g., Barr and Huff, 1997; Barr *et al.*, 1992; Nadkarni and Barr, 2008). First, we identified a sample of firms that met the criteria of new venture in terms of age; i.e., they are 10 years old or younger (Zahra, 1996), they have fewer than 300 employees and were privately held before the year of initial public offering

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(IPO), and they are founder managed. Second, we employed two criteria to select a sample of firms with clear growth objectives to increase the likelihood that they are in the active stages of strategic adaptation: the industry criterion (new ventures founded in technology-intensive industries) and the IPO criterion (Gilbert, McDougall, and Audretsch, 2008). Third, a primary goal of the research design was to capture belief structures of new venture managers unobtrusively, and the data collection method employed to accomplish this (i.e., content analysis of public documents) required that the population of interest for this study consist of firms for which a large amount of publicly available data exists. Finally, this study attempts to control, to the maximum extent possible, for variations in the dependent variables introduced by institutional and other country-level factors that are not the principal goals of this investigation. Thus, we used a sample of U.S., non-subsidiary, publicly traded firms.

After considering these initial sampling criteria, a search for firms founded during the 1996–2006 time period that undertook an IPO during the same period was performed in Dunn and Bradstreet's Hoover's database and in Mergent Online database. The 1996–2006 time period was selected so as to ensure the identification of a sufficient number of active high-technology start-ups. Subsidiaries, firms founded for the exclusive purpose of acquiring other companies, firms resulting from mergers, and spin-offs were not included in the sample. The initial search resulted in 445 firms. Of these firms, 104 firms met all the characteristics mentioned above *and* had publicly available annual reports that included letters to shareholders for the year of IPO. The final sample consisted of firms operating in the following industries: pharmaceutical preparations (SIC 2834), medical instruments (SIC 3840), semiconductors (SIC 3674), and computers (SIC 3571).

Data collection: belief structure attributes

There is no means of directly capturing belief structures (cf. Fiol, 1995). At most, what can be captured is the structure of *espoused* beliefs, those revealed through usual modes of communication or through interviews, completion of surveys, or experiments designed specifically to capture beliefs. We followed previous research in strategic management (Barr *et al.*, 1992; Kabanoff and Brown, 2008; Kaplan, 2008; Nadkarni and Narayanan, 2007) and used content analysis of documents that reflect the thinking of new venture managers to capture attributes of their belief structures. Specifically, we analyzed the letters to shareholders from annual reports for the IPO year for each firm. Our choice of data source is motivated by our intention to capture belief structures in use, close to the moment in which organizational actions occurred. Although interviews or surveys could be a useful alternative for capturing belief structures, we wanted to avoid the inherent retrospective bias that often occurs when individuals are asked to recall information from the past (Golden, 1992).

Although there is no direct evidence that these documents are written by chief executives or lead entrepreneurs, it is widely presumed that they reflect and are fair representations of their perceptions (Barr *et al.*, 1992). Further, informal conversations with executives (Barr *et al.*, 1992) and systematic empirical analyses (Fiol, 1995) indicate that there is significant CEO involvement and attention to accuracy in the preparation of letters to shareholders. Most importantly, the emphasis in this study on young and small firms run by founder entrepreneurs mitigates the risk of uncertainty in authorship. Further, letters to shareholders, and in particular the letters to shareholders written for the year in which firms go public, are closely scrutinized by financial analysts, institutional investors, and the business press, which makes it highly likely that founder entrepreneurs are involved in their preparation (Clapham and Schwenk, 1991). Finally, prior literature on managerial cognition and organizational adaptation has established important links between organizational actions and outcomes and cognitive constructs derived from letters to shareholders (Barr *et al.*, 1992; Bowman, 1984; Nadkarni and Barr, 2008; Nadkarni and Narayanan, 2007), which establishes their predictive validity.

To address potential impression management and authorship issues, we first used the management discussion section from each firm's 10K reports for comparison (Nadkarni and Barr, 2008; Nadkarni and Narayanan, 2007). Form 10Ks are required to be filed with the Securities and Exchange Commission within 90 days of the company's fiscal year end, and present more detailed information than annual reports on the company's most recent business activities. To compare the contents of the letters and the management discussion section, we randomly selected five firms from the sample and divided the number of common concepts for

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the two documents by the total number of concepts in the letters. The number of shared concepts between the two documents ranged from 61 to 80 percent, suggesting an acceptable level of convergence between the two documents (Carley and Palmquist, 1992; Nadkarni and Narayanan, 2007). In addition to matching the content of the letters to shareholders to the 10K reports, we randomly selected 20 firm actions (e.g., strategic alliances, new product-related) made by firms in our sample and reported in various publications for the period of time covered by our sample (e.g., *The Wall Street Journal*). We then compared the date of the announcement with the year in which the action was mentioned in the letters to shareholders and found no significant differences.

Constructing causal maps

In order to obtain valid and reliable representations of founder-manager's causal maps, we followed the four-step causal mapping procedure advocated by Axelrod (1976). Our choice of causal mapping as the method of analysis is consistent with the assumption that causal reasoning is the primary way in which strategic decisions are developed and understood, and it is thus the appropriate methodology to be employed to capture the belief structures associated with firm action (Barr, 1998; Barr *et al.*, 1992; Huff, 1990).

In the first step, two coders (one of the authors and a PhD student trained in strategic management and blind to the study's hypotheses) independently identified statements in the letters to shareholders that clearly implied a cause-effect relationship between the environment and actions and between actions and their importance. Examples of key words used to identify causal statements are "if-then," "because," "so," "as." The same two coders then coded each statement into causes and effects. Consistent with the standards of content analysis (cf. Krippendorff, 2004), interrater reliability was assessed for both identification of statements to code and the coding of the statements into causes and effects. All coding procedures were conducted manually. The initial level of agreement between the two coders for the identification of the statements to be coded was 89.7 percent. The disagreements were discussed until both coders agreed on all statements to be coded. The initial level of agreement for the identification of statement causes and effects was 94 percent (Cohen's κ 0.88). Once again, the remaining disagreements were discussed until both coders agreed on all causes and all effects.

In the second step, we used the causes and effects identified in the first step to build "raw causal maps." To this end, we aggregated the raw causes and effects into generalized concepts (e.g., changes in legislation, advertising). Aggregation reduces the risk of misclassification of concepts due to different wording used by individuals (Carley and Palmquist, 1992). Three strategy and/or entrepreneurship scholars (experts) were consulted to ensure that the identified concepts were distinct and at the same level of abstraction. This procedure generated 110 raw concepts.

In the third step, the raw concepts were classified into theoretically grounded, broad conceptual categories that represent the concepts of interest (e.g., macro-environment, marketing related). Generalizing similar concepts in documents makes the concepts comparable across individuals and firms (Carley and Palmquist, 1992) and ensures that the categories are distinct and uniform in breadth and abstraction (Carley and Palmquist, 1992; Fahey and Narayanan, 1989; Nadkarni and Narayanan, 2007). We identified an initial set of categories by consulting with academic experts and using entrepreneurship and strategic management academic literature and textbooks (e.g., Hitt, Ireland, and Hoskisson, 2008; Timmons and Spinelli, 2006) to ensure that category names are consistent with the terminology currently in use in both the strategic management and entrepreneurship fields and to verify the short definitions we generated that could later be used in the expert panel validation process. By using established theoretical literature, we ensured that the categories are relevant and distinct (i.e., the *theoretical relevance* of the categorization scheme; Carley and Palmquist, 1992; Nadkarni and Barr, 2008). We revised and added new categories to this initial set of categories as we engaged in aggregation or exploratory filtering (Carley and Palmquist, 1992) to generalize raw cause-effect concepts into broad categories. This procedure generated 23 distinct categories. Of the 23 categories identified, 3 reflect the environment, 15 reflect organizational actions, and 5 reflect various dimensions of performance.

The categorization scheme was validated in the fourth step using a panel of five academic experts (i.e., strategic management and entrepreneurship scholars; Dean and Snell, 1996). The use of the expert panel ensured the face validity of the final categorization scheme. The judges were provided

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with a list of the 110 raw concepts, the list of categories, and their corresponding definitions and were asked to classify the concepts into categories. Reliability was assessed (average percent agreement 88.6%) across the judges and only items whose classification was agreed on by three or more judges were retained. This reduced the number of raw concepts from 110 to 98. The final categorization scheme is similar to categorization schemes previously developed in the literature (e.g., Nadkarni and Barr, 2008), which further validates the approach taken in this study.

Data collection: organizational actions

In order to establish a temporal relationship between belief structures and firm action, we identified new organizational actions that were initiated in the year after the IPO by searching Factiva and LexisNexis Academic databases for announcements of new actions undertaken by each firm in the sample. These data sources were supplemented with searches of company websites and publicly available firm documents. This search resulted in the identification of a total of 2,239 actions. We used the typology of actions developed through the content analysis of the letters to shareholders and validated by an expert panel to categorize the actions. This categorization scheme included 15 types of actions related to the following: marketing, finance, new products, cooperative alliances, competition/competitiveness, top management team changes, human resources, capacity, international, the firm's IPO, structure, restructuring, service, corporate social responsibility, and low cost/pricing. Two graduate students enrolled at one of the authors' university and completely blind to the theoretical rationales and the hypotheses of the study conducted the categorization. Intercoder reliability was computed (percent agreement 96.5% and Cohen's κ 0.95), and remaining disagreements were discussed to achieve consensus.

Measures: dependent and independent variables

Diversity of organizational actions

To capture the degree to which actions initiated by new ventures consist of a diverse range of action types, we used Ferrier *et al.'s* (1999) Herfindhal-type index of competitive simplicity. Diversity of organizational actions $= \sum(\text{Na/NT})^2$, where Na/NT is the share or proportion of organizational actions in the ath category. Low scores represent firms that engage in highly diverse actions while high scores represent firms that engage in less diverse actions.

Frequency of organizational actions

To capture frequency of new venture actions, we counted the number of different actions initiated by a firm during the year following the IPO.

Speed of organizational actions

Speed was measured as the amount of time elapsed between the announcement of the intent to undertake a given action and the date of its implementation. We computed an aggregate measure of speed at the firm level by averaging the number of days between the date of the media announcement of actions to the date of their implementation as mentioned in subsequent announcements or in the firms' 10Ks. Our triangulation of various sources of data (company websites, media announcements, and company annual reports) on the speed of action revealed that new product-related actions (total of 371) were the only types of actions for which a relatively accurate measure of speed (the number of days from when action is announced until action is implemented) could be computed. There were several companies (10 of the 104) that did not undertake new product-related actions in the years in which actions were captured. These data are treated as missing data during statistical analyses even though they are not such from a theoretical perspective.

Industry growth

This variable was measured as yearly percentage change in industry gross sales. We computed the growth rate for the year of IPO as the percentage increase (decrease) in sales from the previous year (Eisenhardt and Schoonhoven, 1990).

Belief structure complexity

We used two measures to capture belief structure complexity: *comprehensiveness* and *connectedness* (Calori *et al.*, 1994; Carley and Palmquist, 1992;

Eden *et al.*, 1992). Comprehensiveness was measured by adding the total number of concepts in a casual map (Nc) and connectedness was measured by dividing the total number of linkages (Nl) in a causal map by the total number of concepts in that map (N/Nc). A composite measure of complexity was computed by averaging the two standardized individual measures.

Belief structure centrality

We computed centrality using a network-based measure of centrality: degree centrality (Borgatti, 2005; Freeman, 1978; Nadkarni and Barr, 2008). Degree centrality focuses on direct and adjacent paths of a concept with other concepts in the network of concepts representing a map and is a measure of the overall centrality of the map. The formula to compute degree centrality follows:

$$C_D\left(P_k\right) = \frac{\sum_{i=1}^{n} a\left(p_i, p_k\right)}{n-1}$$

where $C_D(P_k)$ = number of concepts connected to concept k, $a(p_i, p_k)$ = connection from P_i to P_k (either 0 or 1), and n = number of concepts in the causal map.

Proactive causal logic

Extant managerial cognition literature captures proactive logics as strategy (action) → environment links in the causal map (Eden *et al.*, 1992; Fahey and Narayanan, 1989). Consistent with this work, we employed in-degree (links leading into the concept) and out-degree (links leading away from the concept) analysis of the causal links between environment and actions that appeared in the causal maps (Eden *et al.*, 1992; Knoke and Kuklinski, 1982; Nadkarni and Barr, 2008). The relative importance of the proactive causal links in the overall causal map is captured by the percentage of strategy → environment links (Carley and Palmquist, 1992; Knoke and Kuklinski, 1982). Following Nadkarni and Barr (2008), the final composite measure of proactive logics was obtained by averaging the *z*-scores of in-degree environment, out-degree of strategy, and percentage of strategy → environment links.

We followed prior research and included a number of control variables in our analyses. First, *financial slack* (calculated as the difference between working capital available and working capital required) may influence the extent to which firms exploit environmental opportunities (Mishina *et al.*, 2004). Second, *prior performance* (computed as the increase or decrease in sales from the year prior to IPO year) may affect the ability of firms to implement various firm-level actions. Third, *firm age and firm size* (measured as the log of a firm's total employment for the year in which the cognitive variables were measured) are often related to the firm's resource base and the market positions that they occupy (Hmieleski and Baron, 2008; Keats and Hitt, 1988; Mishina *et al.*, 2004) and may influence the variety, speed, and frequency of actions initiated. Finally, industry characteristics such as *concentration* (measured as the ratio of sales for the industry's top four companies to total industry sales) and industry *type* (dummy variables) may also influence the extent to which new ventures engage in various strategic actions (Eisenhardt, 1989; Nadkarni and Narayanan, 2005; Porter, 1980).

ANALYSIS AND RESULTS

Initial tests performed to ascertain the validity of ordinary least squares (OLS) regression assumptions for our data set indicated that the heteroskedasticity assumption may be violated and that several potentially influential outliers exist. According to Cohen *et al.* (2003), although heteroskedasticity and nonindependence of residuals may not necessarily lead to biased OLS estimates, it may lead to biased confidence intervals (i.e., estimates that are weaker or stronger than they actually are). Following Efron and Tibshirani (1993), we used bootstrapping to assess the robustness of the inferences about parameters to violations of assumptions such as normality or independence of residuals.

The bootstrap analysis revealed that tests of significance related to some of the parameters of interest were affected by possible deviations from OLS assumptions. To address these issues, we decided to implement robust regression estimation techniques (Hampel *et al.*, 1986). Although computationally more intensive than OLS techniques, robust techniques and bootstrapping are not overly affected by violations of assumptions and are particularly useful in handling models that contain financial data. Robust techniques are often preferred to data

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transformations or observation deletion that simply mask violations of assumptions or lead to the elimination of meaningful data (cf. Aguinis, Gottfredson, and Joo, 2013).

We used both LTS (least trimmed squares; Rousseeuw, 1984) and MM estimation techniques (Koller and Stahel, 2011; Yohai, 1987). These techniques yielded similar results; however, we report the MM estimators as they are considered more robust and resistant to outliers (cf. Fox, 2008). We used robust regression functions in both *R* (R Core Team, 2013) (function *lmrob* from the *R* contributed package *robustbase*) and SAS (SAS 9.3) (function *proc robustreg*) to estimate coefficients. Output provided for robust regression varies by statistical software package with some packages (e.g., SAS, Stata) including goodness of fit indices, such as R^2. We note, however, that the interpretation and applicability of OLS-related goodness of fit indices to robust regression is still a matter of debate in the statistical literature.

Descriptive statistics, correlations, and results are reported in Tables 1 and 2. Model 1 includes control variables and Model 2 includes independent effects. Interaction terms were added in Model 3. Consistent with our expectations, the interaction model explains a significantly larger amount of variance than models including control variables or independent effects alone.

Hypothesis 1 predicted that belief structure complexity has a positive moderating effect on the relationship between industry growth and the (1) diversity, and (2) frequency of organizational actions. Examination of the regression coefficients in Model 2 and the corresponding graphs (Figures 1 and 2) reveals that, as industry growth increases, new venture managers with higher levels of belief structure complexity are better able to translate industry signals into diverse organizational actions than new venture managers with lower levels of belief structure complexity ($p < 0.05$). However, the pattern of this effect is inversed when analyzing frequency of organizational actions ($p < 0.05$). Simple slope tests confirmed the pattern of relationships observed for both high levels and low levels of belief structure complexity. These results offer partial support for Hypothesis 1.

Hypothesis 2 predicted that, as industry growth increases, new venture managers with higher levels of proactive causal logic will translate industry signals into more (1) diverse, and (2) frequent organizational actions than new venture managers with lower levels of proactive causal logic. Examination of the regression coefficients and the corresponding graphs reveals a pattern of effects consistent with our expectation for diverse ($p < 0.01$) and frequent actions ($p < 0.10$). Simple slope tests confirmed this pattern of relationships for high and low levels of

Table 1. Descriptive statistics and correlations

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Diversity																
2. Frequency	−0.18															
3. Speed	−0.18	0.19														
4. Complexity	−0.16	−0.15	−0.15													
5. Centrality	−0.02	−0.11	−0.18	0.32												
6. Proactive causal logic	−0.10	−0.12	0.15	0.38	0.20											
7. Industry growth	0.00	−0.04	0.15	−0.19	0.03	−0.20										
8. Financial slack	0.07	0.17	0.01	0.08	0.17	0.08	−0.21									
9. Prior performance	−0.16	0.27	0.14	0.11	0.10	0.08	−0.15	0.30								
10. Industry concentration	−0.02	0.15	−0.24	−0.17	0.05	−0.08	0.04	0.29	0.17							
11. Firm age	−0.02	0.10	−0.02	−0.09	−0.17	−0.02	−0.17	0.08	0.04	−0.14						
12. Firm size	0.03	0.07	−0.03	0.04	0.16	−0.07	−0.04	0.29	0.28	0.13	0.08					
13. Industry 1	0.09	−0.19	0.16	0.00	−0.06	0.07	−0.17	−0.16	−0.23	−0.49	0.11	−0.34				
14. Industry 2	−0.12	−0.07	−0.01	−0.04	−0.05	0.09	−0.03	−0.09	−0.03	−0.16	0.10	0.16	NMF			
15. Industry 3	0.14	0.25	−0.16	0.10	0.03	−0.12	−0.05	−0.07	0.15	0.41	−0.16	0.06	NMF	NMF		
16. Industry 4	−0.10	0.13	−0.08	−0.03	0.21	−0.19	0.27	0.24	0.22	0.47	−0.12	0.23	NMF	NMF	NMF	
Mean	0.27	22.23	29.69	1.27	22.40	0.01	8.80	3.66	13.04	0.42	4.38	135.27	0.55	0.17	0.09	0.19
Standard deviation	0.10	12.14	25.29	0.28	6.43	1.65	10.89	1.31	64.73	0.133	2.30	118.22	0.50	0.38	0.28	0.30

Correlations are significant at $p < 0.05$ when coefficients are |0.2|.

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Table 2. Robust regression analysis results of the effect of industry growth and belief structure attributes on new venture strategic actions

	Diversity			Frequency			Speed		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
Control variables									
Firm age	−0.002	−0.002	0.002	4.990**	5.289**	4.868**	−3.760	−5.711†	−6.109†
	0.010	0.016	0.015	1.886	1.758	1.809	4.326	3.950	3.466
Firm size	0.014	0.017	0.014	−0.300	−0.643	−0.376	−0.323	0.191	0.211
	0.016	0.018	0.016	0.763	0.663	0.667	2.134	2.136	1.900
Prior performance	−0.002**	−0.002**	−0.002†	0.033†	0.126**	0.034†	0.061*	0.076†	0.071*
	0.000	0.000	0.001	0.018	0.027	0.017	0.025	0.042	0.035
Industry concentration	−0.070†	−0.060†	−0.050	0.821	3.433	−0.222	−46.198*	−26.842	−26.396
	0.040	0.035	0.050	13.307	21.82	17.593	20.694	18.843	18.783
Financial slack	−0.003	−0.005	−0.005	0.223	0.441	0.186	0.790	1.135	1.363
	0.009	0.011	0.010	0.796	0.726	0.703	2.373	2.634	2.467
Industry 1	−0.017	−0.020	−0.021	0.682	0.723	0.586	−7.150	−10.114	−7.682
	0.022	0.020	0.020	2.257	2.112	2.165	6.836	9.038	9.188
Industry 2	−0.007	−0.039	−0.010	11.800*	12.884*	12.487*	−17.427†	−18.362†	−17.713*
	0.034	0.046	0.039	5.916	6.042	6.203	9.468	9.280	8.829
Industry 3	0.005	0.009	0.008	2.765	0.325	0.722	12.951†	−7.634	−7.641
	0.035	0.024	0.025	3.632	6.600	5.583	7.567	10.103	9.965
Direct effects									
Industry growth		0.000	−0.003†		0.025†	0.092		0.180†	0.129
		0.001	0.002		0.015	0.106		0.093	0.105
Complexity		−0.040	−0.042		6.494	7.288†			
		0.050	0.030		3.925	4.180			
Centrality								−0.825†	−0.825**
								0.484	0.299
Proactive causal logic		0.008	0.009*		−1.025	−0.873			
		0.006	0.004		0.664	0.571			
Interaction effects									
Complexity × industry growth			−0.008*			−0.312*			
			0.004			0.107			
Centrality × industry growth									−0.050***
									0.011
Proactive causal logic × industry growth			−0.002**			0.063†			
			0.000			0.039			
R^2	0.13	0.15	0.22	0.18	0.20	0.25	0.14	0.19	0.24
N (sample size)	104.00	104.00	104.00	104.00	104.00	104.00	94.00	94.00	94.00

Diversity and speed are reverse coded, a number closer to zero is indicative of more diversity or speed.
***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; †$p < 0.10$ (two-tailed)

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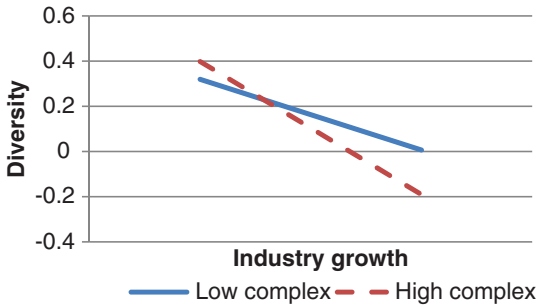

Figure 1. The effect of belief structure complexity on the relationship between industry growth and diversity of new venture strategic actions (diversity is reverse coded)

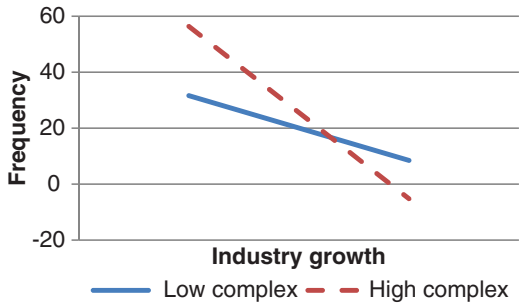

Figure 2. The effect of belief structure complexity on the relationship between industry growth and frequency of new venture strategic actions

proactive causal logic. These results offer support for Hypothesis 2.

Hypothesis 3 predicted that, as industry growth increases, new venture managers with high levels of belief structure centrality will translate industry signals into faster actions than new venture managers with lower levels of belief structure centrality. Examination of the regression coefficients in Model 3 and of the corresponding graph (Figure 3) reveals strong support for this hypothesis ($p < 0.001$). Simple slope tests confirmed this pattern of relationships.

Figures 3–5 suggest that interaction effects with belief structure centrality and proactive logic are stronger than anticipated. As illustrated, the slope of the relationship between the action characteristics (diversity, speed) and industry growth are reversed for high and low levels of the focal structural attribute (proactive and centrality). Crossover (disordinal) interactions appear when interaction effects are stronger than main effects coupled with the existence of a number of sample cases in the range of the values where the cross

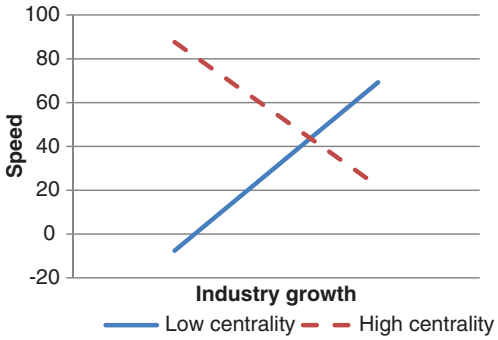

Figure 3. The effect of belief structure centrality on the relationship between industry growth and speed of new venture strategic actions (speed is reverse coded)

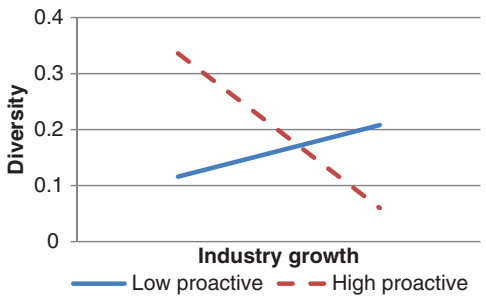

Figure 4. The effect of proactive causal logic on the relationship between industry growth and diversity of new venture strategic actions (diversity is reverse coded)

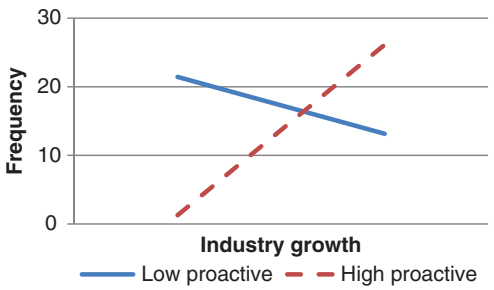

Figure 5. The effect of proactive causal logic on the relationship between industry growth and frequency of new venture strategic actions

occurs (cf. Cohen *et al.*, 2003). These results further validate the theoretical lens employed.

Robustness tests

To ascertain the robustness of our results, we bootstrapped our regression estimates (Aguinis *et al.*, 2013; Efron and Tibshirani, 1993; Fox, 2008; Stine, 1989). We randomly generated 1,000

bootstrap samples through case resampling and constructed confidence intervals (95%) for our interaction terms using the bias-corrected percentile method. The results confirmed that the pattern of effects obtained through our initial tests is robust (all interaction terms were significant at the 0.05 level, with the exception of the interaction between proactive causal logic and industry growth, which was significant at the 0.1 level).

To rule out the alternative explanation that the significant effects may be driven by our pharmaceuticals subsample, we conducted an additional robustness check. We compared the amount of variation on the moderating variables between the sample of pharmaceutical firms ($N = 57$) and the rest of the sample ($N = 47$). These analyses revealed that there are no significant differences between the two subsamples on the following variables of interest: industry growth ($p = 0.12$), belief structure complexity ($p = 0.70$), belief structure centrality ($p = 0.65$), and proactive causal logic ($p = 0.48$).

Our sample includes a limited number of firms from the computer industry and firms that undertook an IPO during the 2001–2003 time period. To account for the dot.com bubble effect (IPOs conducted between 1997 and 2000) and the 2001–2003 economic downturn, we estimated models with additional control variables (dummies). The inclusion of these variables did not significantly alter our results and, to maintain parsimony in our analysis, we did not include them in our final reports.

POST HOC ANALYSIS: THE PERFORMANCE IMPLICATIONS OF NEW VENTURE STRATEGIC ACTIONS

Prior research suggests that in contexts characterized by high uncertainty and complexity, such as those characteristic of new ventures, experimentation along various dimensions of the organizations, broad action repertoires, and fast responses are indicators of successful adaptation and may lead to firm performance (Brown and Eisenhardt, 1997; Eisenhardt, 1989; Miller *et al.*, 1996; Nicholls-Nixon *et al.*, 2000). We tested this proposition in the context of our study by using a well-established measure of new venture performance (i.e., sales growth over a period of three years) captured in the years subsequent to those when actions were captured (Hmieleski and Baron, 2008). Results are presented in Table 3.

As expected, diversity of strategic actions is positively related to new venture performance ($p < 0.1$). Contrary to our expectations, fast implementation of strategic actions is negatively related to new venture performance ($p < 0.05$), and frequency of new venture action does not have a significant impact on new venture performance. The results suggest that adopting an aggressive monitoring posture and frequently probing the environment (Brown and Eisenhardt, 1997; Nicholls-Nixon *et al.*, 2000) is not significantly related to new venture performance. This might be due to the resource-constrained new venture context where frequent actions may disperse limited attention and resources across too many

Table 3. OLS regression results of the effect of new venture strategic actions on performance

	New venture performance	
	M1	M2
Control variables		
Firm age	9.897†	10.639†
	5.907	5.785
Firm size	14.878	18.634*
	13.916	13.587
Industry concentration	−538.999**	−513.050**
	158.739	155.305
Financial slack	10.442	7.762
	11.365	11.093
Prior performance	−0.245	−0.177
	0.574	0.565
Industry growth	−3.310*	−3.690
	1.498	1.468
Industry 1	32.990	23.126
	38.380	36.444
Industry 2	176.640**	207.172**
	62.310	60.882
Industry 3	146.650***	189.586***
	48.040	51.521
Direct effects		
Diversity		−196.128†
		100.207
Frequency		0.049
		1.173
Speed		1.148*
		0.542
R^2	0.24	0.32
Model F	2.93**	3.13**
N (sample size)	104	94

Diversity and speed are reverse coded, a number closer to zero is indicative of more diversity or speed.
***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; †$p < 0.1$ (two-tailed)

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unproductive/unnecessary adjustments. Thus, while frequent actions may lower the hazard of death for the organization (Singh, Tucker, and House, 1986), they do not necessarily translate into growth in the way that diverse actions do. The finding that speed of organizational actions is negatively related to new venture growth highlights the complex nature of the concept of speed. Early work on the topic of speed and firm performance has focused on the positive impact of *speed of decision making* on firm performance (Baum and Wally, 2003; Bourgeois and Eisenhardt, 1988; Eisenhardt, 1989). Our study looks at the *speed of implementation of a previously reached decision.* Taken together, the results of studies on decision speed and this study on implementation speed may provide a more complete perspective on this topic. Assuming that any action must be timely in order to improve performance, the action must occur within a given period of time between the emergence of an event that requires a decision and the actual response. It may be that those firms that spend less time debating the decision and more time figuring out how to effectively implement it are more successful than those who spend more time making the decision and are therefore forced to rush through implementation in order to make a timely response.

DISCUSSION AND IMPLICATIONS

What are the drivers of new venture strategic adaptation? In this study, we addressed this question by conceptualizing strategic adaptation as an information processing process in which new venture strategic actions are reflections of how new venture managers make sense of signals associated with the environments in which they compete. Drawing from the literature on managerial cognition, we argued that belief structure attributes are an important facilitator of the information processing activities they carry out and, when examined in conjunction with an attribute of the environment in which they compete, of strategic actions. We also drew from literature on continuous adaptation to identify the types of firm actions that are likely to be associated with new venture strategic adaptation. Our results suggest that the espoused belief structures characterized by high levels of complexity, centrality, and a proactive causal logic may allow new venture managers to make sense of complex industry signals and translate those signals into the types of firm-level actions that are important in strategic adaptation. Taken together, our findings extend prior literature on firm strategic adaptation. We first discuss the implications for *early-firm* strategic adaptation. We then discuss implications for the broader strategic adaptation literature.

Belief structures, industry context, and new venture strategic adaptation

Our study provides a bridge between the deterministic and choice perspectives that have been taken in prior research on new venture strategic adaptation. By jointly examining the influence of industry and belief structures, we show that *both* perspectives are critical to understanding the factors that lead to new venture strategic adaptation. Some prior research (e.g., Feeser and Willard, 1990; Sandberg and Hofer, 1987) has exhibited a bias toward ecological models and a deterministic stance on these issues with limited interest towards choice variables. Others take a decidedly choice-oriented perspective (e.g., Baum *et al.*, 1998; Nicholls-Nixon *et al.*, 2000) and argue for the importance of entrepreneur-related attributes for new venture strategic action. However, this perspective has underplayed the role of environment in new venture strategic action. By employing a theoretical lens—information processing—that rests on the assumption that choice and deterministic variables are intertwined, we develop a model of new venture strategic adaptation and test it within the context of growth-oriented new ventures. Our study highlights the *interactive* nature of the relationship between individual (choice) and industry context (deterministic) that leads to new venture strategic action.

Our study provides an elaborated understanding of the role of belief structures in new venture strategic adaptation processes. Our results reveal significant relationships between industry growth and specific belief structure attributes and the nature of firm action, and support the argument that belief structures play an important role in identifying and translating opportunity signals into firm level actions that are associated in the literature with forming a better understanding of the environment, successful strategic adaptation, and ultimately higher levels of performance (Brown and Eisenhardt, 1997; Eisenhardt and Schoonhoven, 1990; Forbes, 2005). The results suggest that new

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venture strategic actions are determined, in part, by the managerial capacity for noticing and interpreting environmental forces and for making decisions about the types of actions required to adapt effectively. As hypothesized, complex belief structures facilitate a more diverse set of actions, suggesting that new ventures managers that navigate their environments with more complex belief structures are better able to discern among an abundance of environmental stimuli emanating from high growth environments and translate them into diverse courses of action, thereby mirroring the variety of signals present in those environments and achieving the requisite variety required for effective action (Weick, 1979). Interaction between industry growth and proactive causal logic was associated with frequent and more diverse actions, suggesting that such logics motivate actions associated with framing signals from the environment as opportunities to influence the nature of that environment through action. High levels of belief structure centrality that direct attention towards relevant signals in the environment were found to contribute to swift implementation of new product-related actions as industry growth increased. The strength of these relationships, as represented by the opposing slopes related to proactive logics and centrality, underscore the importance of certain levels of specific belief structure attributes for the translation of industry signals into new venture strategic actions.

Our results provide additional, interesting insights into the role of belief structures in new venture strategic action. Contrary to what prior research on organizational adaptation in high velocity environments suggests (e.g., Bogner and Barr, 2000; Nadkarni and Barr, 2008), high levels of belief structure complexity *inhibit* frequent new venture actions when associated with industry growth. This finding suggests that entrepreneurs who hold complex belief structures of their firm and its environment do not necessarily interpret signals in the environment as opportunities to engage their firms in more actions, but rather in a *more diverse set* of actions. New ventures with more complex belief structures may be engaging in a more sophisticated form of environmental interpretation and subsequent experimental probing than those with simpler models. Rather than engaging in frequent experimental probes designed to discover more about a single dimension of the environment, multiple actions designed to market test the domestic market viability of a new product, for example, complex belief structures, may lead to better recognition and discernment among diverse elements in the environment and allow new ventures to engage in fewer but more nuanced array of probes designed to learn about multiple dimensions of the environment, such as the domestic market viability of a new product, international markets, potential alliances, and adjustments to capacity.

Finally, we extend prior literature on cognition and early stage firm adaptation (e.g., Tripsas and Gavetti, 2000) that has argued for the importance of entrepreneur's beliefs in guiding the choice of activities (strategies) in which new firms engage and in the subsequent development of capabilities by clearly identifying and analyzing a set of belief structure attributes that, when examined in conjunction with an important aspect of the environment in which the new firm competes, promote experimentation with a high variety of actions and aid decision implementation. Both experimentation (as reflected in the diversity of actions a firm pursues) and action implementation (as reflected in speed) are important capabilities that new firms need to develop and balance for successful adaptation in highly turbulent environments (Gavetti, 2005).

Implications for the broader strategic adaptation literature

Our results highlight the potential for greater insight into the process of continuous adaptation through the inclusion of cognitive factors. While prior research has identified organizational characteristics associated with actions that typify continuous adaptation—diverse, fast, and frequent—such as simple rules and time-paced change (Brown and Eisenhardt, 1997), it has not explicitly considered the influence of top managers' belief structures. Prior research does, however, suggest that aspects related to top managers' belief structures can have a significant influence on organizational adaptation in fast-paced environments or those experiencing discontinuous change (Bogner and Barr, 2000; Eggers and Kaplan, 2009; Kaplan, Murray, and Henderson, 2003).

Our preliminary results suggest that finer-grained analyses of the nature of interactions between entrepreneurs' belief structure attributes and dimensions related to the environment are warranted when explaining continuous adaptation. For example, our study suggests that entrepreneurs with high levels of proactive causal logic may be better able to translate

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signals from the environment into what prior theory (e.g., Bingham and Eisenhardt, 2008; Brown and Eisenhardt, 1997) suggests is an appropriate level of frequency, while those with low levels of proactive causal logic do the opposite of what theory would suggest.

Prior work in this research stream has highlighted the important role of managerial cognition to firm adaptation, but these findings have resulted from simulations (e.g., Gavetti *et al.*, 2005), small sample case studies (e.g., Barr *et al.*, 1992; Tripsas and Gavetti, 2000), or studies that focus on the role of cognition in firm reaction to major environmental discontinuities such as changes in regulations (e.g., Barr *et al.*, 1992) or technology introduction (Eggers and Kaplan, 2009), thereby limiting their generalizability. Our study of 104 firms operating in four different high-technology industries provides evidence that the association between managerial cognition and firm adaptation may be widely generalizable across firms, industries, and is not exclusively tied to specific environmental jolts.

Finally, our *post hoc* analyses raise several interesting issues concerning the model of continuous adaptation that has been put forward as leading to higher performance among firms in high-velocity environments (e.g., Brown and Eisenhardt, 1997; Davis, Eisenhardt, and Bingham, 2009). As noted earlier, our results suggest that, when tested simultaneously, not all of the actions identified in these models are associated with higher performance. This result could point to contextual boundaries as the continuous adaptation model was developed based on studies of established firms in a single industry. The new venture context may be different enough from that of established firms that actions associated with continuous adaptation do not directly translate into new venture performance. Or it may be that the observations made in the continuous adaptation studies are particular to the microcomputer industry. It may also be that the different action types vary in either their level of effect on performance or in the type of performance outcomes they affect. For example, diversity of action may be the main promoter of effective adaptation, with speed and frequency playing a more minor or supporting role. Or it may be that, while diversity affects sales performance, frequency and speed influence other outcome measures such as market share or profitability. This difference in results points to the need for more large-scale studies of adaptation in high-velocity environments.

Limitations and future research directions

Although the results presented in this study are encouraging, a number of theoretical and empirical limitations in the analysis call for further research. The goals of capturing belief structures unobtrusively and of controlling for variations in institutional contexts and industries to the maximum extent possible required that the sample be limited to a sample of founder-managed publicly traded firms competing in the United States. In addition, while the theoretical model and hypotheses apply to all growth-oriented new ventures or firms in the active stages of strategic adaptation, the focus on high-tech new ventures limits the generalizability of the findings. The extent to which our empirical findings generalize to different institutional and cultural settings or to firms that are not publicly traded, that are older and highly diversified, or that compete in other types of industries are empirical questions that should be addressed in future work.

In adopting an information processing perspective, we assumed that the role of belief structures was to facilitate the activities associated with information processing, and our results are consistent with such a role. The associations that we found between environment, belief structure attributes, and actions do not, however, provide any insight into exactly how the various structures we studied influenced each element associated with information processing (e.g., noticing, interpretation). Alternative, experiment-based studies may be able to draw clearer connections between process stages and structural attributes.

The cross-sectional design of our study limits our ability to make causal inferences about the observed relationships. The fact that our action data were lagged from the time period for which the industry and cognition data were captured supports our case for causality. Our arguments would perhaps be made stronger if both the independent and dependent variables were measured on multiple occasions over time. However, trade-offs need to be recognized when taking such an approach as the young firms in our sample would enter a more mature stage (e.g., new ventures that undertook an IPO during the seventh year of their existence would become "mature" firms by the 10th year of their existence according to most definitions) where additional sources of variation (e.g., organizational structure and governance) will need to be taken into account.

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