How does An Entrepreneur's Ability Influence the Propensity to Exploit Novel Opportunities? The Moderating Role of Personality and Environment

Lena Lee and Poh Kam Wong

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Lena Lee, National University of Singapore

Poh-Kam Wong, National University of Singapore

Abstract

While prior research has examined the influence of entrepreneurs' ability and personality on entrepreneurial behavior separately, our study's contribution is to confirm their joint effects, as well as their interaction effects with the dynamism of the environment on entrepreneurs' opportunity exploitation behavior. Our study's findings are consistent with the emerging opportunity-exploiter nexus framework of Shane and Venkataraman, which posits that the rate and nature of entrepreneurial exploitation activities are jointly determined by the nexus of environmental factors that shape the emergence of opportunities and the supply of opportunity-seekers with the right entrepreneurial personalities and abilities to exploit such opportunities. Specifically, we found that highly critical entrepreneurs who are high in extraversion, agreeableness, openness to experience, independence, and emotional stability have higher propensity to exploit novel opportunities in uncertain environments.

INTRODUCTION

The ability to recognize, evaluate and exploit opportunities is recognized by both researchers and practitioners as an important driver for new venture creation (Shane and Venkataraman, 2000) Among these three phases of opportunity discovery, opportunity exploitation is probably the closest and most fundamental step to actual business start-up (Choi and Shepherd, 2004). Yet, with the exception of Choi and Shepherd (2004), there have been few empirical studies on this issue, particularly on the antecedents to opportunity exploitation in the extant literature. Our paper specifically examines the influence of internal predictors and the environment on individuals' propensity to exploit novel opportunities in the context of new-technology based firms (NTBF). While the majority of technology-based firms were founded on the basis of opportunity (Oakey and Cooper, 1991) e.g. technology opportunity and/or market opportunity, these firms may differ in terms of the novelty of the exploited opportunity. Some firms may introduce products or services that are totally new to the world, while others may introduce refinements of existing ones. The question is how and in what capacity can entrepreneurs exploit novel business opportunities?

The existing literature emphasized that the opportunities entrepreneurs exploit are based on their prior knowledge (Shane, 2000; Venkataraman, 1997), and therefore the novelty of opportunities is closely related to the novelty of entrepreneurs' knowledge base i.e. technical knowledge and market knowledge. Drawing on the critical thinking literature, we propose that the entrepreneurs' critical thinking ability is a key determinant of their adeptness at exploiting novel knowledge. Given that critical thinking requires the use of cognitive skills to solve problems, formulate inferences, and calculate likelihoods of the probability of a desired outcome (Halonen, 1995), individuals with high critical thinking skills are more likely to seek, identify, and exploit new technical and market knowledge for start-ups.

However, scholars have affirmed that personality, an independent construct from cognition influences the way critical thinking is directed and exploited (Sternberg, 1988). The logic is that two people with comparative levels of critical thinking but varying levels of personalities will respond differently to the knowledge and know-how they possess. Past studies on the effects of personality attributes such as extraversion, agreeableness, low anxiety/emotional stability, low control/independence, and openness to experience on start-up propensity, survival growth and success of firms have found that each of these personality components is positively related to entrepreneurship in some way or other (Beugelsdijk and Noorderhaven, 2005; Ciavarella et al., 2004; Hisrich, 2000; Singh and DeNoble, 2003), Although no past studies have examined the combined impact of these personality attributes, it is reasonable to assume that a high composite score on these attributes will positively influence entrepreneurs with high critical thinking ability to exploit novel opportunities.

Additionally, the environment literature provides ample evidence that unpredictable environments create more opportunities for entrepreneurs to innovate and explore new ideas (Dess et al., 1997). Unlike predictable environments where customers demand for standard products and services, dynamic environments consist of unpredictable customer tastes and uncertain product-service technologies (Milliken, 1987). A volatile environment offers more avenues for highly critical entrepreneurs to realize innovative solutions as they have the ability to critically analyze the capricious conditions that are present in the environment. In other words, the environment moderates the likelihood of entrepreneurs with high critical thinking ability to exploit new knowledge. Taken as a whole, we contend that highly critical entrepreneurs who are high in extraversion, agreeableness, emotional stability, openness to experience, and independence have higher propensity to exploit novel opportunities in unstable environments.

LITERATURE REVIEW

In a world characterized by increasing international competition and radical changes in patterns of consumption and production, the need to proactively pursue new opportunities and solutions is important. It is not sufficient to have new ideas; they must lead to "the successful product, assimilation and exploitation of novelty in society" through innovation (European Commission, 1995, p. 9). The entrepreneur's ability to recognize and exploit novel opportunities for new venture creation is a source of competitive advantage, particularly in relatively unpredictable environments that require change for immediate survival (Freel and Robson, 2004).

Previous work has examined many factors that play a role in the recognition and exploitation of opportunities for new business ventures. Among the myriad of factors, prior knowledge of the market, customers, and the industry's technology have been identified as especially important (Venkataraman, 1997). For example, studies on entrepreneurial opportunities found that prior knowledge of customers needs greatly enhances entrepreneurs' ability to identify potentially valuable business opportunities that meet these needs (Shane, 2000). Recent evidence in the literature emphasized the synonymity between novel opportunities and novel knowledge (Saemundsson and Dahlstrand, 2005). Two dimensions of the founders' knowledge base such as technical knowledge and market knowledge have been established as important determinants of the extent of novel opportunity exploitation that entrepreneurs seek to exploit (Autio and Lumme, 1998). Novel market knowledge allows entrepreneurs to more effectively serve their markets (Shane, 2000) while novel technological knowledge opens up avenues for entrepreneurs to respond rapidly to competitors' advancements (Cohen and Levinthal, 1990). According to Autio and Lumme (1998), the novelty of opportunities ranges from low, when opportunities are based only on existing

technical and market knowledge, to high, when opportunities are based only on new technical and market knowledge.

Given the synonymity between novel opportunities and novel knowledge, the question is in what capacity can entrepreneurs exploit novel business opportunities based on prior new market and technical knowledge? Shane and Venkataraman (2000, p. 222) postulated that certain cognitive properties are necessary in order to appreciate and exploit prior knowledge. Indeed, human intelligence (Corbett, 2005) and personality (McCrae and Costa, 1997) perspectives suggest that entrepreneurs' abilities and personalities are positively related to their success at exploiting opportunities. Entrepreneurs are not a homogenous population and there could be different types of entrepreneurs, distinguished by their growth orientation, motivation and type of business (Caird, 1993). Similarly, entrepreneurs could also be differentiated by the types of opportunities that they exploit. Yet, little is known about the personal characteristics of entrepreneurs who have the capacity to exploit novel opportunities.

Personal characteristics of entrepreneurs have been acknowledged as key determinants that differentiate different categories of entrepreneurs (MacMillan et al., 1985). As Shaver and Scott (1991) eloquently put it: "Economic circumstances are important; social networks are important; entrepreneurial teams are important; marketing is important; finance is important; even public agency assistance is important. But none of these will, alone, create a new venture. For that we need a person, in whose mind all of the possibilities come together, who believes that innovation is possible, and who has the motivation to persist until the job is done". Our paper extends the ongoing research on entrepreneurial characteristics by focusing on two individual aspects of entrepreneurs such as their ability and personality.

In a rapidly changing world, there are many opportunities for entrepreneurship and in view of the importance of the role played by individuals in the process, it is imperative to

recognize people with the entrepreneurial ability to exploit novel opportunities. The traditional views of entrepreneur as a decision maker, resource combiner, and risk-taker (Van Praag and Cramer 2001) indicate that entrepreneurial ability is an important determinant influencing entrepreneurs' adroitness at exploiting novel opportunities. In our study, we characterized entrepreneurial ability based on Olson's (1985) "two mode thinking" perspective. Essentially, this perspective takes on the view that the tasks people perform for certain jobs determine the abilities that are required to perform them. Olson asserted that the tasks entrepreneurs undertake could be synthesized into a process that consists of two phases with each phase representing a unique set of activities.

The first phase consists of inventive activities such as the awareness and creation of original ideas in response to identified needs, while the second phase comprises of innovative activities such as the implementation and marketing of new ideas. Olson acknowledged the possibility that there would be "situations where no clear division could be established between invention and innovation" but maintains that "these terms generally serve to separate the entrepreneurial process into distinguishable phases". The first phase requires creative and intuitive thinking abilities to assist entrepreneurs in identifying initial opportunities while the second phase requires rational and critical thinking abilities to assists entrepreneurs in exploiting opportunities for extended development. Our focus is on the second phase of the entrepreneurial process where rational and critical thinking assume a significant role in influencing entrepreneurs' capacity to exploit novel opportunities.

Critical thinking ability (hereinafter referred to as CTA) has been accepted as a primary tool for dealing with the many dilemmas and paradoxes in today's turbulent environment (Novelli, 1993). What is CTA? There is no single definition that is widely applied in the literature (Halonen, 1995) but CTA is generally recognized as the use of cognitive skills or strategies that increase the probability of a desirable outcome. It is used to

describe thinking that is purposeful, reasoned, and goal directed for the purpose of solving problems, formulating inferences, calculating likelihoods, and making decisions (Halpern, 1996). Individuals with high critical thinking abilities are reflective, focused, and able to recognize the existence of problems, and apply the relevant skills and knowledge to solve the problems. In the context of opportunity exploitation, entrepreneurs are expected to be sensitive to market needs and be able to prescribe solutions to meet these needs (Ardichvili et al., 2003). In this respect, we posit that CTA is essential because it directs entrepreneurs' capabilities to draw on their prior knowledge, particularly new knowledge to create a "fit" between underutilized resources and unmet market needs.

The skills that define CTA such as the competency to identify problems, gather relevant information, evaluate possible solutions, and apply the best solution (Halonen, 1995) are closely associated with the elements of the opportunity exploitation process such as perception of market needs, recognition of "fit" between market needs and underutilized resources, as well as the deployment of the underutilized resources to meet market needs (Hills, 1995). Findings from cognitive science research indicate that well-connected knowledge structures are more easily converted into new combinations of patterns (Matlin, 2002). Matlin advocated that in order to develop new combinations of resources and implement changes, it is important for individuals to establish connections between knowledge stored in memory and other cognitive systems. We argue that one way in which such connections could be formed in order for entrepreneurs to realize the economic potential of their prior knowledge is through the enhancement of their critical thinking ability.

However, the existing literature has established that an individual's critical thinking ability is directed by his/her personality (Sternberg, 1988). Two individuals of similar abilities might behave quite differently, depending on how their personalities direct and moderate their abilities. Sternberg's theory of "the triachic mind", which emphasizes the

importance of critical thinking, signifies that personality factors could influence the effectiveness of an individual's critical thinking. He argued that personality could enhance or obstruct the free flow of critical thinking, and prevent individuals from making the most of their ability. The basic premise is that the interface between critical thinking ability and personality could provide a better prediction of performance on certain tasks and situations. Based on this premise, we assert that the interaction between critical thinking ability and personality provides a stronger explanation than critical thinking alone of the entrepreneurs' propensity to exploit novel opportunities.

Commentaries by Sternberg (1988, 1990) demonstrate that personality could in many ways affect the full realization of an individual's critical thinking ability. During the past four decades, personality factors have been used to predict the individual's entrepreneurial propensities (Baum and Locke, 2002; McClelland, 1965). Despite the conflicting results obtained (Sexton and Bowman 1983), the fundamental proposition that entrepreneurs are members of a unique homogenous group still attracts interest among entrepreneurship scholars (Brandstätter 1997; Ciavarella et al., 2004; Hisrich 2000; Singh and DeNoble, 2003). Although most studies that have attempted to understand the nature of entrepreneurs have examined the impact of personalities, far fewer studies have explored which personality types are more likely to start new businesses based on novel opportunities. Drawing on the extant personality literature, we propose that personality has a significant influence on entrepreneurs' propensity to exploit novel opportunities for new venture creation through its interaction with the entrepreneurs' critical thinking ability.

Personality traits such as extraversion, low anxiety, agreeableness, openness to experience, and low control have been found to be a robust indicator of an individual's personality (Cattell, 2000). However, these traits have yet to be tested with respect to entrepreneurial opportunity exploitation. An extravert has a need to be around others,

socializing and working with others, rather than remaining alone. Extravert people are also touted to be assertive and more likely to take on leadership roles (Judge and Higgins, 1999). Extraversion, sometimes referred as the “need for affiliation” (Begley and Boyd, 1985) is the inclination to be sociable to external events and activities, a trait which facilitates the development of social networks and partnerships with suppliers and customers (Barringer and Greening, 1998). The ability to establish networks with suppliers, customers, and advisors is a critical aspect of the start-up process (Baron and Markman, 2000), and doing so effectively could increase the likelihood of entrepreneurs with high critical thinking ability to identify and exploit new knowledge for new venture creation.

Individuals with low anxiety are confident and are able to keep their composure under stressful conditions. They are less prone to stress and are able to maintain relationships (Hurz and Donovan, 2000). On the other hand, individuals with high anxiety are less able to withstand the stressful circumstances at start-ups, and could develop negative views around the possibilities of developing new ventures based on novel and untested ideas. Albeit with the critical thinking ability, these individuals are less likely to be resilient at overcoming the riskiness of exploiting novel opportunities, and managing the uncertainties of starting a business based on new knowledge. Another important trait that could strengthen the positive relationship between critical thinking and propensity to exploit novel opportunities is agreeableness. Entrepreneurs who are agreeable are able to maintain quality relationships with other individuals and firms, and thus more likely to receive essential information for new venture creation (Larson and Starr, 1993). Those high on agreeableness are said to be courteous and flexible. This friendliness would enable entrepreneurs to garner support from stakeholders and develop alliances with other individuals, which could result in new market and technology knowledge (Baron and Markman, 2000).

Openness is the tendency to be creative, original, and receptive to new ideas and experiences, a trait closely associated with creativity (Kuratko and Hodgetts, 1995). Open individuals display a preference for variety, enjoy grasping new ideas, and have an appreciation for novelty (McCrae and Costa, 1997). These attributes are crucial for exploiting new opportunities in the venture creation process as constant technological and market changes in today's business environment demand individuals who are open and fearless to try out new ideas. It would be inconceivable for highly critical entrepreneurs who lack the creative feel for novelty to be able to exploit new market or technology knowledge for business start-ups. Finally, low control refers to the individual's level of self-control and restraint, a characteristic not influenced by societal norms and expectations. Low control is a personality trait that relates to the need for autonomy (Caird, 1991) and self-confidence (Koh, 1996). Individuals who have low levels of tolerance for control prefer to make decisions on their own, are not bounded by societies' views, and would be more likely to develop the courage and initiative to search for novel opportunities to exploit. A low need for external control moderates the relationship between entrepreneurs' critical thinking ability and their propensity to exploit novel opportunities. Among entrepreneurs with high critical thinking ability, a low need for external control would enable them to venture into uncharted waters and exploit new knowledge without the desire to conform to societal pressures and the need to seek assurance from stakeholders.

While researchers like Sternberg (1988) has argued that motivational and emotional factors could impede the efficacy of an individual's critical thinking, few if any studies have examined this connection. The above reviews on critical thinking ability and personality suggest that the influence of critical thinking on an entrepreneur's propensity to exploit novel opportunities for new venture creation is in part driven by his/her personality dispositions. The lack of personality attributes such as extraversion, agreeableness, openness to

experience, emotional stability, and self-control among entrepreneurs are considered as an impediment to the full realization of their critical thinking ability for exploiting opportunities based on new knowledge.

Therefore, we propose the following hypotheses:

Hypothesis 1: Among entrepreneurs with high critical thinking ability, a greater composite score on the personality attributes of extraversion, agreeableness, openness to experience, low anxiety, and low control will be associated with greater likelihood of opportunity exploitation based on new market knowledge.

Hypothesis 2: Among entrepreneurs with high critical thinking ability, a greater composite score on the personality attributes of extraversion, agreeableness, openness to experience, low anxiety, and low control will be associated with greater likelihood of opportunity exploitation based on new technical knowledge.

The individual-opportunity nexus framework of entrepreneurship has established that opportunity exploitations are not made in a vacuum, but instead are influenced by the environment (Shane, 2003 p. 145). Indeed, there is an emerging consensus in the literature that views the nature of entrepreneurial exploitation activities as jointly determined by the nexus of environmental factors that shape the emergence of opportunities and the supply of opportunity-seekers with the right entrepreneurial personalities and abilities to exploit such opportunities (Shane, 2000; 2003). In line with this stream of thought, our study aims to empirically examine the interactions between individual-level factors i.e. critical thinking ability and personality and the level of uncertainty in the environment. Environmental uncertainty has been historically defined as the unpredictable change in technologies,

customer tastes, and competitive behavior (Galbraith, 1973). Environment uncertainty might involve uncertainty about what actions key organizational constituents such as suppliers, competitors, consumers, and the government might take (Milliken, 1987). A more recent definition by Zahra and Covin (1995) characterized an uncertain environment as "high levels of competitive, market uncertainties, and a general vulnerability to influence from forces external to the firm's internal environment".

Unpredictable environmental conditions provide the impetus to entrepreneurs to spend a greater amount of their time and resources scanning the environment for advanced information and definite cues (Covin and Slevin, 1990). These boundary spanning and information acquisition activities are directed toward understanding existing market demands and technological changes. When entrepreneurs deliberately assess the environment and search for information, they are more likely to identify new knowledge for opportunity exploitation (Hills and Shrader, 1998). While the uncertainties in the environment offer promising prospects for entrepreneurs to exploit novel opportunities, those with strong critical thinking skills and high on extraversion, openness to experience, agreeableness, emotional stability, and self-control have greater propensity than others to appreciate these novel opportunities.

There is copious amount of evidence in the literature that highlight the importance of generating original ideas in unstable environments (Lumpkin and Dess, 1996; Miller and Friesen, 1984; Zahra, 1993). Grant (1996) found that updated knowledge of markets and technologies are critical for firms operating in unpredictable environments while Teece (1998) reported that entrepreneurs would gain competitive advantage in unstable environments if they could constantly reconfigure their resources to exploit new opportunities. Essentially, research has shown that unstable environments often necessitate an innovative orientation (Miller, 1983; Miller et al., 1988). Miller advocated the need for

entrepreneurs in unpredictable environments to “engage in product market innovation and be the first to come up with proactive innovations” (Miller, 1983: 771). In a similar vein, past studies confirmed that firms operating in uncertain environments enjoyed superior performance through risk taking and innovative behavior. It is apparent from the literature that environment uncertainties present an opening for entrepreneurs to identify new opportunities through elaborate information scanning and search. Furthermore, uncertainties in the environment provide the catalyst for entrepreneurs to adapt to the host of unforeseeable changes in the entrepreneurial ecosystem through continuous exploitations of novel ideas (Khandwalla, 1987; Miller et al., 1988). Consequently, highly critical entrepreneurs who are high on extraversion, agreeableness, self-control, emotional stability, and openness to experience would be more likely able to exploit novel opportunities in uncertain environments.

Taken as a whole, we propose that:

Hypothesis 3: Among entrepreneurs with high critical thinking ability, a greater composite score on the personality attributes of extraversion, agreeableness, openness to experience, low anxiety, and low control in uncertain environments will be associated with greater likelihood of opportunity exploitation based on new market knowledge.

Hypothesis 4: Among entrepreneurs with high critical thinking ability, a greater composite score on the personality attributes of extraversion, agreeableness, openness to experience, low anxiety, and low control in uncertain environments will be associated with greater likelihood of opportunity exploitation based on new technical knowledge.

RESEARCH METHOD

Sample

The results of this study are based on pooled data collected from both founders and co-founders of new-technology based firms (NTBF) in years 2000 to 2005 within the West Midlands, North West and London areas in the UK. The literature defines NTBF as an independent (Little, 1977), relatively young firm (Ferguson and Olofsson, 2004), operating in a high technology sector (Autio, 1994). Following these definitions, we used Dun and Bradstreet, the leading credit rating and business information agency in UK to obtain a sample of firms, which were less than twelve months old that operate in the high-technology manufacturing sectors established by Burchart (1987) such as software, ICT hardware, engineering, health and life sciences.

The pooled data for this study were collected in two phases for each of the six years. Prior to the first phase of survey, invitations to participate were mailed to CEOs of firms less than twelve months old operating in the defined high tech manufacturing industries. A total of 1,988 invitations were mailed during the six years and of these 1,988 invitations, 358 CEOs had agreed to participate, yielding an 18% response rate. Possible non-response bias was examined by comparing the representation of high-tech manufacturing sectors of respondents (n = 358) with those of non-respondents (n = 1,630). One-way between group analysis of variance (ANOVA) of high-tech sectors resulted in a statistically non-significant F of 0.81 (p = 0.59).

Upon receiving an agreement from the CEO to participate, arrangements were made to administer the questionnaire face-to-face. The face-to-face meeting with the CEO marked the beginning of the first phase of the survey. To minimize common method variance, part of the questionnaire was also administered face-to-face with the deputy CEO/co-founder of the firm. The first phase of the survey generated 358 pairs (CEO and

deputy CEO) of responses. The second phase of the survey was conducted six months after the first the meeting with the CEOs and deputy CEOs. Questionnaires were emailed to both the 358 CEOs and deputy CEOs who had responded in the first phase. Of the 358 pairs of questionnaires that were emailed, 328 pairs were returned. Those who did not return the questionnaires were either non-contactable or had refused to participate for the second time. At the end of the second phase, we had a total of 328 valid pairs of responses from both the CEOs and deputy CEOs. The personality, critical thinking ability and control questions were administered only to the CEOs while the environment and opportunity exploitation scales were completed by both the CEOs and deputy CEOs. Details of the questions that were solicited from both the CEOs and deputy CEOs in the two phases are delineated in the following section on the study's variables.

Data analysis method

We were interested in predicting the effects of the entrepreneur's critical thinking ability, personality, and the level of environment uncertainty on the novelty of opportunity exploitation based on new market and new technology knowledge. The measures of our dependent variables i.e. novelty of new market knowledge and novelty of new technology knowledge were represented by ordinal data with values ranging from 1 – strongly disagree to 5- strongly agree. Therefore, we used ordinal logistic regression to test our study's hypotheses because ordinal models take into account the ordered classifications of the dependent variables (Long and Freese, 2006).

Dependent variable

Our study focused on 2 dependent variables. The first was the novelty of opportunity exploitation based on new market knowledge, and the second was the novelty of

opportunity exploitation based on new technical knowledge. Both these variables were measured by asking the respondent CEO and deputy CEO their level of agreement on a series of statements, which were anchored on a 5-point Likert scale. Both the CEOs and deputy CEOs responded to these statements via emails during the second phase of the survey. For full details of the study's questionnaire items and its operationalizations, see Appendix 1.

In order to ensure that the data used in the analyses were reliable, we compared the responses of the CEOs with those of the deputy CEOs. We found that there was a high level of convergence between the responses of the CEOs and deputy CEOs on all the measurement items of the dependent variables. One-way ANOVA analyses revealed that there were no statistically significant differences between the responses of the CEOs and deputy CEOs on the dependent constructs ($F = 0.55$; $p = 0.69$ for novelty of market knowledge and $F = 0.39$; $p = 0.81$ for novelty of technical knowledge). Furthermore, the responses of these two groups were positively correlated at the 1% level ($r = 0.75$ for novelty of market knowledge and $r = 0.81$ for novelty of technical knowledge). To minimize the potential effects of common method variance, the responses of the deputy CEOs were used to represent the dependent variables.

Independent variables

The three independent variables in this study were critical thinking ability, personality, and environment uncertainty. Critical thinking ability was measured using the Watson and Glaser's (1990) Critical Thinking Analysis (WGCTA) – Form C, which includes 80 items from five subtests on inference, assumptions, deduction, interpretation, and discussion, each with 16 items anchored on a scale of 1 (True) to 5 (False). For each of the 80 items, respondents were tasked to evaluate the appropriateness and validity of the

propositions. The WGCTA is one of the most widely used instruments for assessing critical thinking skills, and its validity and reliability have been widely researched and established (see Modjeseski, 1982 for review). The *total critical thinking score* is a summation of the five subscale scores. According to Watson and Glaser (1980), the total critical thinking score is a more accurate score measuring critical thinking than the individual subscale scores. The WGCTA instrument was adopted in a myriad of studies that involved managers (Rawls et al., 1975), manufacturing employees (Heraty and Morley, 2000) and management undergraduates (Throrpe and Loo, 2003). In our study, only the CEOs as founders of the business were required to complete the WGCTA appraisal during the first phase of the survey. The total raw scores with a maximum value of 80 were transformed into a standardized score on a Likert scale of 1 (Extremely Low) to 10 (Extremely High) using the norm table provided in the WGCTA manual (Watson and Glaser, 1990).

Personality was measured using Cattell's 16PFi Inventory (2000), which consists of 200 items that comprehensively assess the five-personality constructs of extraversion, low anxiety, openness, agreeableness, and low control. The scores of these five constructs were calculated from the sixteen source traits[1] assessed by the 16PFi, and they provide an overall orientation of the respondent's personality. The 16PF-i is a reliable and the most recent measurement tool for the personality construct (Cattell and King, 2000), which was first created by Cattell and his colleagues more than forty years ago. Only the CEOs were asked to indicate their degree of agreement with each of the 200-item during the first phase of the

[1] The 16 traits are *Factor A*- Cool Reserved vs. Warm-hearted, *Factor B*- Low Intellectance vs. High Intellectance, *Factor C*- Affected by feelings vs. Emotionally Stable, *Factor E*- Accommodating vs. Dominant, *Factor F*- Sober Serious vs. Enthusiastic, *Factor G*- Expedient vs. Conscientious, *Factor H*- Retiring vs. Socially-bold, *Factor I*- Tough-minded vs. Tender-minded, *Factor L*- Trusting vs. Suspicious, *Factor M*- Practical vs. Abstract, *Factor N*- Forthright vs. Discreet, *Factor O*- Self assured vs. Apprehensive, *Factor Q1*- Conventional vs. Radical, *Factor Q2*- Group-orientated vs. Self-sufficient, *Factor Q3*- Undisciplined vs. Self-disciplined, *Factor Q4*- Relaxed vs. Tense-driven

survey. The 200-item scales have been tested for its reliability and construct validity (see Shackleton and Erdos, 2002 for review) and are anchored on a three point Likert scale (true – neither true nor false – false).

The environment uncertainty variable was measured using Miller and Dröge's (1986) five-item descriptive phrases anchored by 7-point semantic differential-type scales. Both the CEOs and deputy CEOs responded to these questions during the first phase of the survey. To ensure that the responses represent the true reflection of the firm's environmental conditions, and not the individual differences between the CEOs and deputy CEOs, we compared the responses of these two groups. We found that there was a significantly positive agreement among CEOs and deputy CEOs of similar firms ($F = 0.62$; $p = 0.49$) than CEOs and deputy CEOs of different firms ($F = 3.04$, $p < 0.001$). This indicates that the responses were true representation of the firm's environmental uncertainties. Given that the deputy CEOs' responses were used to represent the dependent variables, the CEOs' responses were used to represent the environment uncertainty variable.

Control variables

The control variables for this study were gender, age, education attainment, experience within the industry of the new venture, and industrial sector dummies. Only the CEOs were asked to answer the questions on the control variables.

RESULTS

Table I shows the correlation values for the variables. As observed in Table 1, both novelty of market knowledge and novelty technical knowledge were significantly correlated at the 1% level with critical thinking ability ($r = 0.38$ and 0.29 respectively) and experience in

the relevant industry ($r = 0.19$ and 0.20 respectively). In addition, we found that age, personality, environment uncertainty, pre-university/vocational, undergraduate and postgraduate education were positively correlated with both the dependent variables ($p < 0.01$). Apart from the negative correlations between primary education and novelty of market knowledge ($r = -0.12$; $p < 0.05$) and novelty of technical knowledge ($r = - 0.11$; $p < 0.05$) as well as the positive correlation between age and experience within the industry of the new venture ($r = 0.11$; $p < 0.05$), the correlation coefficients among the variables were all below 0.60 (Kennedy, 1992) and none of the VIFs for the models was greater than 2, which was below the guideline of ten by Chatterjee and Price (1991). Thus it was unlikely that multicollinearity among the independent variables affected the findings.

INSERT TABLE 1 ABOUT HERE

Hierarchical ordinal logistic regression was used to examine the amount of variance explained by the base model (control variables only), the main-effects model (controls and independent variables), and the full model (controls, independent variables, and hypothesized interactions). Table II and Table III present the results of the ordinal logistic regressions predicting the novelty of opportunity exploitation based on new market knowledge and new technical knowledge respective. The main-effects models in Tables II and III explained a significant amount of variance over and above the base model, and the full model explained a significant amount of the variance over and above the main-effects model. As observed in Model 1 for both regressions predicting the novelty of market (Table II) and technical knowledge (Table III), age, experience, undergraduate, and postgraduate education, all statistically significant at 0.05 were closely related to the novelty of opportunity exploitation based on new market and new technical knowledge. The findings in Model 1 (Table II and

Table III) also highlighted that secondary education was negatively related to the novelty of opportunity exploitation ($p < 0.05$).

INSERT TABLE II and III ABOUT HERE

The study's hypotheses were tested in Model 3, where the two-way and three-way interactions were incorporated in the regression analyses. Hypotheses 1 and 2 stated that among entrepreneurs with high critical thinking ability, a greater composite score on the personality attributes of extraversion, agreeableness, openness to experience, low anxiety, and low control will be associated with greater likelihood of opportunity exploitation based on *new market knowledge/new technical knowledge*. These hypotheses were supported by the regression analyses. The interaction terms between critical thinking ability and personality were statistically significant at the 5% level with coefficient values of 1.555 and 1.469 for novelty of market knowledge and novelty of technical knowledge respectively. The odds ratios in Model 3 (Table II and Table III) revealed that while entrepreneurs with high critical thinking ability were almost 2 times more likely to exploit opportunities based on new market and new technical knowledge, those with high critical thinking ability and greater composite score on the personality attributes were 3.5 times as likely to exploit opportunities based on new market and new technical knowledge.

Hypotheses 3 and 4 stated that among entrepreneurs with high critical thinking ability, a greater composite score on the personality attributes of extraversion, agreeableness, openness to experience, low anxiety, and low control in uncertain environments will be associated with greater likelihood of opportunity exploitation based on *new market knowledge/new technical knowledge.*. These hypotheses essentially test the three-way interaction between ability, personality, and environment uncertainty. The results in Model 3 of Table 3 and 4 indicated that there were significant positive three-way interactions between

critical thinking ability, personality and environment uncertainty ($p < 0.01$). The findings provided evidence that three-way interactions among ability, personality, and environment uncertainty had higher predictive power than two-way interactions among ability and personality. The beta coefficients for the three-way interactions (b = 2.249 for novelty of market knowledge; b = 2.133 for novelty of technical knowledge) were larger than the coefficients for the two-way interactions (b = 1.555 for novelty of market knowledge; b = 1.469 for novelty of technical knowledge). In addition, the three-way interactions were statistically significant at the 1% level as compared to 5% for the two-way interactions. The odds ratios suggested that among entrepreneurs with high critical thinking ability, a greater composite score on the personality attributes of extraversion, agreeableness, openness to experience, low anxiety, and low control in uncertain environments are close to 5 times as likely to exploit opportunities based on new market knowledge and new technical knowledge.

The results in Model 3 (Table II) also indicated that the pseudo R^2 increased to about 47% from 36% in Model 2, and the significance of the control variables were consistent with Models 1 and 2. .Similar findings were also observed for Model 3 of Table III, where the model variables explained about 43% of the variance in the dependent variable. Essentially, the results of the hierarchical ordinal logistic regressions supported the assertion that the relationship between an entrepreneur's critical thinking ability and exploitation of opportunities based on new market and new technical knowledge is contingent on his/her personality and environmental conditions.

DISCUSSION AND CONCLUSION

Entrepreneurship research based on individual characteristics has long been criticized for the inconsistent findings that differentiate entrepreneurs from non-entrepreneurs. Rather

than focusing on differences between entrepreneurs and non-entrepreneurs, the aim of this paper was to examine the personal variations among different categories of entrepreneurs, particularly to identify distinguishing characteristics of entrepreneurs who start new ventures based on novel opportunities versus those who start new ventures based on existing opportunities. We found that entrepreneurs who exploit novel opportunities do indeed distinguish themselves from those who exploit non-novel opportunities. For starters, entrepreneurs who exploit novel opportunities have higher critical thinking ability. In addition, the positive effects of critical thinking on the novelty of opportunity exploitation are further enhanced when entrepreneurs operate in unpredictable environments, and are high on the composite measure of Cattell's five personality traits i.e. extraversion, agreeableness, openness to experience, emotional stability, and preference for self-control.

The results of our study have a number of policy implications. First, the importance of critical thinking ability for the exploitation of novel opportunities provides an opportunity for policy intervention from the education curriculum perspective. In order to cultivate the skills for critical thinking at an early age, educators could consider aligning their curriculum and courses to promote critical thinking in schools. Students could be exposed to ways on how to improve their ability to critically analyze problems and situations. Courses that focus on inference thinking, recognition of assumptions, deduction, and interpretation skills would help strengthen their overall critical thinking ability. Educators could also train students to think critically under different circumstances by using varied scenarios, role plays, or even real experiences that incorporate the elements of risk and uncertainty.

Second, in today's highly competitive environment, the ability to create new markets and technologies are vital for both survival and profitability. Governments regularly intervene to identify and exploit new ideas and processes in the market (Bridge et al., 1998), and in many instances, support agencies are tasked to select individuals who are worthy of support.

Hence, it would be more effective to select those individuals with the greatest potential for innovation and offer them full support. Amidst the many factors that government agencies should consider when selecting individuals for support such as their track records, capital investments, and strategic directions, the personality and critical thinking ability of these individuals should also be weighed. While some authors view the reliance on personality profile as futile (Gartner, 1989), authors like Fagenson (1993, p. 424) has cited many others who recognize the influence of personality factors on entrepreneurial behavior.

By the same token, the findings of our study elucidate that knowledge of the entrepreneurs' critical thinking ability and personality would be of much interest to investors and lending organizations such as banks when evaluating entrepreneurs' potential for exploiting new market and technological ideas, particularly in an uncertain entrepreneurial eco-system. Identifying entrepreneurs, who have the critical thinking skills and personality to capitalize on novel market and technological opportunities in a business environment characterized by high levels of market and competitive uncertainties would lead to greater number entrepreneurial success stories (Covin & Slevin, 1989; Zahra and Covin, 1995).

For researchers, the implication of this paper is the need for more studies that use multivariate approaches to explore how contextual influences such as the volatility in the business environment and changes in the economic, political, and social environments influence entrepreneurs' opportunity exploitation behavior. In particular, multivariate models that assess the combined effects of individual and environmental factors on the novelty of opportunity exploitation would be of interest. Entrepreneurial activity is a complex and costly process often characterized by unfavorable success rates (Baum and Locke, 2002). Resultantly, identifying and investing in the "right" individuals who are able to identify new market and technological opportunities is imperative. While management scholars could continue to study the impact of organizational resources, the environment, government

assistance, and organizational strategies, more research should be directed towards the understanding of the personal characteristics of entrepreneurs. Among the myriad of individual factors that could potentially influence entrepreneurs' opportunity exploitation behavior, critical thinking ability, as established in our study appears to be significantly related to the exploitation of novel opportunities. Therefore, it would be fruitful for entrepreneurship scholars to gain greater insights on the contribution of this factor.

Consistent with evidence presented by Fagenson (1993), our findings imply that personality is very much a relevant area of research for understanding entrepreneurs' behavior. Although not significant as a single predictor, personality when combined with other antecedent variables such as entrepreneurs' critical thinking ability provides a cogent explanation of entrepreneurs' opportunity exploitation behavior. While this study examined the moderating impact of personality on the ability-exploitation equation using a composite measure of personality based on Cattell's 5 global factors such as extraversion, agreeableness, low anxiety, openness to experience, and low control, it would be useful for future studies to investigate the moderating effects of each of these five personality factors and determine the relative strengths of these factors in regulating the ability-exploitation relationship.

To minimize problems with cross-sectional data, we surveyed our respondents at two different intervals. In particular, the independent variables i.e. personality and ability were measured within 12 months of the firm's start-up date and the dependent variables i.e. novelty of opportunity exploitations were measured 6 months later. In order to ascertain a more accurate causal relationship between the variables, future research could consider measuring entrepreneurs' personality and ability prior to venture creation, and the novelty of opportunity exploitation at the point of start-up. Additionally, while environment uncertainty was used in this study to test the moderating effects of "competitive" environment on

entrepreneurs' propensity to exploit novel opportunities, evaluating the regulating effects of other environmental contexts such as the economic, political, and socio-cultural environments as well as industry differences such as knowledge conditions, demand conditions, industry life cycles, appropriability conditions, and industry structure (Shane, 2003; p. 121) could provide a better understanding of why some entrepreneurs are more successful at recognizing novel opportunities that have emerged from changes in the external world. Last but not least, future inquiries could investigate whether the moderating impact of personality and environmental uncertainty on the relationship between critical thinking ability and novelty of opportunity exploitation is generalizable to other cultures.

Our study makes five main contributions to the understanding of entrepreneurs' opportunity exploitation behavior. First, using an integrative framework that incorporates the psychological and ecological approaches, our study represents one of the first attempts in entrepreneurship research to elucidate the antecedents to entrepreneurs' opportunity exploitation behavior Second, past studies have intensely debated on the usefulness of individual characteristic for differentiating entrepreneurs from non-entrepreneurs (Gartner, 1988), and have recommended that scholars focus their research on different types of entrepreneurs (Sarasvathy 2004). Concurring with Saraswathy, we found that individual factors such as critical thinking ability and personality were useful in distinguishing distinct groups of entrepreneurs, specifically entrepreneurs who start new businesses based on novel opportunities, and those who start based on non-novel opportunities. Third, while personal characteristics like critical thinking and personality were significantly important in determining entrepreneurs' propensity to exploit novel opportunities, these characteristics were more likely to be positively related to the exploitation of novel opportunities under certain environmental conditions e.g., unpredictable environment. Fourth, studies on personality traits have long been criticized for its disparate and inconsistent results, and

many reasons were offered for the inconclusive results obtained (Mischel 1990). In addition to the varied reasons highlighted in the literature, our findings imply that personality does not have a direct effect on entrepreneurs' opportunity exploitation behavior but it moderates the positive relationship between critical thinking and novel opportunity exploitation, providing a more nuanced view of the association between personality and entrepreneurs' behavior. Lastly, from a methodological perspective, our study exemplifies a significant improvement over previous studies as we employed a multi-respondents approach and surveyed our respondents at two different intervals to minimize problems with cross-sectional data.

In summary, while prior research has examined the influence of entrepreneurs' ability and personality on entrepreneurial behavior separately, our study confirms their joint effects, as well as their interaction effects with the dynamism of the environment on entrepreneurs' opportunity exploitation behavior. Consistent with the opportunity-exploiter nexus framework of Shane and Venkataraman, we posit that the nature of entrepreneurial exploitation activities are jointly determined by the nexus of environmental factors that shape the emergence of opportunities and the supply of opportunity-seekers with the right entrepreneurial personalities and abilities to exploit such opportunities.

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TABLE I

Correlation of Variables (N = 328)[a]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Dependent variables																	
1. Novelty of market knowledge	1																
2. Novelty of technical knowledge	0.08	1															
Control variables																	
3. Software	0.03	0.05	1														
4. ICT Hardware	0.05	0.04	0.02	1													
5. Engineering	0.03	0.03	0.01	0.03	1												
6. Health & Life Sciences	0.06	0.02	0.06	0.01	0.02	1											
7. Others[b]	0.02	0.04	0.07	0.02	0.04	0.02	1										
8. Age	0.11*	0.13*	0.06	0.04	0.01	0.03	0.05	1									
9. Experience in relevant industry	0.19**	0.20**	0.05	0.04	0.02	0.05	0.02	0.11*	1								
10. Gender (Male = 1)	0.08	0.06	0.04	0.05	0.04	0.01	0.01	0.04	0.03	1							
11. Primary	-0.12*	-0.11*	0.02	0.07	0.03	0.02	0.03	0.06	0.04	0.01	1						
12. Secondary	-0.08†	-0.12*	0.04	0.03	0.06	0.04	0.06	0.03	0.05	0.03	0.02	1					
13. Pre-university/vocational	0.10*	0.13*	0.07	0.01	0.04	0.06	0.04	0.01	0.02	0.04	0.03	0.04	1				
14. Undergraduate	0.13*	0.12*	0.05	0.02	0.05	0.04	0.03	0.02	0.04	0.02	0.04	0.06	0.03	1			
15. Postgraduate	0.12*	0.11*	0.06	0.50	0.01	0.04	0.06	0.03	0.04	0.04	0.05	0.01	0.02	0.01	1		
Independent variables																	
16. Critical Thinking Ability	0.38**	0.29**	0.03	0.05	0.01	0.07	0.02	0.08†	0.05	0.03	0.04	0.05	0.04	0.06	0.04	1	
17. Personality	0.15*	0.14*	0.02	0.04	0.02	0.05	0.04	0.07	0.08†	0.05	0.02	0.03	0.05	0.05	0.04	0.05	1
18. Environment uncertainty	0.18*	0.16*	0.01	0.03	0.01	0.02	0.05	0.06	0.03	0.05	0.01	0.02	0.06	0.04	0.03	0.04	0.05
Mean	3.53	3.68	0.23	0.25	0.22	0.20	0.10	33.00	8.00	0.54	0.09	0.12	0.24	0.38	0.17	6.55	6.82
Std. Deviation	0.69	0.62	0.47	0.46	0.42	0.37	0.45	1.47	2.78	0.38	0.35	0.42	0.41	0.39	0.33	1.69	1.71
Minimum	1	1	0	0	0	0	0	23	4	0	0	0	0	0	0	1	1
Maximum	5	5	1	1	1	1	1	51	32	1	1	1	1	1	1	10	10

N = 328

a The correlation coefficients were based on the responses of the CEOs

b Others include Plastics & Synthetic Rubber, Aircraft Manufacturing, and Electricity Distribution Apparatus

** $p < .01$

* $p < .05$

† $p < .10$

TABLE II

Ordinal Logistic Regression Predicting the Novelty of Opportunity Exploitation Based on New Market Knowledge
N=328

	Model 1: Controls		**Model 2: Controls + Main effects**		**Model 3: Controls + Main effects + Interaction Terms**		
Pseudo R- Squared	0.128		0.355		0.469		
Log likelihood	-578.841		-469.232		-381.459		
Probability	0.000		0.000		0.000		
	B	**Sig**	**B**	**Sig**	**B**	**Sig**	**ODDS RATIO**
Controls							
Constant	-2.061	0.000	-2.134	0.000	-2.198	0.000	0.008
Software	0.682	0.059	0.603	0.061	0.661	0.069	1.045
ICT Hardware	0.315	0.127	0.389	0.181	0.341	0.173	0.783
Engineering	0.699	0.057	0.704	0.063	0.673	0.062	0.993
Others	0.555	0.249	0.508	0.364	0.503	0.290	0.631
Gender	0.651	0.055	0.644	0.060	0.679	0.052	1.103
Age	1.414	0.040	1.484	0.042	1.503	0.039	1.969
Actual experience	1.529	0.042	1.623	0.044	1.618	0.039	2.002
Secondary	-1.442	0.039	-1.490	0.035	-1.370	0.038	1.883
Pre-University/Vocational	1.002	0.066	1.128	0.052	1.019	0.055	1.129
Undergraduate	1.385	0.044	1.339	0.041	1.321	0.037	1.834
Postgraduate	1.402	0.037	1.413	0.035	1.424	0.030	1.924
Main Effects							
Critical Thinking Ability (CTA)			1.501	0.033	1.499	0.034	1.954
Personality			0.632	0.064	0.646	0.068	1.050
Environment Uncertainty (EU)			0.689	0.058	0.590	0.057	1.093
Interaction Terms							
CTA x Personality					1.555	0.038	3.587
CTA x Personality x EU					2.249	0.000	4.886

TABLE III

Ordinal Logistic Regression Predicting the Novelty of Opportunity Exploitation Based on New Technical Knowledge
N=328

	Model 1: Controls		**Model 2: Controls + Main effects**		**Model 3: Controls + Main effects + Interaction Terms**		
Pseudo R- Squared	0.118		0.323		0.427		
Log likelihood	-590.420		-488.399		-396.563		
Probability	0.000		0.000		0.000		
	B	**Sig**	**B**	**Sig**	**B**	**Sig**	**ODDS RATIO**
Controls							
Constant	-2.155	0.000	-2.189	0.000	-2.202	0.000	0.005
Software	0.651	0.061	0.640	0.065	0.639	0.072	0.993
ICT Hardware	0.323	0.177	0.343	0.193	0.300	0.169	0.754
Engineering	0.666	0.061	0.699	0.066	0.683	0.059	0.845
Others	0.531	0.249	0.508	0.303	0.533	0.330	0.663
Gender	0.601	0.059	0.641	0.063	0.655	0.059	1.004
Age	1.316	0.038	1.394	0.041	1.527	0.033	1.803
Actual experience	1.500	0.039	1.513	0.036	1.528	0.028	1.923
Secondary	-1.400	0.033	-1.390	0.029	-1.389	0.034	1.781
Pre-University/Vocational	1.110	0.068	1.105	0.049	1.008	0.059	1.108
Undergraduate	1.267	0.045	1.289	0.039	1.300	0.027	1.789
Postgraduate	1.390	0.039	1.310	0.037	1.393	0.029	1.802
Main Effects							
Critical Thinking Ability (CTA)			1.604	0.031	1.389	0.036	1.989
Personality			0.601	0.068	0.660	0.088	1.123
Environment Uncertainty (EU)			0.709	0.066	0.690	0.063	1.175
Interaction Terms							
CTA x Personality					1.469	0.044	3.912
CTA x Personality x EU					2.133	0.000	4.653

APPENDIX I

Measure Items and Response Format

Variables	Measurements
Dependent variable	
a) Exploitation of business opportunity based on new/existing market knowledge (α = 0.83)	
Please rate the extent to which you agree with the following statements	
i) Most people in the industry including my competitors feel that the product or service that my company is offering is new to the market/s we currently serve	1 - Strongly Disagree 5 - Strongly Agree
ii) My product/service is developed for a niche or specialized market	
iii) Most of my customers and/or potential customers consider my product/service new and unfamiliar	
b) Exploitation of business opportunity based on new/existing technical knowledge (α = 0.79)	
i) At the point of start-up, there were few competitors offering similar product/servive to my potential customers	1 - Strongly Disagree 5 - Strongly Agree
ii) The technologies or procedures required by this product/service were not available more than a year ago	
iii) I have taken measures or will be taking measures to protect the intellectual property (IP) associated with the products/services that my company is offering	
iv) At the point of start-up, there were no competitors using similar technology associated with the product/service that my company is offering	
Independent variables	
a) Personality (composite measure of Extraversion, Agreeableness, Low Anxiety, High Control, Openness to Experience)	
200-item scale using Cattell's (2000) 16PF-Industrial Personality Test	1 - True 2 - Neither true nor false 3 - False
b) Critical thinking ability	
80-item scale using Watson-Glaser Critical Thinking Appraisal - Form C (Watson and Glaser, 1990)	1 - True 2 - Probably true 3 - Insufficient data 4 - Probably false 5- False
c) Environment uncertainty	
5-item bipolar adjective scale (Miller and Droge, 1986)	7- point bipolar adjective scale
Control variables	
a) Industry dummies	Software, ICT-Hardware, Engineering Health (reference category), Others
b) Gender	Male, Female
c)Age at start-up	Actual age
c) Experience in the industry	Number of years
d) Education attainment	Primary (reference category), secondary, pre-university/vocational qualification, undergraduate, postgraduate