

A data-driven approach to reveal entrepreneurial cognition

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Abstract

Entrepreneurs perform the socially important action of providing products and services to large populations and generating economic value. It is posited that entrepreneurs have unique traits, cognitive faculties, or other attributes. Previous research has examined specific aspects of entrepreneurial cognition individually, but there is limited work examining their effects holistically. Using a wide range of survey instruments, we take an exploratory data-driven approach to reveal the unique cognitive capacities developed by people when engaging in business venturing activities. Exploratory factor analysis revealed five latent factors driving changes in our data: Negative Emotions, Fulfillment & Support, Creative Capacity, Collaborative Personality, and Decision Making Avoidance. Our results find that entrepreneurs avoid decision-making less and are less collaborative than managers. Along an entrepreneur-manager spectrum, creative capacity is different with experience levels. Decision-making avoidance also decreases with increased entrepreneurial experience and the number of companies founded. On the other hand, emotional health and career success remain similar across groups. Our results support that entrepreneurship can be nurtured through optimal environments and experiences and the development of specific cognitive capacities.

Introduction

Entrepreneurship and business venturing is the activity of providing novel value propositions to people by establishing new companies. In doing so, entrepreneurs provide products and services to large populations and generate economic value. Therefore, understanding how entrepreneurs can perform such actions is a very socially relevant topic. By identifying the unique cognitive capacities of entrepreneurs, we can putatively enhance the entrepreneurial attributes and skills of others. Entrepreneurial cognition has been defined as “the knowledge structures that people use to make assessments, judgments, or decisions involving opportunity evaluation, venture creation, and growth” ([Mitchell, 2002](#)). However, the specifics of entrepreneurial cognition and how it can be enhanced and nurtured remain unclear. Through an exploratory data-driven approach, we aim to shed light on the unique cognitive capacities of individuals who engage in entrepreneurship and business venturing.

Previous research has examined specific aspects of cognition in entrepreneurs. Cognitive biases and heuristics in decision-making can benefit entrepreneurs in specific circumstances ([Busenitz, 1992](#)). Psychiatric disorders like ADHD, with symptoms of impulsivity and hyperfocus, influence the decision to engage in entrepreneurship and the success of such actions ([Wiklund et al., 2016](#); [Wiklund et al., 2017](#)). Other cognitive faculties like improvisation and creativity ([Baker et al., 2003](#); [Fillis & Rentschler, 2010](#)), self-efficacy ([Newman et al., 2019](#)), and disinhibition ([Lerner, 2016](#)) can all distinguish entrepreneurs. Additionally, a literature review found inconsistent and unclear results in research searching for psychological characteristics and demographic qualities of entrepreneurs ([Mitchell, 2016](#)). Therefore, rather than studying entrepreneurs as individuals and looking for homogeneous traits, an increasingly common cognitive-based approach examines entrepreneurs’ cognition in the context of their environments. Individual environments and situations require humans to adapt to the situations and develop distinct cognitive capacities, such as tolerance of ambiguity and openness to experiences ([Begley & Boyd, 1987](#); [Zhao & Seibert, 2006](#)). Entrepreneurs often deal with situations of high uncertainty ([Wu & Knott, 2006](#)). As a result, entrepreneurial decision-making relies on heuristics and strategic decision-making ([Busenitz & Barney, 1997](#); [de Fraja, 1996](#);

[Gilbert-Saad et al., 2018](#)). Entrepreneurs are also more prone to overconfidence or representativeness errors ([Busenitz & Barney, 1997](#); [Simon, Houghton, & Aquino, 2000](#)) and other biases like the self-serving bias and planning fallacy ([Baron, 1998](#)). In general, research has shown entrepreneurs to have specific unique characteristics in their cognition relating to decision-making and improvisation that are founded in their environments.

While a large amount of work is done on aspects of entrepreneurial cognition individually, there is limited work examining their effects holistically. Entrepreneurs are not isolated from their environments, and entrepreneurship is not solely a result of any singular quality or characteristic ([Cardon et al., 2012](#); [Foo et al., 2009](#); [Sarasvathy, 2001](#); [Rubenson & Runco, 1995](#)). Different experiences, abilities, social environments, and emotional health all play a role in the resulting behavior of entrepreneurs ([Shepherd et al., 2014](#)). Age, sex, experiences, and education can influence these differences. Therefore, a holistic perspective examining the wider internal and external context of an individual provides a valuable lens to investigate the unique cognitive faculties associated with business venturing. Such an approach would also take into account entrepreneurial experience. Entrepreneurs are often contrasted with the behavior of managing and organizing existing companies as both entrepreneurs and managers perform activities related to building and sustaining a business ([Begley & Boyd, 1987](#); [Busenitz & Barney, 1997](#); [Chen et al., 1998](#); [Zhao & Seibert, 2006](#)). However, existing research is limited by not examining varying levels of entrepreneurial experience. Previous work argues that there are cognitive differences between entrepreneurs and other people, but still leaves a vacuum in the literature for how these specific differences function in a larger environment based on prior experiences. This suggests the need for a more comprehensive data-driven approach.

In this research, we examine the cognitive faculties and behaviors developed when creating a new business venture. We approached these inquiries using measurements and techniques developed in psychology and neuroscience. We assessed participants with a wide range of survey instruments and tasks, including the NIH-Toolkit, Melbourne Decision-Making Questionnaire, Alternative Uses Task and more. This resulted in a large number of variables across different dimensions of cognition. Based on the existing research, we expected differences in creativity, impulsivity, and decision-making. To analyze the data, we performed a rigorous

latent factor analysis. Using an exploratory factor analysis allows us to explore the underlying theoretical structure of our data. With this approach, we found latent factors that explain changes in the data and drive differences in our entrepreneur and manager groups. This helps us interpret the measured variables that have large variabilities. It also allows us to reduce the data and avoid the problem of multiple comparisons. We examine these different factors along several groupings of experience and are not limited to an entrepreneur-manager dichotomy. By including entrepreneurial experience, we approach questions from a holistic framework that allows us to look at the effect of the entrepreneur's environment. Our exploratory analysis reveals the unique cognitive capacities developed by people when engaging in business venturing activities.

Methods

Data Collection

The study recruited subjects by word of mouth, email listservs, and social media, including LinkedIn and Craigslist. Potential participants completed a screening questionnaire designed to identify relevant participants. The inclusion criteria comprised managers or entrepreneurs over the age of 18. We included managers that are part of an existing organization and currently managing a team of over two employees. Entrepreneurs included in this study are founders of an organization with more than two employees. All participants gave informed consent prior to participation and were compensated at \$20 per hour.

The study includes 117 participants - 112 males and 72 females. 21 participants were removed due to incompleteness of the online assessment, resulting in 103 subjects. 70% of the 103 participants identified themselves as male and 30% as female. They had an age range of 20 to 50 years old. They reported their income out of ten groups ranging from less than \$10,000 to over \$200,000. Education levels included high school, bachelor's, master's, and Ph.D.

Participants self-identified as one of the following races: African American, Asian/Pacific Islander/Asian Indian, Hispanic/Latino, White, and Multi-racial. **Table 1** shows the population data of included participants in the data analysis of the two groups of entrepreneurs and managers.

Table 1. Sample size and demographic data

	Entrepreneurs		Managers	
Total	45		58	
Male	35		37	
Female	10		21	
Asian	9		6	
African American	10		26	
Hispanic / Latino	3		0	
White	20		23	
Multi-racial	1		2	
Average Age	33 years		35 years	
Income Group	Less than \$10,000	= 3	Less than \$10,000	= 3
	\$10,001-\$20,999	= 6	\$10,001-\$20,999	= 0
	\$21,000-\$30,999	= 1	\$21,000-\$30,999	= 5
	\$31,000-\$50,999	= 4	\$31,000-\$50,999	= 6
	\$51,000-\$75,999	= 5	\$51,000-\$75,999	= 5
	\$76,000-\$100,999	= 8	\$76,000-\$100,999	= 20
	\$101,000-\$125,999	= 8	\$101,000-\$125,999	= 8
	\$126,000-\$150,999	= 4	\$126,000-\$150,999	= 3
	\$151,000-\$200,000	= 2	\$151,000-\$200,000	= 4
	Over \$200,000	= 10	Over \$200,000	= 3
Level of Education	High School	= 4	High School	= 3
	Bachelors	= 26	Bachelors	= 19
	Masters	= 13	Masters	= 25
	PhD	= 2	PhD	= 11

Survey Scoring

The data analysis followed the process of coding the different scores of each survey measurement, as outlined in **Table 2**. The Toronto Empathy answers were summed to derive totals according to the Toronto Empathy Questionnaire protocol ([Spreng et al.,2009](#)). The Melbourne Decision Making answers were split into four groups: buck-passing, hyper-vigilance,

vigilance, and procrastination, and answers for each group were summed ([Mann et al., 1997](#)). General Self-Efficacy scores were summed to derive totals ([Schwarzer & Jerusalem, 1995](#)). NEO survey scores were summed in each domain ([Costa & McCrae, 2008](#)) and converted into t-scores using the provided t-tables. The Creative Achievements and Activities answers were split into Creative Activities and Creative Achievements, each separated into eight domains. Domain-specific scores were either averaged or summed across each of the questions, and domain-general scores were summed across each of the domain scores ([Diedrich et al., 2018](#)). NIH Toolbox instruments were used to collect the Emotions-Battery, and survey scores were calculated by the NIH Toolbox app (www.nihtoolbox.org). Raw survey scores were converted into t-scores using the provided t-tables. The Alternative Uses Task ([Guilford, 1967](#)) was scored by two independent raters along two dimensions of fluency and originality. Fluency was defined as the number of uses listed, and Originality was defined as the frequency of the use across participants (i.e., one divided by the number of times any of the participants listed the use). An intraclass correlation was performed to ensure good reliability between the two raters and found an intraclass coefficient of .7 for originality and .94 for fluency.

Table 2. *Cognitive capacities, behaviors, and Entrepreneur-Manager spectrum assessments*

Assessment	Measurement
Entrepreneur Manager Quotient	A survey to determine where an individual lies on a spectrum from entrepreneur to manager.
Toronto Empathy	A representation of empathy as primarily an emotional process and component of social cognition. High empathy means accurately perceiving the emotional state of another person. Higher scores indicate higher empathy.

Melbourne Decision Making

Asks from 0-2 how true a series of statements are in each of the four categories:

- Procrastination: feeling pressured and pessimistic about decision-making
- Hypervigilance: delaying decision-making
- Buck-passing: avoiding decisions and leaving decision-making to others
- Vigilance: the consideration of information and alternatives

NEO Five-factor inventory

A measure of five domains of personality:

- Neuroticism: emotional instability
- Extraversion: sociability, emotionally expressive
- Agreeableness: altruism, kindness, cooperativeness
- Openness: curiosity, creativity
- Conscientiousness: thoughtful, good impulse control, preparedness

Inventory of Creative Activities and Achievements (ICAA)

Asks to report creative activities (CAct) and achievements (ICAA) (CAch). The inventory contains eight different domains (literature, music, art/craft, creative cooking, sports, visual art, performing art, and science) and 3 questions for each of these domains.

- CAct: the number of times an activity has been carried out
- CAch: the level of achievement

Reward Responsiveness

- Reward Responsiveness (RR): measures sensitivity to rewards independent of punishment
- Behavioral inhibition system (BIS): measures responses to anxiety cues in the environment

General Self-efficacy Scale (GSE)	Measures confidence in one's ability to cope, solve problems and accomplish goals. Scored from 'not true' to 'exactly true'. A higher score indicates more self-efficacy.
Alternative Uses Test (AUT)	Participants have two minutes to come up with as many uses different from the common use for six common objects. Scored across two domains: <ul style="list-style-type: none">● Fluency: how many uses participants list● Originality: how unique these uses are
NIH-Toolbox Emotions Battery	Questions on emotional health are answered on five- or seven-point Likert scales. Measured across multiple subdomains: <ul style="list-style-type: none">● Positive Affect, General Life Satisfaction, Emotional Support, Friendship, Loneliness, Perceived Rejection, Perceived Hostility, Sadness, Perceived Stress, Somatic Fear, Affective Fear, Aggressive Anger, Affective Anger, Hostile Anger, Meaning and Purpose, and Instrumental Support.

Data Analysis

Following the scoring, we employed an Exploratory Factor Analysis (EFA) to reveal latent factors in the data set. We employed comparative analysis between two groups - Entrepreneurs and Managers, and among the Entrepreneurs-Managers spectrum. The groups were defined based on the participant's responses to the Entrepreneur Manager Quotient ([Auernhammer, 2021](#)). We also employed analysis based on the total number of companies founded and differences in career success measured through income and self-rated success. We looked for any group differences in sex, race, age, income, and education. A chi-squared test of race and education between entrepreneur and manager groups showed significant differences between the two groups ($p=.05$ and $p=.02$). Sex, age, and income were not significantly different between the two groups.

Exploratory Factor Analysis (EFA)

We analyzed the data through an EFA to determine the underlying latent factors between numerous measured variables. To test the appropriateness of an EFA, we first performed Bartlett's test for sphericity. This was significant ($p < .001$), suggesting the correlation of our variables is different from zero. Then we performed a Kaiser-Meyer-Olkin test to check sampling adequacy and found an overall MSA of .73, suggesting a large enough sample size and enough variance for an EFA to be appropriate. A Parallel Analysis computed with maximum likelihood extraction and oblique rotation determined that five to six factors were greater than chance. We tested the five-factor model, resulting in explaining 45% of the variance with a strong loading of variables on all five factors. We also tested and compared a six factors model, resulting in a model explaining 49% of the variance and an additional factor that did not have strongly loaded variables. Testing the two models resulted in the same measures of fit - a root mean square of residuals of .06, a root mean squared error of approximations of .07 and a comparative fit index of .83. We choose to use the five-factor model for simplicity. The loading values at 0.5 and above were included in each factor, following the accepted guidelines and for the theoretical interpretation of the factors ([Fabrigar et al., 1999](#); [Stevens, 2012](#)).

Analysis of the difference between Entrepreneurs and Managers: We compared the resulting factors from the EFA for each group: Entrepreneurs and Managers, identifying the difference in cognitive capacity and behavior between the two groups. Significance was determined with a Multivariate Analysis of Covariance (MANCOVA) using education and race as covariates. The combined factors were found significant ($p < .001$). We determined which of the 5 factors is significant by performing a post hoc Analysis of variance (ANOVA) of each factor.

Analysis of differences among the Entrepreneur-Manager Spectrum: We examined differences between levels of entrepreneurial experiences to further explore entrepreneurial capacities and behaviors. We compared differences among the Entrepreneur-Manager spectrum using the Entrepreneur-Manager Quotient ([Auernhammer, 2021](#)). Participants were separated into four groups: (1) entrepreneurs with no managerial experience, (2) entrepreneurs with

managerial experience, (3) managers who were previously entrepreneurs (4) managers who were never entrepreneurs. We assessed the covariance through a MANCOVA between the four groups and the five factors from the EFA, with education and race as covariates.

Analysis of the difference in total Companies Founded

We examined the relationship between the number of Companies Founded and the five factors of the EFA. We calculated partial correlations with education and race as covariates to examine the difference between participants who founded either zero, one, two, or three and more companies, with companies founded as defined by the Entrepreneur-Manager Quotient and study criteria.

Analysis of the difference in Career Success

The last analysis included the measurement of Career Success: (1) income and (2) self-reported success in all participants. We examined the partial correlations with education and race as covariates between the five factors and (1) income and (2) self-reported success. We also explored the groups' differences in entrepreneurs' and managers' career success through the same analysis.

Results

The analysis resulted in five factors from the EFA, allowing us to compare differences between Entrepreneurs and Managers. This comparative analysis revealed (1) two significant differences between Entrepreneurs and Managers (2) two differences in the four categories among the Entrepreneurs-Managers spectrum and (3) no significant differences in success.

Exploratory factor analysis results

The exploratory factor analysis resulted in five latent factors, which we labeled as Negative Emotions, Fulfillment & Support, Creative Capacity, Collaborative Personality, and Decision Making Avoidance. **Figure 1** shows the scree plot and factor loadings of each factor of the exploratory factor analysis.

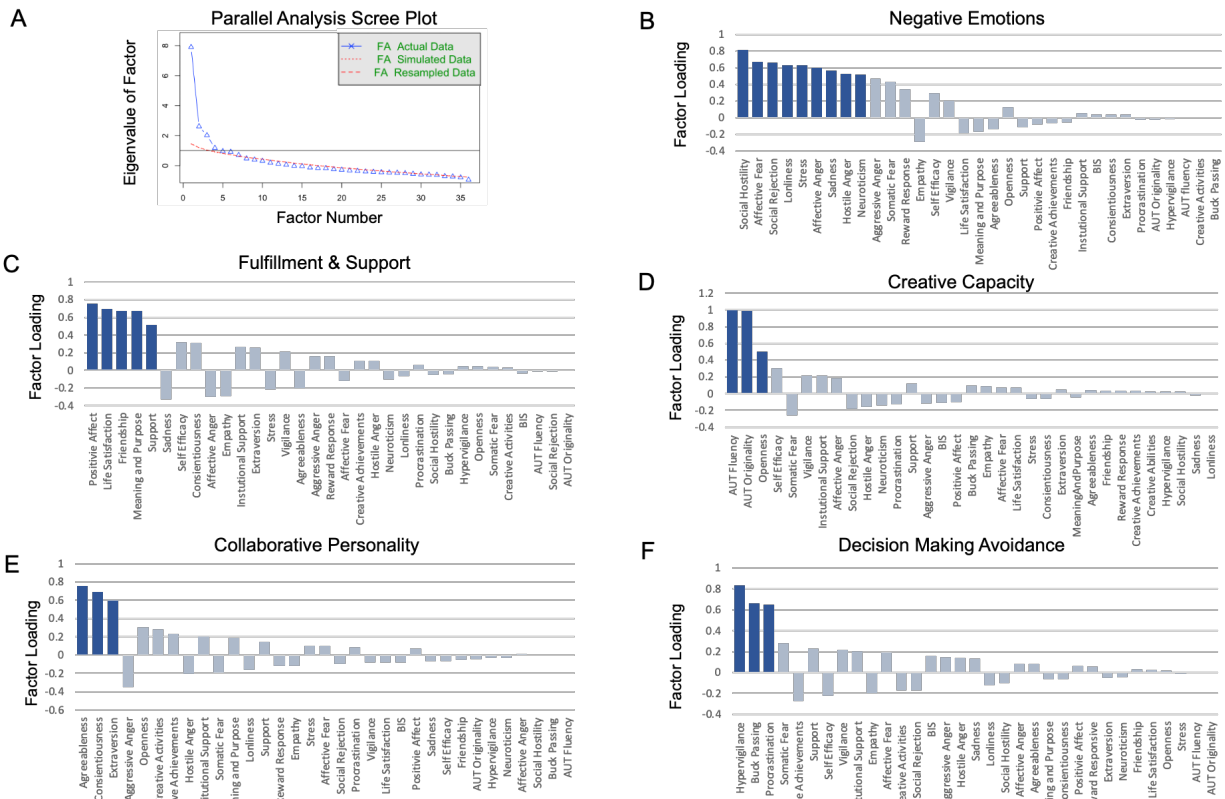


Figure 1. Results of the Exploratory Factor Analysis. A) A scree plot is used to determine the number of factors to retain. The blue line shows the eigenvalues from the actual data. Red lines represent the simulated and resampled data that the actual data is compared against. B-F) Five latent factors were found in the exploratory factor analysis. Blue bars denote the variables comprising each factor, with height being the factor loading score.

Each factor relates to a different cognitive and social aspect of entrepreneurial and managerial activities and related tasks: emotional and social health (positive and negative), personality, creativity, and decision-making. ‘**Negative Emotions**’ comprises nine items relating to negative emotional states: social hostility, affective fear, social rejection, stress, loneliness, affective anger, sadness, neuroticism, and hostile anger (**Figure 1B**). The factor loadings reach between .81 to .51 with Cronbach’s alpha of $\alpha = .89$, explaining 14% of the variance. ‘**Fulfillment and Support**’ consists of five items relating to general life fulfillment and social support, including factor loadings from .75 to .51 with Cronbach’s alpha of $\alpha = .86$. The factor explains 11% of the variance. This factor comprises positive affect, life satisfaction, meaning & purpose, friendship, and support (**Figure 1C**). ‘**Creative Capacity**’ includes three items relating to creativity and

openness to ideas. The factor loadings reach from .99 to .50, and Cronbach's alpha of $\alpha = .59$, explaining 8% of the variance. This factor is composed of alternative uses fluency, alternative uses originality, and openness (**Figure 1D**). '*Collaborative Personality*' is composed of three items from the NEO personality test. The factor loadings reach between .75 to .59 with a Cronbach's alpha value of $\alpha = .74$, explaining 7% of the variance. This factor includes agreeableness, conscientiousness, and extraversion (**Figure 1E**). '*Decision-Making Avoidance*' comprises three items relating to avoiding decision-making from the Melbourne Decision Making Quotient. The factor incorporates factor loadings from .83 to .65 and Cronbach's alpha of $\alpha = .77$, explaining 6% of the variance. The factor includes hypervigilance, buck-passing, and procrastination (**Figure 1F**).

Entrepreneur and Manager differences

The comparative analysis of the five factors of the two groups, Entrepreneurs and Managers, resulted in statistically significant differences in Decision Making Avoidance and Collaborative Personality, as illustrated in **Figure 2**.

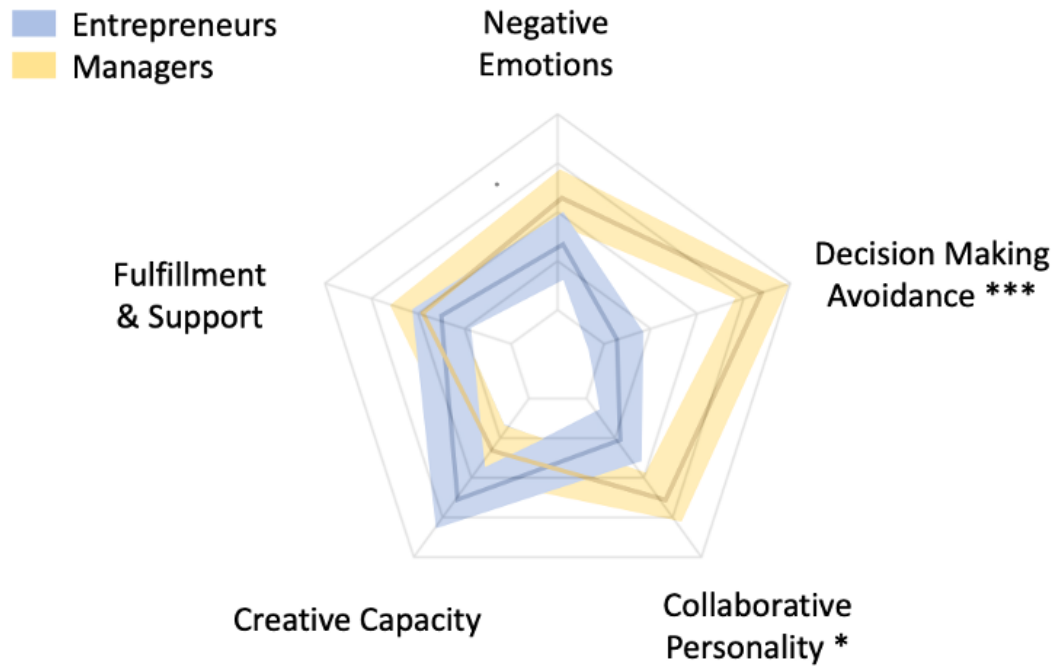


Figure 2. *Group Differences in Factors:* A radar plot of entrepreneurs and managers showing their average factor score for each of the five factors found in the exploratory factor analysis. Shaded regions show standard error. * $p < .05$; *** $p < .001$

These findings revealed that entrepreneurs score significantly lower on Decision-Making Avoidance ($p < .001$) and Collaborative Personality ($p = .03$) than managers. Additionally, the analysis showed no significant differences in Creative Capacity, Negative Emotions, and Fulfillment & Support when compared between the two groups of entrepreneurs and managers.

Difference across the Entrepreneur-Manager Spectrum

The analysis of the difference among the Entrepreneur-Manager spectrum revealed statistical significance in Decision-Making Avoidance ($p < .001$) and Creative Capacity ($p = .04$). These results revealed that Decision-Making Avoidance decreases and Creative Capacity increases with entrepreneurial experience, as shown in **Figure 3**.

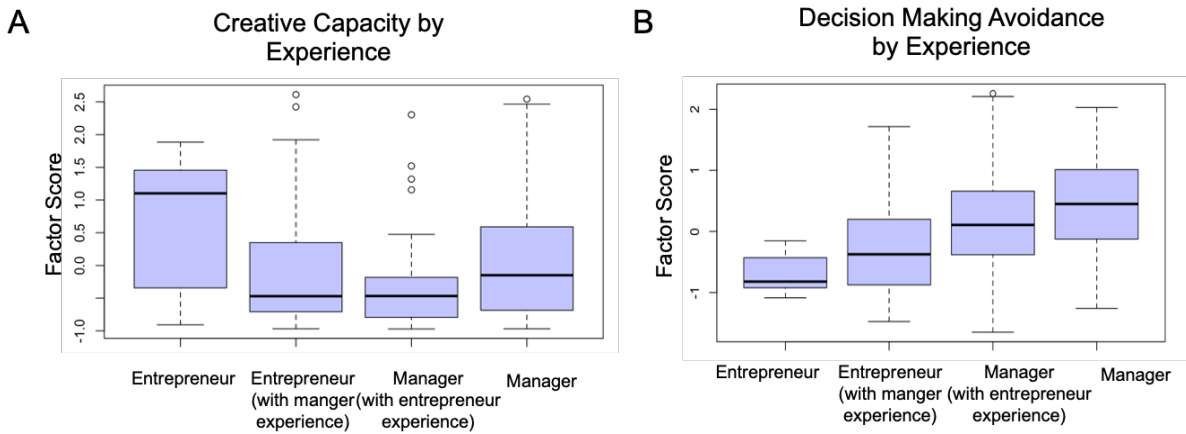


Figure 3. Score plot of difference in Creative Capacity and Decision-Making Avoidance factor among the Entrepreneurial and Managerial spectrum.

Difference across total number of Companies Founded

The partial correlations of the five factors among the Entrepreneurs by the total number of companies founded revealed a significant difference in Collaborative Personality ($p = .01$), and Decision Making Avoidance ($p = .002$). Both increase with the fewer companies founded, as shown in **Figure 4**.

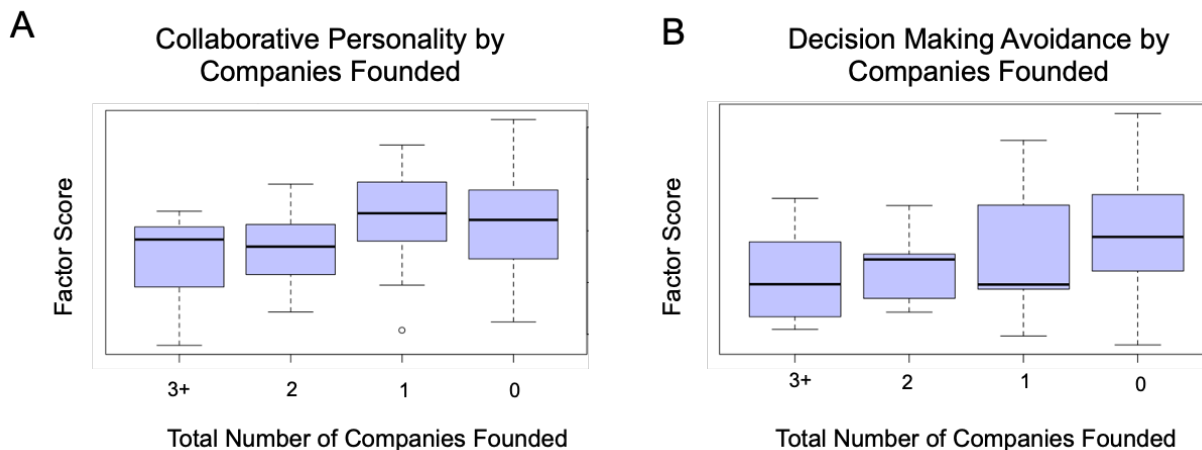


Figure 4. Significant correlations between factors and the total number of companies founded: Box plots showing the mean and distribution of the factor scores grouped by the number of companies founded: 0, 1, 2, 3, or more.

Difference among Entrepreneurs' and Managers' Career Success

The partial correlations among differences in Career Success measured by income and self-reported success revealed no significant differences. Similarly, the analysis of group differences

in entrepreneurs' and managers' Career Success resulted in no significant differences between groups for either measurement. The size of the company and the number of people supervised were also not significant.

Discussion

In this research, we explored the cognitive capacity of entrepreneurs and managers and the relationship between entrepreneurial experience and behavior. We did this by conducting surveys on self-identified entrepreneurs and managers. Using an exploratory factor analysis, we found five latent factors underlying our data: Decision Making Avoidance, Collaborative Personality, Creative Capacity, Negative Emotions, and Fulfillment & Support. We also measured career success through self-reported success and income. We have three main findings. (1) Entrepreneurs scored lower on decision-making avoidance and collaborative personality than managers. (2) There were significant differences in decision-making avoidance and creative capacity based on entrepreneurial experience. (3) Negative Emotions and Fulfillment & Support, as well as Career Success, remained stable across groups.

Our first findings address the differences between entrepreneurs and managers. These results show that entrepreneurs approach how they make decisions differently than managers. They are more inclined to make decisions, less likely to pass the responsibility of making decisions onto others and feel less negatively about making decisions. They also tend to be less self-disciplined, prepared, cooperative, and emotionally expressive than managers. This fits the larger profile of entrepreneurs as impulsive, independent, and preferring to make their own decisions. Future interventions should focus on enhancing these qualities of entrepreneurs and promoting decision-making.

We next build on previous work comparing entrepreneurs and managers and look more closely at the individual's prior experiences. Going beyond the dichotomy of entrepreneurs and managers, our next findings show significant differences in groups based on a spectrum of entrepreneurial and managerial experience. There were significant differences in Decision-Making Avoidance and Creative Capacity based on their entrepreneurial and managerial experience. These results imply that entrepreneurial decisions are made from the individual's past experiences as an entrepreneur. Supporting this explanation, the more companies

participants founded, the lower they scored on Decision-Making Avoidance and Collaborative Personality. These results go beyond static differences between entrepreneurs and managers to show that experiences and environmental context play a key role in entrepreneurs' cognitive capacity. They imply that practicing making decisions in entrepreneurship may lower one's hesitancy toward decision-making. Future longitudinal studies can track the effects of such experiences. Additionally, project-based learning could replicate these experiences without engaging in actual entrepreneurship. As such, any entrepreneurial education should focus on the experience of entrepreneurial activities throughout the project and problem-based learning to develop efficient decision-making capacities.

Our results demonstrate similarities between entrepreneurs and managers. There were no significant differences in Negative Emotions, Fulfillment & Support, or success between any groupings. These results highlight that different contexts of entrepreneurial and managerial behavior relate to differences in cognitive capacity and behavior but not emotional wellness or success. Our evidence supports the idea that people adapt to their environments and change as needed to sustain their emotional wellness and success. Different cognitive capacities are, therefore, necessary in different circumstances. Entrepreneurs do not seem to rely on static differences but rather on cognitive capacities that they evolve to fit their chosen tasks. Interventions should therefore be goal-based, not simply skill-based. Future research with a larger sample size could look more closely at how prior successful experiences relate to decision-making.

Our findings have implications for entrepreneurial practice and education. An individual does not need to possess specific inherent qualities. Instead, certain cognitive capacities can be developed. This is in line with the assertion that entrepreneurs are “built, not born” ([Mitchell, 2016](#)), and that entrepreneurship is an intentionally planned behavior ([Krueger & Carsrud, 1993](#)). More specifically, our findings suggest that prior experience plays a vital role in making entrepreneurial decisions by reducing avoidance. Therefore, educating people through project and problem-based learning can develop entrepreneurial cognition. It should focus specifically on (1) avoiding procrastination and taking responsibility for decisions, (2) working independently, and (3) developing creativity. Research on procrastination in college students could be adapted to entrepreneurial decision-making, specifically acceptance and commitment training ([Scent, 2014](#)). Creative enhancement is possible through a design-thinking-based

Creative Capacity Building Program that has been shown to lead to longitudinal changes in brain activity associated with spontaneous improvisation ([Saggar et al., 2017](#)). In addition to training, an optimal environment can improve entrepreneurial cognition. Environmental and situational factors like good role models, resources, and freedom from criticism have been identified as influencing creativity in people ([Amabile & Gryskiewicz 1989](#); [Witt & Beorkrem 1989](#), [Runco 2004](#)). Maximizing these factors could foster entrepreneurship. Overall, a person's cognitive capacity and behavior can develop and change in relation to their environmental context. Becoming an entrepreneur requires a combination of optimal environments, experiences, and cognitive capacities.

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