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Personality in Norm and in Pathology**DIVIDE BETWEEN ENTREPRENEURS AND NON-  
ENTREPRENEURS: NEUROSCIENTIFIC PERSPECTIVE OF  
THE ATTITUDE TO RISK**

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**Abstract**

Our research is an argument in the discussion about the specificity of entrepreneurial thinking: whether entrepreneur is a person with a special type of thinking (person-centric view), or he is more or less situationally “happens in the right place” (person-opportunity view). We extend traditional cantillonian notion of entrepreneurship and build our hypothesis on it. We observe subjects (self-reported entrepreneurs and non-entrepreneurs), involved in solving laboratory risk task. We measure left-frontal EEG asymmetry (stress) and arousal levels, as well as propensity to risk taking, using standard Balloon Analogue Risk Task (BART). We generally find that the level of propensity to risk, as well as stress and arousal levels, varies among participants according to their position in division of labour system. Patterns of stress and arousal levels in entrepreneurs differ from those of non-entrepreneurs. Our paper makes contribution to both person-centric and individual-opportunity lines of entrepreneurship research, exploring possible ways to integrate it.

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## 1. Introduction

What makes a person an entrepreneur? Is entrepreneurial behavior (as well as cognition, intention, etc.) emitted by individual themselves or elicited by external environment? Are entrepreneurs “creatively destructing” the world, as Schumpeter noted, or just merely looking for changes, responding to them and exploiting the opportunity, as was noted by Drucker?

What is “entrepreneurship” in general - where is the boundary of this concept? Can we point out something, that unites situations of a local shopkeeper running a shawarma shop; of a technology entrepreneur, creating a space tourism industry; of a corporate manager, launching a new line of business in a corporation; of a departmental clerk, implementing digital innovation in public services; or of a university professor applying for a research grant? Can we point out the common features of their personality and thinking?

The issue of the true nature of the entrepreneur (or entrepreneurship) is not only at the core of academic discussions (Aparicio et al., 2021; Kroeger & Wright, 2021; Rajan, 2021; Ricciardi et al., 2021; Yangjie et al., 2021). It has important implications for varying spheres. When bank or venture capitalist is providing funds to the entrepreneur, should it put more emphasis on personal track-record of the entrepreneur, or it has to emphasize data, characterizing industry perspectives? When regulator in emerging market is designing educational program or distributing grants for SME – should “division of entrepreneurial labour” system, involving many different types of entrepreneurs, or, instead, it should concentrate on finding, educating and providing funds to entrepreneurial high PO’s, some special kind human, possessing unique features?

Regulators, striving to promote entrepreneurship and overcome path dependence, faced with challenges of similar scale. Nowadays, entrepreneurial economy is considered to be one of the most prospective potentiality to recover from the economic downturn (Yu et al., 2018). To design appropriate policies, regulator as social planner have to model the agent, for which regulation is designed to obtain desired outcome.

This inspires numerous researches in the field of entrepreneurship to understand the way entrepreneurs think; how stress influence entrepreneurial behaviour (Fernet et al., 2016); how affect influences creation and intentional pursuit of entrepreneurial ideas; how passion affects entrepreneurial decision making (Cardon et al., 2017).

Neuroscience has enriched the field of understanding of some aspects of entrepreneurship. At the same time, some scholars express lack of trust towards applying neuroscience for entrepreneurship researches for the reasons of complexity and difficulty to conduct and interpret. Some scholars insist that “fMRI is not and will never be a mind reader”. Nevertheless, some researchers conduct neural studies finding the ways of successful incorporation of neuroscience theory and entrepreneurship experiments. Moreover, the innovations in organizational neuroscience have recently been engaged in corporate culture transformations, with the main focus on the switching of the mindset of employees’ to entrepreneurial behavior as the key to go beyond industrial boundaries (Dehghanzadeh et al., 2016).

The rest of the paper is organized as follows. In the second section, we point to the broad context of our research, reconstructing discussion in which our research is positioned and clarifying a number of

concepts. Namely, we formalize “more inclusive definition” of entrepreneurship and draw some implications from it. In the third section, we formulate key research questions. In Section 4 we indicate broader purpose of our research. In Section 5 we describe research hypothesis and the method for testing it. In the sixth section, we describe results obtained. In Section 7 we conclude.

## 2. Problem Statement

Our research is an argument in the discussion about the specificity of entrepreneurial thinking: whether entrepreneur is a person with a special type of thinking (person-centric view), or he is more or less situationally “happens in the right place” (person-opportunity view). Before proceeding to the formulation of the research question and the description of our approach, let us clarify several concepts.

### 2.1. Division of labour system is key to understanding unique position of entrepreneur

In our study, we interpret the concept of an entrepreneur broadly. We argue that the archetypes cited in the Introduction — the local shopkeeper, the tech entrepreneur, the corporate intrapreneur, the governmental or academy innovator — at a certain level of abstraction render the same action. They re-design or extra-design the division of labor system, creating new positions in it, creatively combining the resources available to them, finding and contracting missing ones, in order to respond to some need that exists objectively, but, perhaps, has not yet manifested itself in the form of a well-articulated "market demand".

### 2.2. Three dimensions of the notion of entrepreneurship

**Scale of activity.** Thus, the concept of the division of labor system (DLS) is key to our understanding of the essence of entrepreneurial action. The variety of contexts in which this concept can be used corresponds to the variety of situations of taking an entrepreneurial position. A local entrepreneur will design a local system for the division of labor to provide local consumers with fast food. A technological entrepreneur creating a new type of space rocket creates, firstly, an DLS for the design and production of such missiles, and secondly, an DLS that generates a demand for such missiles. Within these high-level DLS's, thousands of entrepreneurs will extra-design them with their local actions. These two limiting points in terms of the scale of activity confine the continuum of situations corresponding to business entrepreneurship.

**Initiative: proactive/reactive.** In addition to that, we argue that academician applying for the grant is also engaged in entrepreneurial activity. No research is carried out in isolation from global DLS, both DLS within the research itself (“Whose results will I use as a resource? Who will use my research as their resources?”), and more general DLS, for which research as a whole acts as a provider of knowledge to create new technologies. When entrepreneurship is considered in such broad context, it is important to distinguish independent action of creating new opportunity proactively, as opposed to reactively taking position in situation, already well-formed by someone else.

**Commitment: guaranteed gain/risky gain.** Another dimension that is needed in order to clarify the concept of entrepreneurship is the level of commitment. That is, something, on which (Cantillon,

2010) points comparing people to bonds and stocks; and on which (Taleb, 2018) points, speaking about “skin in the game”. A degree, to which corporate or government intrapreneur, and university grantee as well, depend on the successful implementation of their actions, varies. At one end of the spectrum there is a position at which the actor receives a certain degree of guaranteed flow of gains, at the other - an unstable flow of gains, completely dependent on the situation and actions.

We adhere to the view that entrepreneurship does not depend on the scale of activity, but at the same time, the closer the action to to “100% proactive” point on the Initiative, and to the “100% risky gain” on the Commitment, the more “entrepreneurial” the action in question is. This implies, in particular, that entrepreneurs are not necessarily, inherently risky people: a person can, for example, proactively invest time and effort to create riskless gain opportunity, or commit to multiple situations, thus “diversifying” between them. Having said that, we are not claiming that entrepreneurs ignore risk/ambiguity at all: it might be important part of their internal reality, but as something, which has to be minimized, for example.

### **3. Research Questions**

Thus, attitude to risk is one of two key features of entrepreneurial thinking. Therefore, in this study, we focus on the entrepreneurial attitude to risk, namely, we ask two questions:

- how integral is the desire to take risks for an entrepreneur?
- Is there anything special about an entrepreneurial attitude to risk?

#### **3.1. Hypothesis**

On overall, it seems that risk taking propensity and ambiguity tolerance is at the core of almost all views at entrepreneur, both person-centric and person-opportunity-centric. It is believed that tolerance for ambiguity is an entrepreneurial characteristic and those who are entrepreneurially inclined are expected to display more tolerance for ambiguity than other.

Thus, the framework hypothesis of our study is the idea that entrepreneurs have a special type of attitude to risk, i.e. there has to be some specific regularities in the attitude to risk, that would be more often found among people, who in social reality are inclined to take an entrepreneurial position, and less often found among others.

BART, by design, is not only risk-taking, but also ambiguity-tolerance task, as probabilities of balloon pops is unknown to participant, and learning from observations is impossible (each balloon have unique internal probability of pop, unknown to participant).

Our working hypotheses are:

- H1: entrepreneurs will be riskier when solving BART task;
- H2: they will exhibit less stress during risk task;
- H3: they will more arousal during risk task.

## **4. Purpose of the Study**

In broader sense, our research is a contribution to the construction of a valid system of profiling people for the propensity to take an entrepreneurial position. We want to get a “machine” that allows us to get a combination of behavioral data and EEG as input, and then draw a conclusion about how inclined the subject is to entrepreneurial activity, and how likely his success in this area is.

## **5. Research Methods**

### **5.1. Participants**

45 adult working participants were involved in research, 18 of them described themselves as engaged in entrepreneurial activities, the rest - as employees, having predictable salary. We therefore build on original cantillonian understanding of entrepreneurship. Participants were invited mainly through three channels:

- University MBA programme participants (entrepreneurs and employees);
- Heads and co-founders of “traditional” SMEs, invited through Moscow centers of local entrepreneurship support (entrepreneurs and employees);
- Serial entrepreneurs and startup founders from Winno Moscow community (entrepreneurs).

The BART (Balloon Analogue Risk Task), developed by Lejuez et al. (2002), is computerized test, designed to measure risk-taking propensity in gamified context. It is argued, that it correlates both with naturalistic and economic risk-taking (Schonberg et al., 2011). On each trial, participants “pump” a simulated balloon without knowing expected probability of explosion. Each pump increases the potential reward to be gained but also the probability of explosion, which wipes out all potential gains for that trial. In most studies, balloon explosion probabilities are drawn from a uniform distribution, and participants must learn explosion probabilities through trial-and-error. BART is extensively used as stimulus in neuroscientific research literature. Recently it was also often used in EEG brain research (Pinner & Cavanagh, 2017), in risk-taking as well as other contexts.

### **5.2. Stress and arousal measurement**

Generally, we follow procedure of Black et al. (2014). We used NeuroIDSS (<http://neuroidss.ru>, Moscow) EEG equipment. Experimental session lasted about 30 minutes. Scalp voltages were recorded using 32 Ag/AgCl wet electrodes in a cap according to the 10-20 international system: F7, F3, Fz, F4, F8, FT7, FC3, FCz, FC4, FT8, T7, C3, Cz, C4, T8, TP7, CP3, CPz, CP4, TP8, P7, P3, Pz, P4, P8, PO7, PO3, POz, PO4, PO8. After cap were applied to participant, experienced researcher visually checked quality of the signal from each electrode in test EEG session, during which participants were asked to sit still, and then clench teeth several times, and blink eyes several times.

Experimental session followed test session. During experimental session BART stimulations were displayed using PsychoPy software. EEG signals, stimulation events and participant’s responses were recorded using OpenVIBE software.

Further, data was processed in OpenVIBE Designer and R project software. Raw data was cleaned using bandstop and bandpass filters. Time-based epoching were further applied, with epochs lasting 1,024 seconds with 0.25 seconds overlap. Alpha and beta waves were further extracted. Left frontal asymmetry was calculated, following Black et al. (2014), as in Figure 1.

$$\frac{\alpha(F3)}{\beta(F3)} - \frac{\alpha(F4)}{\beta(F4)}$$

**Figure 1.** Left frontal asymmetry

Arousal was calculated as in Figure 2.

$$\frac{\beta(F3) + \beta(F4)}{\alpha(F3) + \alpha(F4)} - 0.5$$

**Figure 2.** Arousal

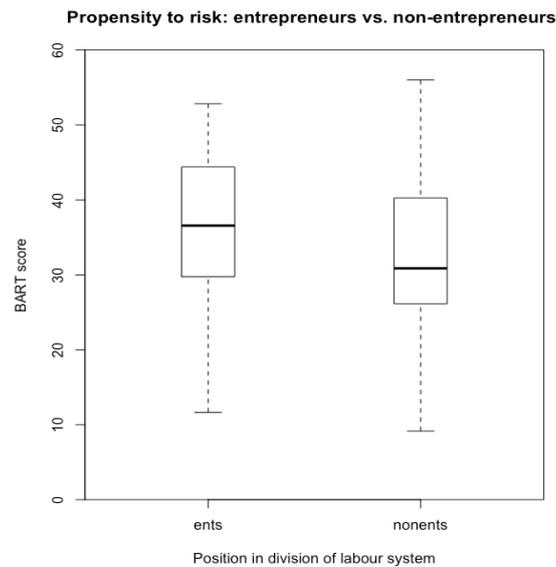
### 5.3. Data processing

Arousal, left-frontal asymmetry, BART responses data was further processed in R project. Left-frontal asymmetry was normalized by dividing data, obtained during BART stimulation, to data, collected prior to first stimulus display. For each participant we calculated average stress, average arousal, and BART score. According to Lejuez et al. (2002), BART score was calculated as average number of balloon pumps for unpopped balloons. Final dataset was united with self-reported data on entrepreneurial orientation.

## 6. Findings

### 6.1. Risk propensity among entrepreneurs

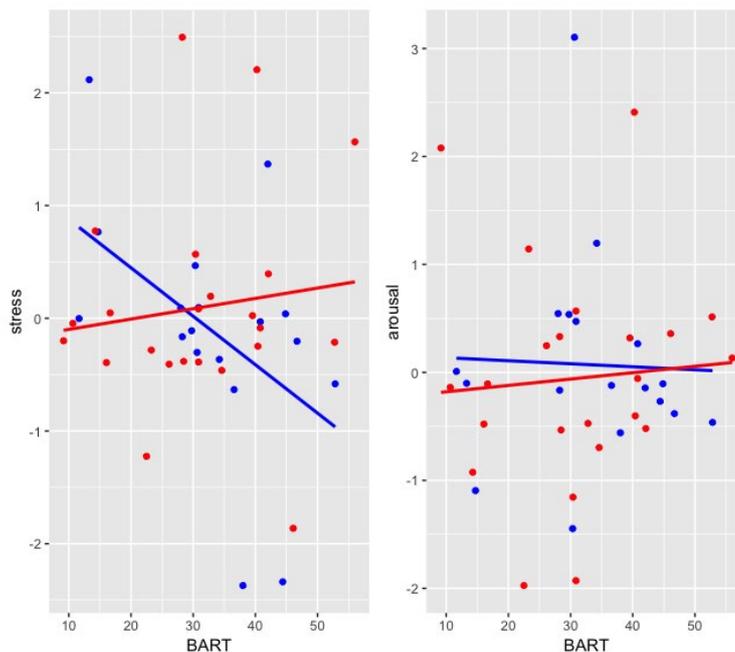
Distribution of BART scores among entrepreneurs and non-entrepreneurs are antipodal (see Figure 3). On average, entrepreneurs are riskier in terms of BART score. On the other hand, while non-entrepreneurs are less risky as group, they exhibit more variability in individual BART scores. Due to two entrepreneurs-participants with risk tolerance below 20, and generally small size of the sample, tests suggest that difference in means is not significant.



**Figure 3.** Distribution of BART scores among entrepreneurs and non-entrepreneurs

## 6.2. Patterns of stress and arousal among entrepreneurs and non-entrepreneurs

Taken alone, BART scores could be regarded as support for opportunity-centric line of research. While on overall entrepreneurs scored insignificantly higher in BART, the variance of scores was high both among entrepreneurs and non-entrepreneurs (see Figure 4). Hence, there are many risk-seekers among non-entrepreneurs, as well as risk-avoiders among entrepreneurs. This supports central prediction of opportunity-centric literature that there are at least three types of entrepreneurs (pure arbitrageurs, risky arbitrageurs, and shumpeterian disrupters), and primary distinction is the attitude to risk.



**Figure 4.** Stress and arousal patterns across entrepreneurs and non-entrepreneurs

Interpretation changes, when we add neuro-measurements to consideration. It reveals that stress pattern for entrepreneurs and non-entrepreneurs significantly differs. Risk-takers in entrepreneurs group exhibit the lower level of stress within group, and risk averse entrepreneurs – higher levels; which is symmetrically opposite to non-entrepreneurs' group.

### **6.3. Research limitations**

Our research is not without limitations. It is believed that BART risk task is good at measuring both financial (monetary, economic) and non-financial (casual, existential) risk aversion. Prior evidence shows that these two aspects of risk taking are deeply interrelated. However, as literature survey shows, referring to risk taking notion in entrepreneurial context is usually connected with economic aspect of risky behavior, while using risk-taking terms in non-entrepreneurial context usually is connected with casual aspect of risk. We measured both aspects simultaneously, as BART provides such opportunity and is usual tool in both contexts, and we discovered high variability in BART scores among both entrepreneurs and non-entrepreneurs. It is possible that risk-seeking non-entrepreneurs are those, who are seeking non-monetary lifestyle risks, and thus could not be treated on the same basis as entrepreneurs. Another limitation is connected with using self-reporting as a measure of entrepreneurship attitude. Probably, special questionnaire based on cantillonian notion of entrepreneurship would be more proper tool, which is one of possible direction of further research.

## **7. Conclusion**

Our research builds on original cantillonian notion of entrepreneurship. We observe subjects (self-reported entrepreneurs and non-entrepreneurs), involved in solving laboratory risk task. We measure left-frontal EEG asymmetry (stress) and arousal levels, as well as propensity to risk taking. We generally find that the level of propensity to risk, as well as stress and arousal levels, varies among participants according to their position in division of labour system. Patterns of stress and arousal levels in entrepreneurs differ from those of non-entrepreneurs. Our paper makes contribution to both person-centric and individual-opportunity lines of entrepreneurship research, exploring possible ways to integrate it.

### **7.1. Suggestions for further research**

This research is first in the research program that we would briefly outline further. On our mind, EEG and other neuroscientific approaches may enrich and deepen our understanding of risk-stress and person-centric – opportunity-centric nexuses in several ways. First, as many entrepreneurship researchers put it, risk-taking is major, but not the only antecedent of entrepreneurial orientation. Second by importance is pursuit of achievement feature. In this respect, it is interesting to further advance our studies by testing hypothesis that variance in stress levels is correlated with pursuit of achievement.

Second, by further extending person-centric with research on genetic determinants. According to Kuhnen and Chiao (2009), “genes that control emotional brain activation generate stable differences in risk taking across people”, which generally is in line with our findings. But applying this issue to entrepreneurship research, it might be interesting to know, to what extent entrepreneurship features could

be determined by genes, and what part of these determination could be connected with genetically determined risk-taking attitude. These findings may also contribute to research front dedicated to family firms innovation, effectiveness, strategies, etc.

Another potentially rich direction of research is introduction of EEG-stress-arousal issues to the research of firm entrepreneurial orientation, corporate entrepreneurship, SME entrepreneurship. Wales (2011), analyzing 123 papers on firm entrepreneurial orientation and describing corresponding research fronts, highlights key entrepreneurial construct dimensions. 121 out of total 123 papers mention risk-taking attitude as one of key constructs of firm entrepreneurial orientation. Given our preliminary finding that entrepreneurship could be connected to varying levels of risk-aversion, it is interesting to see how intrapreneurs with varying risk aversion are interacting within organization. Does division of entrepreneurial labour within organization differs from the one beyond the borders; are there any good practices; are intrapreneurs are cantillonian entrepreneurs and do they exhibit similar patterns of stress and arousal within group. Research of firm entrepreneurial orientation among russian firms is especially interesting, as Wales (2011) puts it, “we note several important omissions in international EO research. A particularly glaring finding is the lack of EO research in Brazil, India and Russia. Given that these three countries are considered to be among the world’s most rapidly emerging major economies, it is notable that research on EO is virtually non-existent.” This line could be further extended by introduction of national work ethics and cultural differences issues: namely, whether our findings hold for different communities, work ethics, etc.

## References

- Aparicio, S., Audretsch, D., & Urbano, D. (2021). Why is export-oriented entrepreneurship more prevalent in some countries than others? Contextual antecedents and economic consequences. *Journal of World Business*, 56(3), 101177. <https://doi.org/10.1016/j.jwb.2020.101177>
- Black, C. L., Goldstein, K. E., LaBelle, D. R., Brown, C. W., Harmon-Jones, E., Abramson, L. Y., & Alloy, L. B. (2014). Behavioral approach system sensitivity and risk taking interact to predict left-frontal EEG asymmetry. *Behavior therapy*, 45(5), 640-650. <https://doi.org/10.1016/j.beth.2014.01.006>
- Cantillon, R. (2010). *An Essay on Economic Theory*. Auburn, Alabama: Ludwig von Mises Institute.
- Cardon, M. S., Mitteness, C., & Sudek, R. (2017). Motivational cues and angel investing: Interactions among enthusiasm, preparedness, and commitment. *Entrepreneurship Theory and Practice*, 41(6), 1057-1085. <https://doi.org/10.1111/etap.12255>
- Dehghanzadeh, M. R., Kholasehzadeh, G., Birjandi, M., Antikchi, E., Sobhan, M. R., & Neamatzadeh, H. (2016). Entrepreneurship psychological characteristics of nurses. *Acta Medica Iranica*, 595-599.
- Fernet, C., Torrès, O., Austin, S., & St-Pierre, J. (2016). The psychological costs of owning and managing an SME: Linking job stressors, occupational loneliness, entrepreneurial orientation, and burnout. *Burnout Research*, 3(2), 45-53. <https://doi.org/10.1016/j.burn.2016.03.002>
- Kroeger, T., & Wright, G. (2021). Entrepreneurship and the Racial Wealth Gap: The Impact of Entrepreneurial Success or Failure on the Wealth Mobility of Black and White Families. *Journal of Economics, Race, and Policy*, 1(13). <https://doi.org/10.1007/s41996-021-00081-6>
- Kuhnen, C. M., & Chiao, J. Y. (2009). Genetic determinants of financial risk taking. *PLoS One*, 4(2), e4362. <https://doi.org/10.1371/journal.pone.0004362>
- Lejuez, C. W., Read, J. P., Kahler, C. W., Richards, J. B., Ramsey, S. E., Stuart, G. L., Strong, D. R., & Brown, R. A. (2002). Evaluation of a behavioral measure of risk taking: the Balloon Analogue Risk Task (BART). *Journal of Experimental Psychology: Applied*, 8(2), 75. <https://doi.org/10.1037/1076-898x.8.2.75>

- Pinner, J. F., & Cavanagh, J. F. (2017). Frontal theta accounts for individual differences in the cost of conflict on decision making. *Brain research*, 1672, 73-80. <https://doi.org/10.1016/j.brainres.2017.07.026>
- Rajan, P. (2021). Making-Do on the Margins: Organizing Resource Seeking and Rhetorical Agency in Communities During Grassroots Entrepreneurship. *Journal of Business and Technical Communication*, 35, 254-292. <https://doi.org/10.1177/1050651920979999>
- Ricciardi, F., Giacosa, E., & Culasso, F. (2021). Stepchildren or prodigal employees? Motives and consequences of employee entrepreneurship in family business. *International Entrepreneurship and Management Journal*, 17, 229-247. <https://doi.org/10.3389/fpsyg.2021.585698>
- Schonberg, T., Fox, C. R., & Poldrack, R. A. (2011). Mind the gap: bridging economic and naturalistic risk-taking with cognitive neuroscience. *Trends in Cognitive Sciences*, 15(1), 11-19. <https://doi.org/10.1016/j.tics.2010.10.002>
- Taleb, N. N. (2018). *Skin in the Game: Hidden Asymmetries in Daily Life*. Random House.
- Yu, X., Meng, X., Chen, Y., Chen, Y., & Nguyen, B. (2018). Work-family conflict, organizational ambidexterity and new venture legitimacy in emerging economies. *Technological Forecasting and Social Change*, 135, 229-240. <https://doi.org/10.1016/j.techfore.2017.10.003>
- Yangjie, H., An, L., Wang, J., Chen, Y., Wang, S., & Wang, P. (2021). The Role of Entrepreneurship Policy in College Students' Entrepreneurial Intention: The Intermediary Role of Entrepreneurial Practice and Entrepreneurial Spirit. *Frontiers in Psychology*. <https://doi.org/10.3389/fpsyg.2021.585698>
- Wales, W. (2011). Entrepreneurial orientation: A review and synthesis of promising research directions. *International Small Business Journal*, 34(1). <https://doi.org/10.1177/0266242615613840>