JOURNAL OF
EMERGING INVESTIGATORS

Article

Examining cognitive differences between experienced and novice entrepreneurs

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SUMMARY

Entrepreneurship is a widely acknowledged field of study due to its positive impact on society and the economy. However, how and why experienced entrepreneurs think differently from novice ones has not been fully addressed by extant entrepreneurship research. Our study aimed to examine cognitive differences between experienced and novice entrepreneurs by using mixed methods. We first hypothesized that more experienced entrepreneurs tend to have greater risk propensity and greater entrepreneurial opportunity recognition than novice entrepreneurs and that entrepreneurs would be motivated more by internal rather than external factors further into their careers. We then conducted analyses in R on a sample of 103 surveyed and 7 interviewed entrepreneurs using XGBoost models. Our results suggested that adaptive cognition, opportunity recognition, and personality traits play large roles in distinguishing between experienced and novice entrepreneurs. In addition, we found that an excess of imagination and brainstorming could lead to inaction in the beginning stages of a venture, and spontaneity in opportunity recognition could necessitate increased support/power division. We also observed a decrease in abstract ideas, creativity, and the development of new initiatives later in a venture. Moreover, we observed that with more experience, entrepreneurs generally become less risk-averse and consider goals outside financial concerns. By advancing our understanding of entrepreneurial cognition and personalities, especially in novice entrepreneurs, our study offers insights for fostering supportive environments for venture creation.

INTRODUCTION

Entrepreneurship has been widely acknowledged to play significant roles in creating jobs and opportunities, fostering economic growth, promoting inclusivity, creating wealth, and enhancing national competitiveness and productivity (1). In the United States, small businesses employ about 46% of the workforce, contribute roughly 43% of GDP and create approximately 64% of new jobs each year (2). Rather than viewing entrepreneurship merely as an act of creating businesses, Shane and Venkataraman in 2000 conceptualized it as an ongoing process centered on opportunity recognition and exploitation (3). Existing entrepreneurship research has primarily focused on the positive relationship between such entrepreneurial actions and broader social and economic outcomes (1). However, scholars have increasingly emphasized the importance of the "people element", by asking how individuals differ in their ability to recognize and act on entrepreneurial opportunities in the first place.

Literature has suggested that opportunity recognition is closely related to cognitive capabilities. Specifically, prior knowledge, entrepreneurial alertness, and learning have been shown to positively impact opportunity recognition (4). In addition, literature has also suggested that experienced entrepreneurs are more effective at identifying opportunities than novice entrepreneurs, and entrepreneurs' experiences are not only associated with cognitive differences but also with personality and attitudes toward entrepreneurship (5–7). For example, scholars have found that novice entrepreneurs who are driven by intrinsic factors such as self-fulfillment, responsibility, and desire for social impact are more likely to continue creating businesses. Apparently, not all novice entrepreneurs would eventually become experienced ones. Although previous research has suggested that personality factors significantly affect entrepreneurship intention, the direct relationship between personality and cognitive capabilities has not been fully discussed (5). It remains unclear whether and how entrepreneurs' experiences could be associated with their cognitive capability of opportunity recognition, their personalities and entrepreneurial attitudes (8, 9).

Therefore, it's necessary to examine cognitive differences between experienced and novice entrepreneurs, and explore the connection between entrepreneurs' cognition, attitudes, actions, and business performance (10). In our study, we aimed to answer the question: how and why do experienced entrepreneurs think differently from novice ones? We 1) examined the cognitive, personality, and attitude differences between experienced and novice entrepreneurs through quantitative methods and 2) explored how successful entrepreneurs develop their cognitive structures through qualitative methods.

Linking cognitive approaches and personality studies, we proposed that entrepreneurs' experience levels are likely associated with their cognitive capability and personality traits. As a result, we hypothesized that 1) entrepreneurs' experience levels are positively associated with their cognitive capabilities and opportunity recognition; 2) entrepreneurs' experience levels are positively associated with certain personality traits; and 3) entrepreneurs who are intrinsically motivated are more likely to continue pursuing their entrepreneurial journey than those who are extrinsically motivated. Given the complexity of our research goals, we applied mixed methods in this study, combining quantitative survey data with qualitative

https://doi.org/10.59720/24-355

research through interviews. We conducted analyses in R on a sample of 103 surveyed and 7 interviewed entrepreneurs using XGBoost models (1). Our results suggested that adaptive cognition, opportunity recognition, and personality traits differentiate experienced from novice entrepreneurs. Specifically, we found that entrepreneurs' experience is positively associated with their cognitive capabilities but also negatively associated with certain personality traits, such as creativity, neuroticism and openness (3). Furthermore, our qualitative research revealed that as entrepreneurs gain experience, they become increasingly more motivated by internal factors, such as self-fulfillment and creating value, rather than external factors, such as financial success.

RESULTS

Study design and variable definitions

Our research utilized a mixed-methods approach to investigate the relationships between entrepreneurial experience, cognitive capabilities, and personality traits (6). We employed a cross-sectional survey of 103 entrepreneurs to quantify these relationships using Pearson correlations and an XGBoost model, as well as conducted in-depth interviews with 7 entrepreneurs to provide qualitative insights into their evolving thought processes.

The quantitative data included measures of opportunity recognition, personality, and adaptive cognition. For opportunity recognition, a multidimensional construct, we measured it across five dimensions: incubation (subconscious recombination of possibilities before the idea is explicit), Insight (how the idea was formed), evaluation (assessment of the idea's viability), elaboration (attention to internal and external environments), and creativity (11). Adaptive cognition was grouped into three derived variables: goals and organization (setting goals and organizing time/resources), reflecting (reflecting on choices and others' reactions), and adapting (maintaining control in the long run) (12). Entrepreneurial experience was operationalized as a binary categorical variable, coded as 1 if an individual started two or more business ventures prior to their current business or had more than 10 years of business experience, and 0 otherwise. In addition, we collected entrepreneurs' demographic and business information, some of which served as indicators of the entrepreneur's experience. These variables were included in our analyses alongside our main measure of entrepreneurial experience.

Correlations with opportunity recognition

We surveyed 103 participants with a mean age of 44.0 years (SD = 13.3). Of the participants, 34.0% were female and 59.2% were male. 35.0% of the sample held a bachelor's degree, while 24.2% had completed graduate education. Overall, the sample represented a middle-age and well-educated population. For opportunity recognition dimensions, entrepreneurial experience was found to correlate negatively with early-stage ideation but positively with evaluation (**Table 1**). Specifically, we found a significant negative correlation between incubation (entrepreneurs' subconscious idea generation) and the years the business was owned ($r = -0.228$, $p < 0.05$) (**Table 1**). This suggests that the longer an entrepreneur has owned their business, the less time they spend on passively or actively seeking new business opportunities. In contrast, we also found a significant positive correlation between evaluation and experience level ($r = 0.233$, $p < 0.05$), which suggests that experienced entrepreneurs place a greater emphasis on assessing an idea's viability. Finally, there was a significant negative correlation between elaboration and years owned ($r = -0.253$, $p < 0.05$) (**Table 1**), implying that longer ownership reduces the prioritization of customer feedback based on the external environment.

Correlations with personality traits

We found significant correlations between personality traits and entrepreneurial experience (**Table 2**). Specifically, we found a negative association between entrepreneurial

		Business/Entrepreneur Information									
		Experience Level	Past Owned	Current Own	Years Owned	Num Owners	Owners at Start	Hours Spent	Employees	Rev	Rev Growth
Opportunity Recognition	Incubation	-0.035 (0.728)	0.033 (0.741)	0.049 (0.628)	**-0.228*** (0.022)	0.037 (0.716)	-0.107 (0.288)	0.091 (0.363)	0.135 (0.177)	0.135 (0.178)	0.041 (0.687)
	Insight	0.099 (0.323)	0.138 (0.169)	0.118 (0.242)	-0.189 (0.059)	**0.196*** (0.049)	0.142 (0.157)	0.011 (0.913)	0.112 (0.266)	0.094 (0.351)	-0.050 (0.621)
	Evaluation	**0.233*** (0.019)	**0.261**** (0.008)	-0.041 (0.684)	-0.035 (0.727)	0.000 (0.999)	-0.036 (0.719)	0.037 (0.714)	0.030 (0.767)	-0.033 (0.746)	-0.048 (0.632)
	Elaboration	-0.022 (0.828)	0.080 (0.428)	0.065 (0.519)	**-0.253*** (0.011)	0.097 (0.336)	-0.051 (0.610)	-0.035 (0.728)	0.016 (0.874)	-0.044 (0.661)	0.145 (0.147)

Table 1: Pearson Correlations between Entrepreneurial Constructs and Experience/Business Performance. This table presents the Pearson correlation coefficients (r) and significance levels (p-values, 2-tailed t-test, in parentheses) between key entrepreneurial constructs (opportunity recognition) and various measures of entrepreneurial experience and business performance. Entrepreneurial constructs were obtained from survey results (n = 103).

https://doi.org/10.59720/24-355

		Business/Entrepreneur Information									
		Experience Level	Past Owned	Current Own	Years Owned	Num Owners	Owners at Start	Hours Spent	Employees	Rev	Rev Growth
Personality Traits	Neuroticism	0.141 (0.158)	**0.225*** (0.024)	-0.055 (0.587)	**-0.223*** (0.025)	0.225 (0.024)	0.188 (0.059)	-0.091 (0.367)	-0.077 (0.445)	-0.066 (0.514)	-0.029 (0.771)
	Extraversion	0.017 (0.865)	0.029 (0.775)	0.084 (0.404)	0.051 (0.613)	0.065 (0.520)	0.021 (0.835)	**0.197*** (0.048)	0.149 (0.137)	**0.242*** (0.015)	0.104 (0.299)
	Openness	**-0.247*** (0.013)	**-0.237*** (0.017)	-0.141 (0.161)	-0.168 (0.093)	-0.086 (0.391)	-0.185 (0.063)	0.120 (0.231)	-0.091 (0.364)	0.006 (0.956)	0.003 (0.979)
	Agreeableness	-0.051 (0.615)	-0.028 (0.781)	0.149 (0.138)	-0.010 (0.919)	**-0.247*** (0.013)	-0.163 (0.103)	-0.019 (0.854)	-0.079 (0.431)	-0.087 (0.387)	-0.121 (0.229)
Adaptive Cognition	Goals & Org.	-0.056 (0.579)	-0.050 (0.623)	0.013 (0.900)	0.040 (0.690)	-0.060 (0.549)	-0.114 (0.256)	**0.225*** (0.024)	0.085 (0.401)	0.070 (0.488)	0.014 (0.887)
	Reflecting	-0.048 (0.636)	0.065 (0.520)	-0.045 (0.652)	-0.171 (0.086)	-0.078 (0.440)	-0.031 (0.760)	0.010 (0.918)	0.102 (0.308)	0.009 (0.933)	-0.028 (0.785)
	Adapting	-0.111 (0.268)	-0.113 (0.261)	0.008 (0.937)	-0.060 (0.549)	-0.140 (0.164)	-0.103 (0.305)	0.168 (0.093)	0.072 (0.476)	0.037 (0.713)	0.089 (0.376)

Table 2: Pearson Correlations between Entrepreneurial Constructs and Experience/Business Performance. This table presents the Pearson correlation coefficients (r) and significance levels (p-values, 2-tailed t-test, in parentheses) between key entrepreneurial constructs (personality traits and adaptive cognition) and various measures of entrepreneurial experience and business performance. Entrepreneurial constructs were obtained from survey results (n = 103). Neuroticism and agreeableness relate to ownership structure, extraversion relates to effort and success, and openness is negatively linked to experience. Goals and organization are correlated with effort but not experience level.

experience and openness ($r = -0.247$, $p < 0.05$) (**Table 2**), suggesting that entrepreneurs with greater experience tend to report lower openness to new ideas. In contrast, extraversion was significantly positively correlated with hours spent working on the business ($r = 0.197$, $p < 0.05$) and revenue ($r = 0.242$, $p < 0.05$) (**Table 2**). This indicates that sociable individuals spend more time on the business and have more financial success. Finally, there was a significant negative correlation between openness and number of businesses owned in the past ($r = -0.237$, $p < 0.05$) (**Table 2**).

Correlations with adaptive cognition and attitudes

In the Adaptive Cognition and Attitudes Toward Entrepreneurship scale, we found two significant positive correlations (**Table 2**). There was a significant positive correlation between goals and organization and hours spent working on the business ($r = 0.225$, $p < 0.05$) (**Table 2**). This suggests that planning and goal-setting behaviors are intrinsic to entrepreneurship. We also confirmed the reliability of our measures, as the Cronbach's alpha for each variable group was above 0.7, demonstrating high reliability within the variable groups previously defined using XGBoost.

SHAP (SHapley Additive exPlanations) analysis

The XGBoost model and subsequent SHAP plots revealed the features most predictive of "YearsOwned" (**Figure 1**, **Figure 2**). Consistent with the correlation analysis, the SHAP plots for the first incubation and fourth openness statements suggest that the longer an individual has owned their business, the less they perceive they have a good imagination, and they find less enjoyment in thinking about or looking for new business opportunities (**Figure 1A, 1H**). The SHAP feature sina plot showed that neuroticism emerged as the second strongest predictor of "YearsOwned," with higher values associated with shorter business ownership, suggesting emotional stability supports sustained engagement (**Figure 1C, 1F; Figure 2**).

Qualitative interviews

We interviewed seven entrepreneurs (two novice, five experienced) to gain deeper insights into their thought processes and business operations. Our qualitative results have reflected that experienced and novice entrepreneurs differ greatly in their personality traits, like openness and neuroticism. For example, novice entrepreneurs cited unpredictability as a major challenge, often "worrying about

https://doi.org/10.59720/24-355

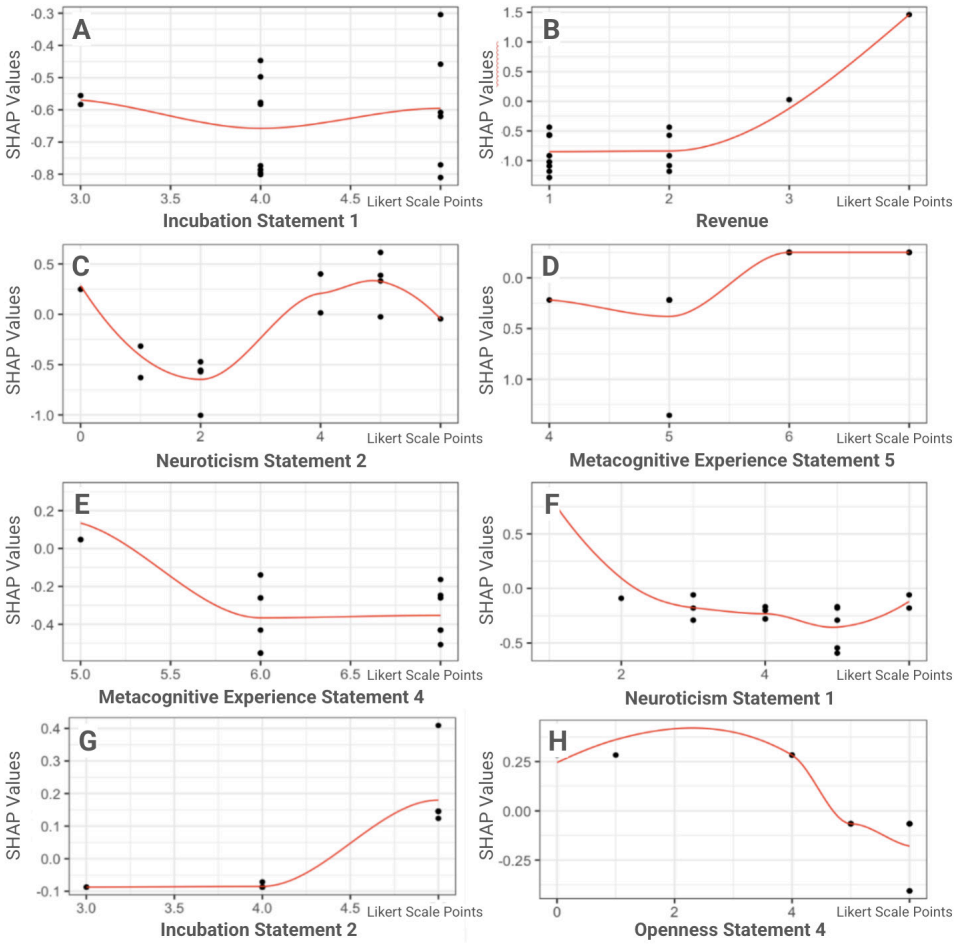

Figure 1: Dependence plot of SHapley Additive exPlanation (SHAP) values versus feature values correlated with years owned. Figure 1 displays the dependence plots of SHAP values versus the feature values, correlated with YearsOwned (survey sample n=103). The y-axis represents the SHAP value, which indicates the feature's contribution to the prediction. The x-axis represents the corresponding score on the measure's Likert scale (e.g., 1: strongly disagree to 5 or 7:strongly agree). The red trendline indicates the correlation between the feature value and the SHAP value. Data is shown for Incubation Statement 1 "I enjoy just thinking about and/or looking for new business opportunities" (A), Revenue (B), Neuroticism Statement 2 "I am relaxed most of the time" (C), Metacognitive Experience Statement 5 "I use my "gut" to tell me when a given strategy I use will be most effective" (D), Metacognitive Experience Statement 4 "I consciously focus my attention on important information" (E), Neuroticism Statement 1 "I have frequent mood swings" (F), Incubation Statement 2 "I often think of new business ideas when I am totally relaxed, doing something unrelated to business" (G), and Openness Statement 4 "I do not have a good imagination" (H).

uncertainties and always planning rather than trying." In contrast, experienced entrepreneurs were more comfortable with risk, stating that "you have to deal with challenges all the time…you can only control your part and you cannot control the rest" and "I just take the risk and develop the concept."

Regarding motivation, both novice and experienced entrepreneurs highlighted that the "best part" of entrepreneurship is doing the thing they "really want to do" and being "in control". However, the qualitative results showed a shift over time: while individuals initially cared about "achieving [their] financial goals," they later realized that success meant "if [they] could be happier, even more than others who achieved that goal." Experienced entrepreneurs usually stated their goal was "make something that's of value." This suggests that as their careers progressed, motivations shifted toward internal factors like self-fulfillment and creating value.

DISCUSSION

Due to the limited examination of what distinguishes entrepreneurs' cognition and actions as they become experienced and successful, we employed both quantitative and qualitative methods to examine the complex relationships among entrepreneurs' experience, cognition, personality traits, and their business performance. Our findings partially support our hypotheses that entrepreneurial experience is associated with differences in cognitive capabilities, opportunity recognition, personality traits, and motivation—as we found both significant positive and negative correlations among entrepreneurs' experiences, opportunity recognition, personalities, and attitudes toward entrepreneurship.

We first hypothesized that entrepreneurial experience would be positively associated with cognitive capabilities and opportunity recognition. We found that evaluation was positively correlated with both the number of businesses previously owned and entrepreneurial experience (**Table 1**).

https://doi.org/10.59720/24-355

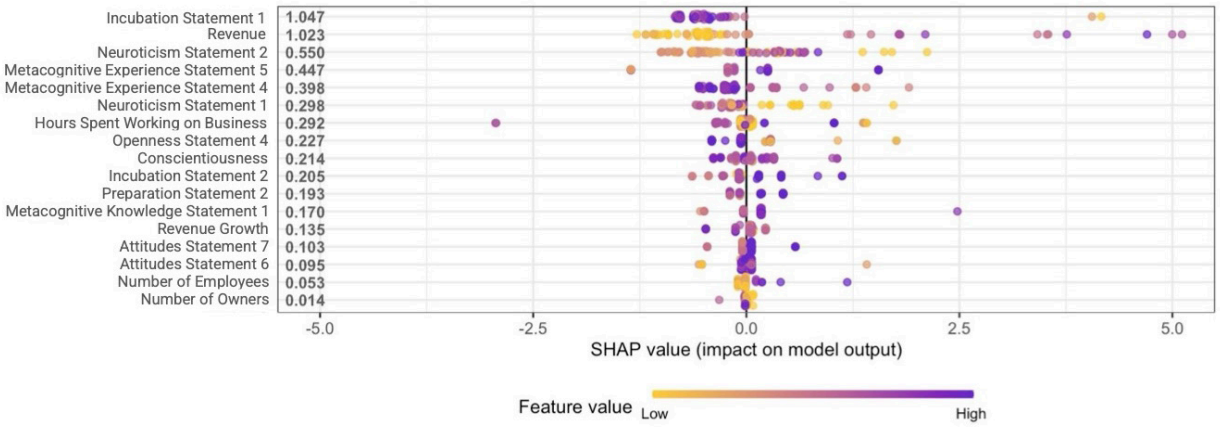

Figure 2: Distribution of SHAP values for the 17 most important features used in the XGBoost model. Figure 2 shows a sina plot using long format data of SHAP values; the target variable is YearsOwned (survey sample n=103). The plot illustrates how each feature (e.g., neuroticism statement 1, extraversion statement 4) affects the prediction of YearsOwned. The color intensity of the dots represents the feature value (e.g., purple indicates high Likert score such as "7-strongly agree", and yellow indicates low Likert Score such as "1-strongly disagree"). Neuroticism, which emerged as a strong predictor, is clearly visible, showing that higher neuroticism scores are associated with lower YearsOwned.

This suggests that experienced entrepreneurs may place greater emphasis on investigating ideas and external support, as evaluation includes consulting others to validate ideas and assessing the business landscape (11). This is counterintuitive because it could be assumed that experienced entrepreneurs would rely more on their own cognition; however, our findings suggest that with experience, individuals recognize the importance of seeking multiple perspectives. In addition, evaluation was not closely associated with creativity, so idea refinement alone may not indicate high-quality opportunity recognition.

However, this increase in evaluation was accompanied by a decrease in ideation. Specifically, incubation, such as the intuitive and non-intentional generation of new business ideas, was negatively correlated with years of business ownership, suggesting that as entrepreneurs gain experience, they spend less time developing or initiating new venture ideas (**Table 1**). Elaboration was also negatively correlated with years owned, indicating that experienced entrepreneurs may place less emphasis on adapting their strategies based on external feedback and changing environmental conditions (**Table 1**). This pattern differs from prior literature suggesting that novice entrepreneurs are less adept at responding to customer demands, as our findings instead indicate a broader reduction in attention to both internal and external feedback over time (9). Nevertheless, this overall shift is supported by the relationship between imagination and experience. Measures of incubation and openness suggest that as entrepreneurs gain experience, they report lower enjoyment of imaginative ideation and reduced engagement in generating new business ideas (**Figure 1**). This indicates a shift from active idea generation toward more passive or experience-driven opportunity recognition, consistent with prior literature (5). We next hypothesized that entrepreneurial experience would be associated with differences in personality traits. Previous studies have noted that personality factors do not distinguish entrepreneurs as much as cognitive factors; however, we found significant correlations between personality factors and entrepreneur experience in our data (13, 14). Neuroticism, a trait reflecting emotional instability and sensitivity to stress, was negatively correlated with years owned, suggesting that with experience, entrepreneurs exhibit lower emotional instability (**Table 2**). As neuroticism is associated with cautious behaviors, this decrease indicates greater emotional stability and a preference for higher risk projects (15). This is supported by the SHAP feature sina plot (**Figure 2**), where neuroticism emerged as the second strongest predictor of YearsOwned, with higher values associated with less experience.

In contrast, openness was negatively correlated with the number of businesses owned and entrepreneurial experience (**Table 2**). Although openness is typically associated with a greater willingness to take risks, our findings suggest that the nature of risk-taking differs between novice and experienced entrepreneurs (15). Novice entrepreneurs tend to be more open and creative but also more neurotic, which may limit their willingness to act on ideas despite high ideation. In contrast, experienced entrepreneurs exhibit lower openness but also lower neuroticism, indicating greater emotional stability. Interview evidence supports this interpretation, as participants emphasized taking risks due to confidence in handling uncertainty, noting that "you have to deal with challenges all the time…you can only control your part and you cannot control the rest." This suggests that experienced entrepreneurs rely less on imagination and abstract idea generation and instead prioritize sustaining and optimizing existing ventures rather than pursuing new, high-risk opportunities. We also hypothesized that entrepreneurs would become more intrinsically motivated over time. Through qualitative analysis, we deduced that motivations change over time, which is something that cannot be captured comprehensively through cross-sectional surveys. We found that with more experience, the motivations behind leading a business and the desire to succeed shifted. In the beginning stages of the new venture, finances and resources are the most important considerations. Over time, this shifts to a more sustainable, long-term goal, including an ingrained sense of creativity and a desire to solve problems.

https://doi.org/10.59720/24-355

This supports our third hypothesis that entrepreneurs are driven more by intrinsic motivations than by extrinsic ones as they progress further into their entrepreneurial career. This finding is consistent with past research which finds that entrepreneurial motivations are dynamic and evolve over time and generally shift to more intrinsic factors like self-fulfillment and social impact (16).

A related theme was the importance of teamwork and external support. Both experienced and novice entrepreneurs considered the need for others' support, raising the question of the impact of team cognition, or differences in the collective cognitive processes of team members (17). This collective mindset is tied to factors like finances, relationships with investors, and the necessity of creativity when an individual lacks direct access to funds. Interviewed entrepreneurs exhibit greater risk propensity further into their careers and were more likely to incorporate calculated risk, supporting our conclusion that risk propensity increases with experience and that experienced entrepreneurs prioritize internal motivations. It is important to note factors that could influence potential discordance between our two methods, surveys and interviews. The surveys may have led participants to focus on tangible, quantifiable elements of their experience. On the other hand, interviews allowed for a deeper, more reflective exploration of entrepreneurs' personal experiences and motivations. Entrepreneurs may also have been more inclined to present themselves as practical and goal-oriented in surveys.

In addition to our primary hypotheses, we observed several noteworthy patterns. First, our findings suggest that both experienced and novice entrepreneurs exhibit similar levels of dedication and planning. In the adaptive cognition and attitudes toward entrepreneurship Likert scale, we found a significant correlation between goals and organization and the number of hours the individual spent working on the business, but not entrepreneurial experience, suggesting that planning and goal-setting behaviors are intrinsic to entrepreneurship, regardless of experience level (**Table 2**).

For opportunity recognition, we found that excessive imagination and brainstorming may lead to inaction in the early stages of a venture (**Table 1**). We also found a significant positive correlation between the first insight statement and the number of current owners of the business, suggesting that an increase in the spontaneity of an entrepreneur's tendencies in opportunity recognition leads to a need for further support or power division (**Table 1**). The third insight statement was also positively correlated with the current number of owners, the number of owners when the business was first formed, the number of employees, and the business' revenue (**Table 1**). This further corroborates that entrepreneurs need support and ideas from others, especially in the stage of recognizing opportunities and generating business ideas, to experience more success.

In terms of personality, neuroticism was positively correlated with the current number of owners of the business, suggesting that individuals with higher emotional instability may rely more on team support (**Table 2**). Extraversion was positively correlated with the hours spent working on the business and its revenue, suggesting that sociable and assertive people spend more time on the business and experience more financial success (**Table 2**). Another notable finding is that extraversion and agreeableness are not significantly correlated with entrepreneurial experience. This pattern suggests that experience may be more closely associated with cognitive-emotional traits tied to uncertainty management and idea generation (e.g., neuroticism and openness) than with socially oriented traits such as extraversion and agreeableness.

Our study had some limitations. First, due to the constraints on questionnaire length, the cognitive measures used in the survey could not comprehensively capture all relevant dimensions, potentially overlooking nuanced aspects of entrepreneurial cognition. Second, the majority of the constructs used self-reported measures, which are unavoidably subject to various forms of bias, for example, social desirability bias, recall bias, response biases, and limited self-awareness. In addition, there were more experienced entrepreneurs among interviewees (five experienced, two novice). This discrepancy could reduce the representativeness of the findings and limit the generalizability of our study. Finally, although our focus was on entrepreneurs, our study could have been strengthened by including non-entrepreneurs as a baseline comparison group. A non-entrepreneur control group was not included due to the study's focus on within-group differences between experienced and novice entrepreneurs, as well as challenges in recruiting a comparable sample with relevant exposure to entrepreneurial decision-making contexts.

Future studies should use a larger sample size and more variables to gain more detailed insight into differences between experienced and novice entrepreneurs. Studies should also consider contextual and institutional, both formal and informal, factors that extend beyond individual characteristics. Additionally, although our findings suggest that experienced entrepreneurs differ in personality from novice entrepreneurs, future research would benefit from employing longitudinal designs to directly assess whether certain personality traits change or evolve as entrepreneurs gain more experience. In summary, understanding entrepreneurial cognition and personalities, especially in novice entrepreneurs, could aid in creating supportive environments for venture creation, which is essential for a successful knowledge-based economy (18).

MATERIALS AND METHODS

Participants and procedures

All research was conducted under the supervision of an experienced mentor and adhered to state and federal regulations. Institutional Review Board (IRB) approval was obtained prior to data collection due to the involvement of human participants.

A cross-sectional survey was developed to assess how experienced and novice entrepreneurs differ in opportunity recognition, personality traits, cognitive capabilities, and entrepreneurial attitudes. Eligible participants were business founders or owners, were at least 18 years old, and had self-identified as entrepreneurs. These participants were sought out directly through personal contacts and indirectly by broadcasting on social media platforms, such as Facebook groups. Moreover, participants were recruited via Prolific, an online research platform. The initial sample consisted of 116 participants. After removing incomplete responses and those failing attention checks—questions designed to ensure participants were paying attention (e.g., instructing respondents to select a specific answer)—the final sample

https://doi.org/10.59720/24-355

included 103 entrepreneurs, all based in the United States. The average age of the entrepreneurs was 44, consisting of 86% males and 32% females.

Recruited participants were sent an online questionnaire through the Qualtrics platform. Participants undertook the questionnaire independently without supervision in approximately 5–10 minutes. Other information and questions were taken from the Census Bureau's Annual Survey of Entrepreneurs (ASE) (19).

Measuring business performance and entrepreneurial experience

Participants were asked about the number of businesses they have owned in the past, the number of businesses they currently owned, how their current business was initially acquired, the industry of their business, the number of equity partners, the hours per week spent working on their business, the number of employees (excluding themselves), the annual revenue, and revenue and profit percent growth (20). "Entrepreneurial Experience" was measured as a binary categorical variable (1 or 0). Participants were assigned a value of 1 if they had started 2 or more business ventures prior to their current business or had more than 10 years of experience managing their business; all others were coded as 0.

Measuring cognitive variations

Haynie and Shepherd defined cognitive adaptability as the ability to effectively learn given feedback from the individual's environment or context (12). For the survey, the original "Generalized Measure of Adaptive Cognition scale" was adapted by condensing the original 36 statements to 15 statements (see Appendix) tailored to reflect the individual as an entrepreneur using a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree) (12).

Attitudes toward entrepreneurship were measured using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), for seven statements that describe the individual's entrepreneurial attitudes, adapted from the Attitudes toward Entrepreneurship scale (8, 9).

Hansen et al. defined opportunity recognition as a multidimensional construct including five core dimensions (i.e., preparation, incubation, insight, evaluation, and elaboration), which is related but different from creativity (11). This approach and instrument were followed to measure each dimension by using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

More specifically, to measure preparation, referring to the entrepreneurs' ability to acquire and access market knowledge, two specific statements were used: "I listen extremely well to what customers say they want and don't want as a way of identifying opportunities" and "I knew who the first customers would be before introducing our first product/service".

For incubation, defined as "where the knowledge domains collide to create new associations", two statements were used: "I enjoy just thinking about and/or looking for new business opportunities" and "I often think of new business ideas when I am totally relaxed, doing something unrelated to business".

For insight, which refers to how the idea was formed, three statements were included to measure whether the idea was serendipitous (e.g., "The idea behind this business just seemed to suddenly appear"), accidental (e.g., "Our venture idea came for an accidental process that just happened to uncover the concept"), or from others (e.g., "Other people bring new venture business ideas to me").

For evaluation, referring to the assessment of this idea's viability, two statements were used: "In-depth market analysis is often used more for impressing financial sources than for actual decision making" and "It is often better to enter a market and, if necessary, make changes than to take the time and money to first do formal marketing research".

Lastly, elaboration refers to whether the entrepreneur pays close attention to both internal and external environments and continues to pivot their business ideas when necessary. Specifically, the two statements used were: "On entering the market with a new venture, I made major changes based on customer feedback" and "It is easier to see the real opportunities after you begin to enter a new market (compared with before you start)".

Since previous publications have indicated that some dimensions of opportunity recognition are not strongly associated with creativity. Creativity was separately measured by using a 5-point Likert scale for the statement "I set aside a few minutes each day or week to be creative" (11).

The Mini International Personality Item Pool (IPIP) scale was used to measure the Big Five personality traits, using a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree), for 20 statements that described the individual as a person (21). There were four statements measuring each of the five-factor model traits (22). Values were averaged to obtain measures.

Qualitative interviews

In addition to the survey, seven business founders/owners, who were 18 years or older and also self-identified as entrepreneurs in the local community were also invited to participate in 30-minute semi-structured interviews. An experienced entrepreneur was defined as an individual who had started 2 or more business ventures prior to their current business or had more than 10 years of experience managing their business at the time of survey completion (23). Of these seven, five were experienced and two were novice entrepreneurs.

Participants were informed of possible risks and consent was obtained at the beginning of the interview. Participation was completely voluntary, and responses were kept anonymous and confidential. Interview questions were designed to be non-invasive. Questions regarding the participants' experiences and feelings as an entrepreneur were used to guide the interview. Following the interview and analysis process outlined by Gilbert-Saad et al., this study adopted an inductive approach, utilizing coding procedures suggested by grounded theory (24).

Analysis of survey responses

All analyses for this study were conducted and graphed with R (4.3.2) in RStudio. Responses containing custom-filled text were mapped onto given answer choices (e.g. Industry), if applicable, and re-coded all business information from a nominal to continuous scale.

Principal Component Analysis (PCA) was performed on the items of each scale to form derived variable groups of closely related items, using the *prcomp* function in R.

https://doi.org/10.59720/24-355

Neuroticism, extraversion, openness, agreeableness, and conscientiousness, as well as preparation, incubation, insight, evaluation, and elaboration were labeled as the mean of the corresponding scale variables/related statements. Reverse-coded variables were applied as needed to ensure that a higher scale value consistently reflected a greater presence of the trait being measured (e.g., higher neuroticism, higher openness). This means that for some survey items, response values were reversed (e.g., 1 became 7) so that all items were aligned in the same direction.

Correspondingly, goals and organization, reflecting, and adapting were manually grouped and computed as the mean of related variables/scale items. Goals and organization encompassed scale items that evaluated the extent to which the individual sets specific goals and organizes their time, ideas, and resources to achieve their goals. Reflecting represents scale items that evaluate the extent to which an individual reflects on their own choices and ideas and how others may react to them. Similarly, adapting constitutes scale items that evaluate the extent to which the individual adapts and maintains control over aspects of their business in the long run.

Pearson correlations were obtained using the *cor* function in R, using listwise deletion to handle missing data. Each variable was correlated with the following: Entrepreneurial Experience, whether this entrepreneur is experienced. PastOwned, or the number of businesses owned in the past but not owned currently, CurrentOwn, or the number of businesses owned currently, YearsOwned, or the number of years owned current business/business considered the most successful, NumOwners, or the number of owners currently, OwnersatStart, or the number of owners when the business was first created, HoursSpent, or the average number of hours spent per week working on the businesses owned, Employees, or how many employees the business currently employs, Rev, or the business's revenue in the past year, and RevGrowth, or the business's revenue growth in the past two years.

We obtained descriptive statistics and trained an XGBoost model using the xgboost package (1.7.6.1) on the data to evaluate the most important features. We used SHAP values to visualize the effect of each of the variables on entrepreneurial experience. We used both entrepreneurial experience as well as Years Owned, as both could indicate the entrepreneur's experience. We also used SHAP values to explain differences between experienced and novice entrepreneurs. We generated a sina plot using the sinaplot package in R using long format data of SHAP values for the 17 most important features in XGBoost (SHAPforxgboost), out of the original 69; the dependence plot of SHAP values vs. feature values was correlated with Years Owned.

ACKNOWLEDGMENTS

We would like to thank Jared Scruggs from the Wharton School of the University of Pennsylvania and Ms. Nicole Spinelli from Great Neck South High School for their guidance in the development of this research project.

Received: September 14, 2024
Accepted: September 10, 2025
Published: June 26, 2026

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https://doi.org/10.59720/24-355

APPENDIX

Variable Group	Cronbach's Alpha
Neuroticism	0.795 (4 survey statements)
Extraversion	0.750 (4 survey statements)
Openness	0.749 (4 survey statements)
Agreeableness	0.791 (4 survey statements)
Conscientiousness	0.734 (4 survey statements)
Goals and Organization	0.844 (5 survey statements)
Reflecting	0.719 (3 survey statements)
Adapting	0.707 (4 survey statements)

Table A1. Cronbach's Alpha Values for Variable Groups. Values above 0.7 indicate high internal consistency and reliability of the measure. There was high reliability in the variable groups.

Qualtrics Questionnaire

Business Ownership

How many businesses have you owned in the past, but do not own currently?

- 0
- 1
- 2
- 3 or more

How many businesses do you currently own?

- 1
- 2
- 3 or more

Business Information

How did you initially acquire ownership of this business?

- Founded or started
- Purchased
- Inherited
- Received transfer of ownership or gift

How many total years have you owned this business? Please respond as a number, i.e. "1", "10," etc.

What industry is this business currently in? Select all that apply.

- Accommodation and Food Services
- Administrative and Support and Waste Management and Remediation Services
- Arts, Entertainment, and Recreation
- Construction
- Educational Services
- Finance and Insurance
- Health Care and Social Assistance
- Information
- Management of Companies and Enterprises
- Manufacturing
- Professional, Scientific, and Technical Services
- Real Estate and Rental and Leasing
- Retail Trade
- Transportation and Warehousing
- Utilities

https://doi.org/10.59720/24-355

Wholesale Trade
Other (please specify)

Currently, how many people own this business (shareholders)? Do not combine two or more owners to create one owner, and count spouses and partners as separate owners.
1 person (myself)
2 people
3 people
4 people
5-10 people
11 or more people

When this business was started, purchased, or inherited, how many people owned this business (shareholders)? Do not combine two or more owners to create one owner, and count spouses and partners as separate owners.
1 person (myself)
2 people
3 people
4 people
5-10 people
11 or more people

In 2023, what was the average number of hours per week that you spent managing or working in this business?
None
Less than 20 hours
20-49 hours
40-59 hours
60 hours or more

Currently, how many employees does your business employ, excluding yourself?
Between 1 and 4
Between 5 and 9
Between 10 and 19
Between 20 and 29
30 or more

In 2022 (last year), what was the annual revenue of this business?
Less than $50,000
Between $50,000 and $100,000
Between $100,000 and $200,000
Between $200,000 and $500,000
Between $500,000 and $1,000,000
Between $1,000,000 and $5,000,000
More than $5,000,000

From 2021-2022, what was the percent growth in annual revenue of this business?
Less than -100%
Between -100% and -75%
Between -75% and -50%
Between -50% and -25%
Between -25% and 0%
Between 0% and 25%
Between 25% and 50%
Between 50% and 75%
Between 75% and 100%
More than 100%
Not sure

Demographic Information
What is your age? Please respond as a number, e.g., "25", "50", etc.

What is your gender?
Male

https://doi.org/10.59720/24-355

Female
Prefer to self describe as (non-binary, gender-fluid, agender, please specify)
Prefer not to say

Which of the following best describes you?
Asian or Pacific Islander
Black or African American
Hispanic or Latino
Native American or Alaskan Native
White or Caucasian
Multiracial or Biracial
A race or ethnicity not listed here (please describe)

What was the highest degree or level of school you have completed?
Less than high school graduate
High school graduate - Diploma or GED
Technical, trade, or vocational school
Some college, but no degree
Associate Degree
Bachelor's Degree
Master's, Doctorate, or Professional Degree

Cognitive Variables
The following are statements that could describe you as an entrepreneur. Please indicate how much you agree with each sentence. In general, I... (1 strongly disagree – 7 strongly agree)
Think about how others may react to my actions
Try to use strategies that have worked in the past
Set specific goals before I begin a task
Am good at organizing information
Ask myself how well I've accomplished my goals once I've finished
Use different strategies depending on the situation
Consciously focus my attention on important information
Often define goals for myself
Organize my time to best accomplish my goals
Focus on the meaning and significance of new information
Ask myself questions about the task before I begin
Try to break problems down into smaller components
Challenge my own assumptions about a task before I begin
Try to translate new information into my own words
Use my "gut" to tell me when a given strategy I use will be most effective

The following are statements that could describe your entrepreneurial attitudes. Please indicate how much you agree with each sentence. In general, I… (1 strongly disagree – 5 strongly agree)
Find the process of starting a business very daunting
Enjoy the long-run management of business
Enjoy the early stages of building a business
Feel I can predict and adapt to changing environmental circumstances
Have a short attention span
Frequently try to establish/develop new contacts
Like to be aware of all decisions made about this business and have the final say

The following are statements that could describe your entrepreneurial beliefs. Please indicate how much you agree with each sentence. In general… (1 strongly disagree – 5 strongly agree)
I often think of new business ideas when I am totally relaxed, doing something unrelated to business
Our venture idea came for an accidental process that just happened to uncover the concept
I set aside a few minutes each day or week to be creative
I enjoy just thinking about and/or looking for new business opportunities
On entering the market with a new venture, I made major changes based on customer feedback
In-depth market analysis is often used more for impressing financial sources than for actual decision making
The idea behind this business just seemed to suddenly appear
It is easier to see the real opportunities after you begin to enter a new market (compared to before you start)
I knew who the first customers would be before introducing our first product/service

https://doi.org/10.59720/24-355

Other people bring new venture business ideas to me
I listen extremely well to what customers say they want and don't want as a way of identifying opportunities
It is often better to enter a market and, if necessary, make changes than to take the time and money to first do formal marketing research

Personality
The following are statements that could describe you as a person. Please indicate how much you agree with each sentence. In general, I… (1 strongly disagree – 7 strongly agree)

Am not interested in abstract ideas.
Make a mess of things.
Get chores done right away.
Often forget to put things back in their proper place.
Am not really interested in others.
Am relaxed most of the time.
Have difficulty understanding abstract ideas.
Have frequent mood swings.
Get upset easily.
Have a vivid imagination.
Sympathize with others' feelings.
Like order.
Do not have a good imagination.
Seldom feel blue.
Feel others' emotions.
Talk to a lot of different people at parties.
Am the life of the party.
Keep in the background.
Am not interested in other people's problems.
Don't talk a lot.

Interview Questions

Business Information:
1. How many businesses have you owned in the past, but do not own currently?
2. How many businesses do you currently own?

Please answer the following questions with consideration to the business you currently own/the business you consider the most successful of those that you currently own:
1. How many total years have you owned this business?
2. What industry is this business currently in? (e.g. administration, construction, manufacturing, real estate, information, professional services, etc.)

First, tell me the story of your career (Rae, 2004):
1. What kind of personal exposure did you have to entrepreneurship before starting out in business?
2. Did you have any business or technical training?
3. Why did you decide to start a business/your different businesses? Tell me about your business/businesses.
4. What are the main motivations in your life?
5. Ask to tell life story from early life onward, and how it connects to their business experience.
6. Explore each stage of their life story and career, recollect significant episodes in their development.

Current Situation (Martin and Smith, 2010):
1. What have been your most significant learning experiences in your career, and how have these affected you?
2. Tell me about your early career and what you've learned from it, going into your present career.
3. What business successes and failures have you experienced and how did you deal with or react to them?
4. What are some of your present business activities, and how do they differ from when you first started?