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**STUDENTS' PROPENSITY TO
INNOVATE: CORRELATES,
DETERMINANTS,
AND IMPACT ON GPA**

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STUDENTS' PROPENSITY TO INNOVATE: CORRELATES, DETERMINANTS, AND IMPACT ON GPA³

This paper investigates the correlates and determinants of the propensity to innovate (PtI), measured as innovative cognitive style according to Kirton (1976), and its impact on grade point average (GPA). Determinants were chosen based on Schweizer's (2006) novelty generation model: sensation seeking, creativity, risk-taking, and proactivity. The data were collected from 203 students from HSE University (125 females and 78 males) by survey and were analysed using correlation and regression analysis. Correlation analysis revealed significant positive relations between PtI, sensation seeking, creativity, risk-taking, and proactivity. According to the determinants analysis, risk taking measured as liking extreme sports and self-estimated high-risk attitude all increase PtI, while parental higher education decreases it. Female students are less prone to innovate compared to male students. GPA analysis showed that a high propensity to innovate reduces the GPA of economics students, and that adaptors' success in studying depends on a set of factors that differs from factors leading to the success innovators' group. The paper contributes to knowledge about individual PtI, its correlates, determinants, and impact on GPA. As far as we know, this is the first study which uses such a combination of factors, especially regarding the inclusion of risk-taking as a determinant of PtI.

JEL Classification: G41

Keywords: propensity to innovate, KAI, sensation-seeking, creativity, risk-taking, proactivity, GPA

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1. Introduction

Innovation is one of a key driver of economic development; based on the data from the World Bank and Global Innovation Index researchers found a correlation of 0.62 between GDP per capita and Global innovation index [Procházka & Čermáková, 2015]. Innovations also increase the productivity and welfare of the population. Innovation is created by people, and their personality is one of the key factors in innovation success [Schweizer, 2006]. However, individual ability to create new is differs [Kirton, 2004]. Dyer *et al.* (2009) noticed that we know almost nothing to say why one person is more innovative than others. To enhance the innovation, we should understand what the determinants of the propensity to innovate (PtI) are.

Why are some people more prone to innovations than others? And where are their areas of success? To answer the first question, we should understand what individual characteristics are necessary to innovate. We consider Schweizer's (2006) Novelty generation model (NGM) as a description of the innovation creation process. Innovativeness depends on an individual's propensity to innovate (PtI) and the external circumstances which allows or prevents its realization [Schweizer, 2006]. Schweizer (2006) highlighted three elements of individual innovative behavior: novelty-seeking, creativity, and innovative performance.

As estimation of individual PtI, by itself, is a quite difficult task; we measured it using Kirton's adaptive-innovative cognitive styles classification, Kirton adaption inventory (KAI). Cognitive style is a complex of how people perceive information, work with it, and make decisions [Kirton, 2004]. Kirton (1976) highlighted two groups of people with opposite cognitive styles: adaptors and innovators. The adaptors' motto is "do better", while the innovators' is "do differently". Cognitive styles are quite stable during the whole life [Kirton 2004]. KAI is used in Maric *et al.* (2021), Imama *et al.* (2021), Alalouch (2021), McElroy *et al.* (2007), Thong & Yap (1995).

We partially develop ideas from Yagolkovsky (2019), who found a positive correlation between innovativeness measured as PtI, sensation seeking (SS), creativity, and IQ. We took SS and creativity based on his paper as determinants of PtI and add risk taking (RT). We ignored IQ as we supposed that, for innovation, specific knowledge is more significant. We checked the impact of PtI on grade point average (GPA) and differences in GPA determinants between adaptors and innovators. The novelty of the research in comparison with Schweizer (2006) and Yagolokovsky (2019) is presented in Table 1. It consists in the analysis of the relationship between PtI, SS, creativity, RT, proactivity, and GPA.

Table 1. Novelty of the research

Component	Schweizer (2006), theoretical	Yagolkovskiy (2019), correlations	Current research, regressions
PtI	Yes	Yes	Yes
SS	Yes	Yes	Yes
Creativity	Yes	Yes	Yes
IQ	No	Yes	No
RT	No	No	Yes
Proactivity	Yes	No	Yes
GPA	No	No	Yes

The goal of the research is to empirically establish relationships between individual PtI, SS, creativity, proactivity, and RT and estimates PtI's impact on GPA. We contribute to the research which considers the relationship between personal traits (usually Big 5 or 7 traits) / cognitive styles / creativity and risk-attitude [Sabater-Grande *et al.*, 2022; Zhang *et al.*, 2019; Charness & Grieco, 2019; Eckel & Grossman, 2002], and to the literature studying GPA determinants.

2. Propensity to innovate

One of the first to use the term, propensity to innovate was Maclaurin (1953). PtI may be revealed in the creation of something new [Goepel *et al.*, 2012], novelty adoption [Ali, 2019] or even in reaction to innovation [Yigit & Aksay, 2015]. In this study, we consider PtI as the ability to create innovation. What does innovation mean? The term innovation has acquired various meanings over the years: the process of developing a new item, the new item itself, and the process of adopting the new item [Zaltman *et al.*, 1973].

We distinguish PtI from innovativeness, which we consider as the revealed PtI. Innovativeness is well-studied in economics where innovative output is primarily measured by patents and citations and input by R&D/Sales [de Carvalho *et al.*, 2017; Evdokimova, 2021]. In psychology, innovativeness and PtI are synonyms [Yagolkovsky, 2018] and its correlates depend on the context [Sternberg & Lubart, 1991]:

- Personality traits: extraversion, acceptance of challenges [Heunks, 1998], tolerance to ambiguity [Sternberg & Lubart, 1991];
- Cognitive abilities: higher cognitive abilities [Sternberg & Lubart, 1991], creative thinking, problem-solving skills [Amabile, 2011];
- Motivation: intrinsic motivation [Amabile, 1985], willingness to take risks [Heunks, 1998];
- Knowledge and experience, past success [Hwang, 2014];

- Social networks: interacting with diverse networks, engaging in collaboration [Burt, 2004];
- Organizational support: culture, leadership style, resources [Isaksen & Akkermans, 2011; Baer & Frese, 2003].

To measure innovativeness as an individual trait there are some approaches: KAI [Kirton, 1976], the big 5 personal traits [Costa & MacCrae, 1992], and the individual innovations scale (IIS) [Hurt *et al.*, 1977]. KAI and IIS are similar to each other, while the big 5 personal traits are wider in scope [Sabater-Grande *et al.*, 2022; Harrison *et al.*, 2020]. We have chosen KAI as Cropley & Cropley (2015) and Bobic *et al.* (1999) note that KAI measures individual PtI. Kirton (1976) divided people into 2 groups: innovators and adaptors and noticed that both of them are creative. A comparison of adaptors and innovators is presented in Table 2.

Table 2. Difference between adaptors and innovators

Innovators	Adaptors
Motto	
"do differently"	"do better"
Problem defining	
Reject the generally accepted perceptions	Define the problem in frame of generally accepted constraints
Advantages	
Create new	Incorporating new into existing structure
In organisation good in	
Radical change or crisis	Managing current systems

Source: Kirton (2004)

Adaptors are creative in a narrow range, looking for small improvements, initiating changes close to current organisational practices, and gradually pushing boundaries. An adaptive manager accepts established procedures as necessary, makes minor changes to existing boundaries, and is seen as consistent, safe, and reliable. Innovators have different mindsets. They have the ability to create and do things differently, although not always better. A manager with an innovative style regularly questions established routines and may be viewed by adaptive managers as undisciplined and unresponsive to the concerted actions of others. According to Kirton (2004), an effective team should include both innovators and adaptors.

So, we suppose that the closer an individuals' cognitive style is to an innovative one, the higher their PtI. Now when we understand what PtI means, we are interested in its determinants.

3. Determinants of propensity to innovate

According to Schweizer (2006), there is no common definition in the literature regarding different innovation terms, such as innovativeness, novelty-seeking, creativity, and innovative

performance. To order the terms, she suggested the novelty generation model (NGM). The starting point in the model is the “need for cognition”, which is novelty seeking. The second one is “innovation creation” and the last one is “innovative performance” which is responsible for the realization of an innovative idea. The NGM is conceptually presented in Figure 1. The sequence of stages in NGM is very close to Amabile’s (2011) componential theory of creativity which consisted of 3 main blocks: motivation, creative skills, and the creativity process.

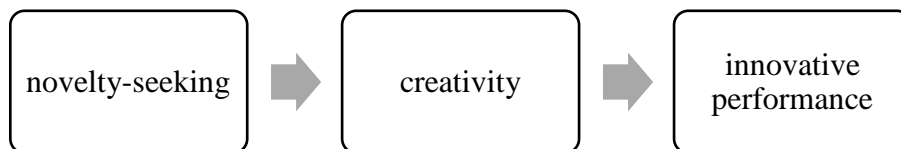


Figure 1. The key idea of the novelty generation model (NGM).

Source: Schweizer (2006)

We concentrate on individual abilities, not external circumstances because we are working with PtI and external circumstances would affect its realization which is innovativeness. We consider the elements of NGM as determinants of individual PtI, as NGM highlights the individual characteristics which are necessary for innovation creation, thus providing an opportunity for a person to innovate [Yagolkovskiy, 2018]. We suppose that the higher the individual’s desire to seek for new, creativity, and innovative performance characteristics, the higher their PtI. We used some proxy for each element of NGM:

- Novelty seeking – SS,
- Creativity – verbal creativity and creative achievements tests,
- Innovative performance – RT and proactivity.

Further, every determinant will be discussed in detail.

Sensation seeking

Schweizer (2006) used the term “novelty seeking” based on ‘novelty-seeking’ genes: DRD4, DRD2-A2, SLC6A3-9 [Benjamin *et al.*, 1996; Ebstein *et al.*, 1996; Prolo & Licinio, 2002]. Novelty seeking is often considered as a concept relevant to the need to seek out new information, and to explore in response to novel stimulation [Cloninger *et al.*, 1993]. Another concept, SS, developed by Zuckerman [Zuckerman *et al.*, 1978; Zuckerman, 1994; Zuckerman & Kuhlman, 2000] is defined as: “a trait defined by the seeking of varied, novel, complex, and intense sensations and experiences, and the willingness to take physical, social, legal, and financial risks for the sake of such experience”

[Zuckerman, 1994, p.26]. According to these 2 definitions, we can conclude that the term SS is wider and includes novelty-seeking.

According to Kirton (2004) and Yagolkovskiy (2019), there is a positive correlation between SS and PtI. SS stimulates innovation according to Schweizer (2006). We suppose that a person with high SS actively perceives the world, which gives them the opportunity to notice what can be improved, gaps in information or a process, and a need that has not yet been satisfied — the satisfaction of which is an opportunity for innovation.

H1a: SS positively correlates with PtI.

H1b: SS increases PtI.

Creativity

The second step in the NGM model is “creativity”. Schweizer (2006) divided it into novelty-finding and novelty-producing. Creativity is the ability to create something new [Yagolkovskiy, 2019]. According to Schweizer (2006), creativity depends on 3 main traits: low levels of cortical and frontal-lobe activation [Mednick, 1962], associative capabilities [Carson *et al.*, 2003], and latent inhibition — the ability to keep many things in mind at the same time [West, 2002].

There are numerous definitions of creativity. Ochse (1990), Feist (1998) and Sternberg & Lubart (1999) say that creativity is producing something new and useful. Simonton (1999) and Plucker *et al.* (2004) added that originality depends on the sociocultural background. Creativity may be revealed in producing something new but also in adaptation. Creativity may be incentivized, for example, Charness & Grieco (2019) found that financial incentives in the form of tournament competition increase creativity but only in closed questions, not open ones, while a nonmonetary incentive in the form of ranking is efficient for both types of questions.

Gelade (1995) and Yagolkovskiy (2019) found a positive correlation between PtI and creativity. If we consider creativity at the psychological level, we can see that it is the ability to combine different ideas, concepts, and images. As a result, a person creates a new combination, that is, they innovate. Moreover, it is not possible to create something new if you cannot even imagine it, therefore we can conclude that creativity is a prerequisite of innovativeness, which means that it is a part of innovative potential or PtI.

H2a: Creativity positively correlates with PtI.

H2b: Creativity increases PtI.

Innovative performance: RT and proactivity

West (2002) and Cropley *et al.* (2011) agree that an innovative process includes not only the generation of new ideas but also their possible modification and subsequent application, which are taken into the NGM as the third step — innovative performance, which includes social adoption of the innovation. Schweizer (2006) highlighted the main determinants of innovative performance: achievements need, self-confidence, perseverance, assertiveness, proactivity, extraversion, and cooperativeness. Many authors used these components in research as explanatory variables for innovativeness [Garcia & Calantone, 2002; Laursen *et al.*, 2012; Hormiga *et al.*, 2013]. A novelty of the current research is using RT as a determinant of PtI in regression analysis with other PtI determinants.

Risk assumes that there are possible outcomes and at least one of them is unwelcome [Zhang *et al.*, 2018]. Innovative activity is unpredictable and risky, which is why its success depends on the innovators' risk-attitude. According to Loch (2017) and Shen *et al.* (2018), RT is a prerequisite of creativity. It is difficult to think of something new (novelty finding) or create something new (novelty producing) if innovators cannot even imagine new creations due to risk avoidance.

H3a: RT positively correlates with PtI.

H3b: RT increases PtI.

Innovation is risky and these risks are related to social rejection, self-estimation, and efficiency. Every component of NGM depends on RT: risk seeking is an incentive for and correlates with SS [Horvath & Zuckerman, 1993; Efimov *et al.*, 2022], creativity cannot be revealed without RT [Dewett, 2007; Tyagi *et al.*, 2017], and innovative performance includes RT. At each step of the model, we see a correlation with risk, thus, we consider known risk determinants as control variables for PtI.

One of the most cited papers about RT determinants is Dohmen *et al.* (2011). They tested the validity of survey methodology for RT evaluation and considered gender, age, height, parental education, and income as control variables. For different types of risk, they highlighted the significance of such variables as marital status, having children, religion, place of living, academic and professional degrees, health status, and employment type.

Also, there is a known approach for RT evaluation is in 5 main fields of risk perception: ethical, financial, health/safety, recreational, and social — the domain specific RT (DOSPERT) scale [Blais & Weber, 2006; Weber *et al.*, 2002], which proved that determinants of RT change depending on the

circumstances. DOSPERT may contain 30 or 40 questions. To reduce the number of questions in the survey, we used relatively simple RT measures based on Charness *et al.*, (2013), Gneezy & Potters (1997), and Eckel & Grossman (2002).

One interesting result was obtained by Arslan *et al.* (2020). The authors studying RT asked respondents to explain their choice and when others read these explanations, they estimated the respondents' RT at the same level as the respondents did.

Based on the literature, we highlighted some RT determinants used as a control variable for PtI in this study presented in Table 3.

Table 3. RT determinants.

RT determinant	Source
Age	Brooks <i>et al.</i> , 2018; Guenzel & Malmendier, 2020; Serfling, 2014
Gender	Adams & Raganathan, 2017; Charness <i>et al.</i> , 2013; Rossi <i>et al.</i> , 2017
Family history	Ngan-ling Chow & Zhao, 1996; Bernile <i>et al.</i> , 2017
Education	Allemand <i>et al.</i> , 2017
Extreme Sports	Brymer, 2010

Another factor that impacts innovative performance is proactivity [Schweizer, 2006]. It may be considered unimportant at the beginning, but this indicator separates inventors and innovators, which is why activity is considered as a separate component of innovative performance.

H4a: Proactivity positively correlates with PtI.

H4b: Proactivity increases PtI.

4. The impact of PtI on GPA

We are interested not only in the determinants of PtI, but also in its impact on outcomes, which may be considered as measures of success in some field. For instance, Houtz *et al.* (2003) considered creative self-perception and Harder *et al.* (2015) considered self-estimated efficacy as such measures in relation with cognitive styles. The collection of data about students provides the opportunity to analyze the impact of cognitive style on GPA. The novelty of our research is that the chosen measure of success, GPA is an independent variable, free from self-estimation bias. Determinants of GPA have been studied for a long time, for example, Cohn *et al.* (2004) found that GPA depends on gender, Nelson (2003) highlighted age, gender, prior academic performance, alcohol consumption, and number of calls to parents as GPA determinants.

Also, there is a branch of studies devoted to cognitive style impact on GPA. Some authors did not find any relationship between cognitive style and GPA, for example DeTure (2004) and Altun & Cakan (2006). Marcic *et al.* (1990) showed no differences in average grades between adaptors and innovators. However, Friedel & Rudd (2006) found that learning style positively correlated with self-reported GPA. Karwowski *et al.* (2009) noticed that cognitive style measured by KAI does not correlate with GPA, but KAI subscales do. Such inconclusive results leave a space for the further analysis of the impact of cognitive styles on GPA.

The specificity of our hypothesis is not the presence or absence of a relationship between cognitive style, measured by KAI and GPA, but in including an education major, economics in our case. The education major assumes a certain cognitive style by itself. According to Jones & Wright (2011) adaptors would be more successful in their studies in economics than innovators, because such a course of study is more adaptive than innovative as it requires learning existing information during the early stages of study and includes the creation of new only at higher educational levels according to Bloom's taxonomy [Bloom *et al.*, 1956].

H5: Innovators have lower GPA than adaptors studying in adaptive educational programs.

In terms of this study, it may be reformulated as PtI reducing the GPA of economics students.

5. Methodology and data

Measurement

To measure individual **PtI**, we used the Alternative Kirton adoption inventory (Altkirt) — a short version of KAI, developed by Bobic *et al.* (1999). **SS** was estimated using the brief sensation seeking scale (BSSS) developed by Hoyle *et al.* (2002). It includes some pairs of statements for testing individual characteristics in the same 4 dimensions as Zuckerman suggested. **Creativity** was assessed using the Mednick verbal test adapted for Russian adults by Voronin and Galkina (1994) and the Creative achievements questionnaire (CAQ). **RT** was estimated using 3 methods:

1. The Gneezy & Potters (1997);
2. The Eckel & Grossman (2002);
3. Self-estimation.

The Gneezy & Potters (1997) method implies an investment choice: the given sum is X , part of the given sum: $x < X$, can be invested and brings an income kx , where $k > 1$ with probability p , and 0 with probability $(1 - p)$. So, the expected gain is:

$$U(x) = (1 - p) * (X - x) + p * (X - x + kx) \quad (1)$$

An additional requirement, that $k * p > 1$ is to make the investment option attractive. Risk-lovers and risk-neutrals will invest X , while the risk-averse choose $x < X$. This method allows the opportunity to measure the depth of risk-aversion but it cannot distinguish risk-lovers from risk-neutrals. However, risk-lovers are quite rare and risk-lovers can be identified using the Eckel & Grossman (2002) method to measure RT.

The Eckel & Grossman (2002) method asks respondents to choose 1 of 6 suggested games shown in Appendix 5. The expected return increases simultaneously with risk. So, it is expected that risk-averse participants will choose games 1-4, risk-neutrals – game 5, and risk-lovers – game 6.

All questions are presented in Appendix 5.

Regression analysis

We formed 2 models to test the hypotheses: Model 1 for hypotheses 1–4 about the determinants of PtI and Model 2 for hypothesis 5 about GPA determinants. Model 1 was estimated using ordered logit regression.

Model 1. PtI determinants (H1b-H4b)

$$Prob(PtI_i = j) = f(\beta_1 * SS_i + \beta_2 * RT_i + \beta_3 * Creativity_i + \beta_4 * Proactivity_i + Controls_i), \quad (2)$$

where $f(x) = \frac{1}{1+e^{-x}}$; where x is the linear combination of explanatory variables, and i is index of the respondent.

Model 2. GPA determinants (H5)

Following Nelson (2003) we used the variable *Addicted* as proxy for alcohol consumption and the variable *Awards* as proxy for prior achievements. Based on Brugiavini *et al.* (2020) such parental characteristics as education and titles/awards were taken into account in Model 2.

$$GPA_i = \alpha + \beta_1 * PtI_i + \beta_2 * SS_i + \beta_3 * RT_i + \beta_4 * Creativity_i + \beta_5 * Proactivity_i + \beta_6 * Addicted_i + \beta_7 * Awards_i + \beta_8 * Parents_i + Controls_i + \varepsilon_i, \quad (3)$$

where i is respondents' individual number, ε_i is a random error. The estimation of Model 2 was done using ordered logit and OLS regressions for a robustness check.

Table 4 presents the description and measurement of the variables used in the analysis.

Table 4. Description of variables

Variable	Description
<i>Dependent variables</i>	
PtI	The sum of answers on 9 binary choice questions of Alternative Kirtman Adoption Inventory (Altkirt) [Bobic <i>et al.</i> (1999)] [0, 9], where >3 – innovator person, < 4 – adaptor;
GPA	The average score in studying in the winter of 2021/22, [4, 10];
<i>Tested variables</i>	
Sensation Seeking (SS)	Sum of answers on a 7-point, Likert, Brief Sensation Seeking Scale (BSSS) [Hoyle <i>et al.</i> (2002)] contained 8 questions [8, 56];
Risk taking (RT)	3 measures: 1) Gneezy & Potters (1997) (to invest) [0, 1000], 2) Eckel & Grossman (2002) (to receive) [1, 6], 3) self-estimation [1, 3], where 3 is risk-loving;
Creativity	2 measures: 1) Mednick's (1962) verbal creativity test, [0, 10], 2) Creative achievements questionnaire (CAQ), [0, 28];
Proactivity	Self-estimated proactivity [1, 4].
<i>Control variables</i>	
Gender (Female)	Dummy variable: 1 – female, 0 – male;
Age	Number of full years;
Addicted	Dummy variable: 1 – has addictiveness, 0 – no;
Extreme	Dummy variable: 1 – like extreme sports, 0 – no;
Awards	Dummy variable: 1 – has awards and titles, 0 - no;
Number of universities	Number of Universities in which student studied in (including mobility);
Parents' titles	Categorical variable: 2 – both parents have special titles, 1 – one parent has special titles, 0 – no one has;
Parents' education	Categorical variable: 2 – both parents have higher education, 1 – one parent has higher education, 0 – no one has;

Data

The data were collected using an online survey (a link for the google form is in the Materials and Method section) in October–December 2021. Respondents are Russian speaking HSE University economics students and recent graduates. 247 participants filled the questionnaire, but only 203 observations were used for models without GPA and 169 for models with GPA due to incomplete questionnaires or respondents being foreign students which can lead to sample heterogeneity.

We constructed a sample including students from all years of education with a focus on bachelors' students (see Appendix 2). In most cases, students received a point for completing the survey — equivalent to answering a question during seminars — as an incentive.

The data about GPA were gathered from publicly available HSE University's data after the first half-year of the 2021-22 academic year (December 2021), avoiding self-estimation bias.

Unfortunately, since the survey included the option to be completed anonymously, we were able to collect data about the GPA indicator only for the non-anonymous responses, which was 169 out of 203 responses. Summary statistics are presented in Table 5, the correlation matrix is in Appendix 2.

Table 5. Summary statistics

Variable	Definition	Obs	Mean	Std. Dev.	Min	Max
PtI	Propensity to innovate	203	3.2759	1.7214	0	8
SS	Sensation-seeking	203	31.9803	8.7144	10	56
Mednick	Mednick verbal creativity score	203	68.0538	16.4584	0	100
CAQ	Creative achievements questionnaire score	203	8.8670	4.4552	0	22
RT_inv	Risk-taking to invest	203	648.8719	289.1516	0	1000
RT_rec	Risk-taking to receive	203	3.6552	1.4348	1	6
RT_self	Risk-taking self-estimated	203	2.0640	0.4459	1	3
Proactivity	Self-estimated proactivity	203	2.6946	0.7348	1	4
GPA	Grade point average	169	7.3695	0.8390	5.24	9.59
Age	The number of full years	203	20.5369	2.3761	12	35
Education year	Education year in university	203	3.4039	1.5589	1	6
Gender (Female)	Gender	203	0.6157	0.4876	0	1
N universities	The number of universities where student studied	203	1.3596	0.6776	1	5
Extreme	Liking extreme sports	203	0.4975	0.5012	0	1
Addicted	Having addictiveness	203	0.3153	0.4658	0	1
Parents' education	Presence of parents' higher education	203	1.7438	0.5203	0	2

The representative respondent is female, 20 years old, in her 3rd year of university, adaptor, relatively creative, with an average GPA 7.3/10, whose parents both have higher education.

To better understand the differences in GPA determinants, descriptive statistics on a 0–8 scale for PtI distribution are presented in Figure 2.

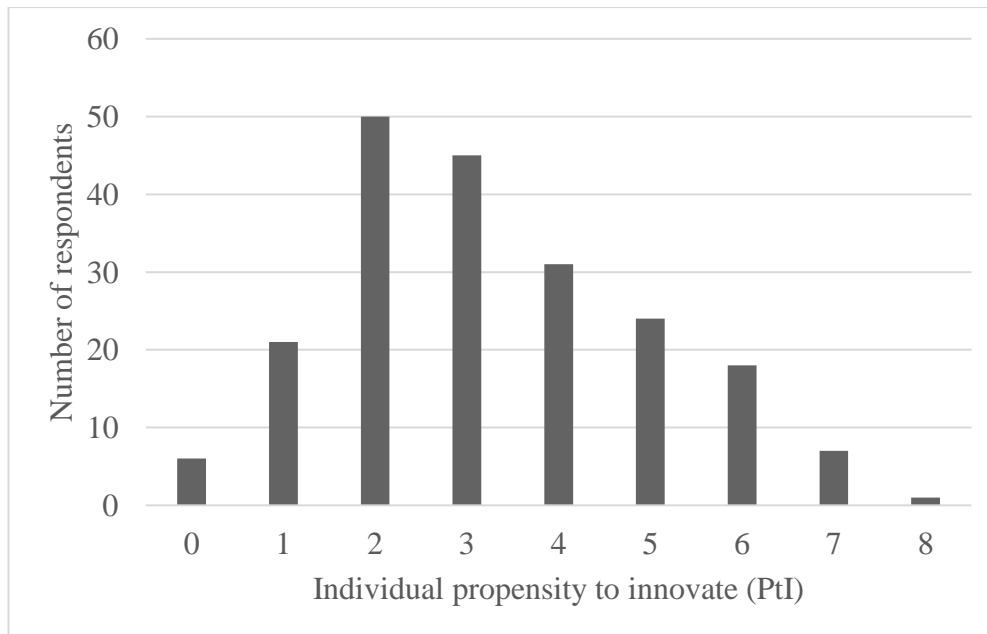


Figure 2. PtI distribution.

There is a relatively significant dominance of adaptors in the sample, which may be caused by the fact that respondents are economics students, and this program may be considered not attractive for innovators due to high popularity and low risk [Jones & Wright, 2011]. We therefore considered “0”, “7” and “8” values of PtI as outliers. Adaptors have PtI from 0–3, and innovators from 4–8 (see Appendix 4 for alternative specifications).

According to Kirton (2004), the sample should be divided by 3 groups—adaptors, innovators, and those in the middle. However, this classification is not feasible for our study given the limited number of observations.

Table 6. Mean values of variables in dependence on adaptors – innovators (A-I) scale.

Variable	Adaptors, PtI ∈ [0;3]	Innovators, PtI ∈ [4;8]
N observations,	122	81
%	60%	40%
PtI	2.0984	5.0494
s.d.	0.8568	1.0356
SS	30.336	34.4568
s.d.	8.6450	8.2690
Mednick	66.0324	71.0983
s.d.	15.8694	16.9544
RT_inv	628.4426	679.6420
s.d.	297.2631	275.4344
RT_rec	3.5574	3.8025
s.d.	1.4830	1.3548
RT_self	1.9836	2.1852
s.d.	0.4261	0.4503
Proactivity	2.5574	2.9012
s.d.	0.7048	0.7349
Gender (Female)	0.6885	0.5062
s.d.	0.4650	0.5030
GPA: N observations,	103	66
%	84%	81%
GPA	7.4584	7.2305
s.d.	0.8307	0.8394

Based on mean values of variables in dependence on the A-I scale shown in Table 6, we can highlight 2 main groups of differences. Firstly, innovators have higher SS, and creativity measured by the Mednick verbal test, RT measured by all 3 measures, and proactivity. Secondly, adaptors have higher GPA. In general, women are more adaptive than innovative. No significant differences in other variables were found.

6. Results

Correlates of PtI

Correlation analysis was done to check the correlations between PtI, SS, creativity, proactivity, and RT (H1a–H4a), the correlation coefficients and their significance are presented in Table 7.

Table 7. PtI's correlations with SS, creativity, and innovative performance proxies: proactivity and RT.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PtI (1)	1.000							
SS (2)	0.306***	1.000						
Mednick (3)	0.117*	0.073	1.000					
CAQ (4)	0.099	0.195***	-0.0132	1.000				
RT_inv (5)	0.056	0.079	-0.0084	-0.094	1.000			
RT_rec (6)	0.111	0.147**	0.1482**	-0.066	0.260***	1.000		
RT_self (7)	0.254***	0.33***	0.1314*	0.102	0.148**	0.267***	1.000	
Proactivity (8)	0.231***	0.241***	0.1110	0.16**	0.073	0.078	0.287***	1.000

*** p<0.01, ** p<0.05, * p<0.1

N obs. = 203

We found that SS is the most influential driver of PtI—the correlation coefficient is 0.3. However, according to Schweizer (2006), all 3 stages of the innovation creation process (NGM) are important. Thus, having only high SS does not lead to innovation creation. Creativity measured by the Mednick verbal test is also important and correlates positively with PtI (0.12) at the 10% significance level, however CAQ is not correlated. Inconclusive results were obtained regarding RT: RT to receive and to invest under risk do not correlate with PtI, but self-estimated RT does. However, all 3 measures of risk are correlated with each other. Proactivity correlates significantly and positively with PtI (0.23). Therefore, we cannot reject H1a–H4a that PtI positively correlates with SS, creativity, and innovative performance in the forms of RT and proactivity.

PtI determinants

Two regressions were estimated to reveal PtI determinants as extreme sports and self-estimated RT are correlated (0.32 at the 1% significance level). According to the analysis, 6 determinants significantly impact PtI, other factors are not significant, the results are presented in Table 8.

Table 8. Average marginal effects for PtI obtained from ordered logit regression with robust standard errors.

	(1)	(2)	(3)
VARIABLES	PtI		
SS	0.0567***	0.0566***	0.0553***
	(0.0173)	(0.0173)	(0.0180)
Mednick	0.0081	0.0071	0.0074
	(0.0072)	(0.0075)	(0.0078)
Proactivity	0.0029	0.0430	0.0586
	(0.1130)	(0.1190)	(0.1190)
RT_self	0.5600*	0.5950**	
	(0.2870)	(0.2750)	
Extreme sports			0.4900*
			(0.2920)
Gender (Female)		-0.4170	-0.4550*
		(0.2710)	(0.2640)
Parents' education		-0.5360*	-0.5240*
		(0.2790)	(0.2830)
N universities		0.4950**	0.4870**
		(0.2360)	(0.2360)
Pseudo R-squared	0.0334	0.0499	0.0488
Observations	203	203	203

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

SS, extreme sports, self-estimated RT, and the number of universities all impact PtI positively, identifying people with these characteristics as having an innovative cognitive style and help to develop it. Females whose parents have higher education have a more adaptive cognitive style.

There is possible endogeneity, so we tested potentially endogenous explanatory variables such as number of universities, SS, and extreme sports using endogeneity test after IV 2SLS. The results showed the absence of endogeneity and are presented in Table 9.

Table 9. Endogeneity tests for variables “N Universities”, “SS”, “Extreme sports” in Table 8.

Test	N Universities		SS		Extreme sports	
	Statistic	p-value	Statistic	p-value	Statistic	p-value
Durbin (score) chi2(1)	0.00137	0.9704	2.1258	0.1448	0.0220	0.8815
Wu-Hausman F(1,196)	0.00133	0.9710	2.0742	0.1514	0.0214	0.8837

Also, robustness check was done using the inclusion of additional variables such as Age, Addicted, and Awards; and the exclusion of insignificant and significant variables. The results are presented in Appendix 3 and show the robustness of the results.

Positive sign of SS supports hypothesis 1b, the significance of self-estimated RT and extreme sports supports H3b. Creativity and proactivity do not impact PtI significantly in our sample and the estimation of separate models for innovators and adaptors does not provide a statistically significant difference. So, we can conclude that H1b and H3b are confirmed while H2b and H4b are rejected.

The impact of PtI on GPA

To check the H5, we initially estimated GPA determinants for the whole sample without division for adaptors and innovators (see Table 10). The number of observations has decreased due to the absence of GPA for some of the respondents as anonymisation was optional.

Table 10. Average marginal effects obtained from ordered logit regressions and the results of OLS regressions with robust standard errors for GPA.

	(1)	(2)	(3)	(4)
VARIABLES	GPA			
Method	Ologit	OLS	Ologit	OLS
PtI	-0.1150 ⁺	-0.0512 ⁺	-0.1280 ⁺	-0.0557 ⁺
	(0.0775)	(0.0357)	(0.0790)	(0.0371)
Extreme	-0.5800**	-0.2670**	-0.5850**	-0.2770**
	(0.2750)	(0.1240)	(0.2700)	(0.1260)
Addicted	-0.6210**	-0.2850**	-0.5960**	-0.2900**
	(0.3030)	(0.1270)	(0.3000)	(0.1310)
Awards	1.0810***	0.4950***		
	(0.2880)	(0.1230)		
Parents' titles			0.3780**	0.1410*
			(0.1920)	(0.0817)
Constant		7.4250***		7.6680***
		(0.1570)		(0.1520)
Observations	169	169	169	169
R-squared		0.144		0.0850
Pseudo R-squared	0.0156		0.0098	

Robust standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1, ⁺ p<0.15

PtI is negatively significant for GPA at the 15% level, which confirms H5 and shows a high GPA is a signal of an adaptive cognitive style for economics students. We also conducted an endogeneity test and found no endogeneity. Extreme sports and addicted reduce GPA. Awards and parental titles increase GPA. Parental titles and awards correlation coefficient is 0.2. Other variables are not significant for the whole sample. The signs of control variables are in line with previous studies [Nelson, 2003; Brugiavini *et al.*, 2020].

Continuation of analysis: GPA's determinants among A-I groups

We suppose that innovators and adaptors will study successfully for different reasons [Subotic *et al.*, 2018]. To compare GPA determinants for adaptors and innovators, we divided the sample for 2 subsamples: innovators has PtI $\in [4;8]$ and adaptors with PtI $\in [0;3]$. There were a small number of innovators in our sample, consequently, we will treat the results as a weakly robust. RT is not significant in this specification, but extreme sports, which is correlated with self-estimated RT (0.3) is used as a proxy for RT. The results are presented in Table 11.

Table 11. Average marginal effects obtained from ordered logit regressions and results of OLS regressions with robust standard errors for GPA in dependence on A-I scale.

	(1)	(2)	(3)	(4)
VARIABLES	GPA			
Sample	Adaptors, PtI $\in [0, 3]$		Innovators, PtI $\in [4, 8]$	
Method	Ologit	OLS	Ologit	OLS
SS	-0.0388*	-0.0163**	0.0334	0.0118
	(0.0206)	(0.0082)	(0.0361)	(0.0156)
Mednick	-0.0197*	-0.0089*	0.0039	0.0019
	(0.0106)	(0.0050)	(0.0099)	(0.0045)
Extreme	-0.5010	-0.1970	-1.1310*	-0.4400*
	(0.3520)	(0.1480)	(0.6020)	(0.2560)
Proactivity	0.3790*	0.1770*	0.1230	0.0032
	(0.2260)	(0.0984)	(0.4290)	(0.1730)
Addicted	-0.8430**	-0.3430**	-0.5340	-0.2650
	(0.4150)	(0.1630)	(0.5030)	(0.2330)
Parents' titles	0.5200**	0.1780*	-0.0681	-0.0323
	(0.2610)	(0.1010)	(0.3310)	(0.1610)
Awards	1.1330***	0.4870***	1.03800*	0.4420*
	(0.3670)	(0.1490)	(0.5700)	(0.2450)
Constant		7.8400***		6.7720***
		(0.4990)		(0.6680)
Observations	103	103	66	66
R-squared		0.226		0.125
Pseudo R-squared	0.0284		0.0189	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

For adaptors SS, creativity, and addicted negatively impact GPA. Proactivity, parental titles and awards – positively. For innovators, extreme sports decreases GPA, while awards increase it. SS, Creativity, and addicted, which reduce adaptors' GPA are not significant for innovators. Extreme sports, which negatively impacts innovators' GPA, is not significant for adaptors.

Proactive adaptors study better while proactivity is not significant for innovators. We can suppose that this is because of the relatively high proactivity level across innovators (correlation coefficient between proactivity and PtI is 0.2, see appendix 2).

The results were tested for robustness to a change in threshold between adaptors and innovators (PtI = 3 & 4) by 2 methods: shifting threshold between for PtI = 2 & 3 (Appendix 4) and excluding PtI=3 from the analysis (Columns 1-2 from Appendix 4 and columns 3-4 from Table 11). The first approach is inferior because we have more innovators than adaptors in the sample, but according to the statistics there are more adaptors in the world and especially studying economics. In the second robustness check we excluded “middle” group from the analysis, however it worsens the analysis as PtI=3 is the largest group. Thus, the results are weakly robust, but both robustness checks are far from perfect. We see no sense to move threshold up to PtI = 4 & 5 because it leads to a dramatic reduction in the number of innovators and the insignificance of the regression. All regressions from robustness check are not significant at 1% level.

7. Conclusion and discussion

This research is the first, to our knowledge, that tests the relationship between PtI and its determinants SS, creativity, RT, and proactivity. We contribute to behavioral economics research by identifying PtI correlations, by estimating the relationships between PtI and its determinants, by adding PtI to the list of GPA determinants, and by comparing the GPA determinants for adaptors and innovators.

We have 9 hypotheses in the research: H1a–H4a continues Yagolkovsky’s (2019) research; hypotheses H1b – H4b are an empirical testing of Schweizer’s (2006) NGM; H5 established the negative impact of PtI on GPA for economics students. The hypotheses’ check summary is presented in Table 12.

Table 12. Hypotheses’ check summary

H	Tested suggestion		Not rejected	Rejected
H1	SS	a) Positively correlates with PtI; b) Increases PtI.	a), b) Not rejected	
H2	Creativity		a) Not rejected	b) Rejected
H3	RT		a), b) Not rejected	
H4	Proactivity		a) Not rejected	b) Rejected
H5	GPA	Negatively depends on PtI	Not rejected	

Most of the hypotheses H1a–H4a and H1b–H4b are not rejected, which allows us to partially confirm Schweizer’s (2006) NGM, however H2b and H4b were rejected. The possible explanation why creativity does not increase PtI (H2b) is in the restricted creativity measurement used in our

study. Only Mednick's verbal creativity score provides some significant results, while CAQ does not. There are many more types of creativity beyond verbal, which were not taken into account in our study, and this is a limitation of this research and an area for future study.

Proactivity does not increase PtI (H4b). We suggest that proactivity will impact PtI at the realisation stage, so increasing only proactivity will not make a person more innovative. Proactivity is one of 7 traits highlighted by Schweizer (2006) responsible for innovative performance, so this is also an area for future study.

Our analysis did not find any endogeneity. However, we had a limited opportunity to check it due to data time invariance. We do not insist that there is no endogeneity at all. The most suspicious variable is SS and its endogeneity can be studied in further research.

We highlight 2 points of practical significance in studying the components of NGM as determinants of PtI. Firstly, it is difficult to measure PtI quickly, when some of its correlates/determinants, such as creativity, RT, and proactivity are visible and may be captured even through a CV. This may be useful for companies and universities. HR departments in innovative companies may use this fact to select people with a high PtI. Universities may use it as part of an interview for the post-graduate studies. Secondly, there are many parties concerned about how to develop PtI. One way our research suggests is through its components, such as the number of universities, extreme sports, and SS.

Also, we found that PtI negatively impacts GPA (H5). In a continuation of the analysis, we consider the differences in the determinants of GPA between adaptors and innovators. We found only 1 factor that influences both adaptors and innovators — awards. Other determinants affect either adaptors or innovators' GPA. However, this relationship may be real only for economics and similar technical professions where relatively low creativity is required.

In addition to the limitations of the study discussed earlier, we should highlight the selection bias caused by the analysis of economics students, so we do not maintain that these results may be similar for all students (investigating students with other majors is another area for future study). Also, using survey methodology may cause a self-estimation bias. For example, self-estimated RT and proactivity are correlated with PtI and SS, while other measures of RT are not correlated. According to our analysis, individual self-perception affects behaviour. We did not consider the impact of external circumstance on PtI as it has huge volatility and was out of our scope. Famous RT's determinant, such as height was not considered. And finally, endogeneity should be checked using panel survey data.

An additional practical implication raised from the GPA analysis is that universities and employers looking for innovative students or graduates should pay attention to hobbies and not only GPA.

We have some ideas for the continuation of the research in addition to those already mentioned: include DOSPERT in the analysis, elaborate the PtI index to include observable individual determinants, take external circumstances into consideration, create a survey methodology combining SS and KAI, check differences in income determinants among A-I groups [Rozhkova et al, 2021].

Materials and method

The questionnaire is available at the link: <https://forms.gle/WmvCzrTvk5FtutAt8>

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Appendixes

Appendix 1. Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) PtI	1.0000													
(2) SS	0.3063*	1.0000												
(3) Mednick	0.1170*	0.0732	1.0000											
(4) RT_self	0.2542*	0.3303*	0.1314*	1.0000										
(5) Proactivity	0.2313*	0.2410*	0.1110	0.2866*	1.0000									
(6) Extreme	0.2303*	0.3570*	0.0917	0.3219*	0.1592*	1.0000								
(7) Addicted	0.1071	0.1430*	-0.0495	-0.0500	0.0224	-0.0603	1.0000							
(8) Awards	-0.0373	0.0373	-0.1739*	-0.0436	-0.0699	0.0283	-0.0115	1.0000						
(9) Parents' titles	0.0207	0.0592	0.0807	0.0887	0.0792	0.0177	0.0062	0.1972*	1.0000					
(10) Parents' education	-0.0865	0.0415	0.0110	0.0497	0.0663	0.0355	0.0693	-0.0336	0.2657*	1.0000				
(11) Gender	-0.1326*	-0.0915	-0.1418*	-0.1595*	-0.0528	-0.0647	-0.0961	0.1959*	0.0948	-0.2533*	1.0000			
(12) Age	0.0604	0.0392	0.0371	-0.0466	0.0292	-0.0134	0.1460*	-0.1207*	0.0361	-0.0484	-0.0817	1.0000		
(13) Universities	0.1649*	0.0859	-0.0068	-0.0438	0.0427	-0.0630	0.1723*	-0.1191*	-0.0987	-0.0323	-0.1491*	0.2669*	1.0000	
(14) GPA	-0.1552*	-0.1324*	-0.1433*	-0.0620	0.0124	-0.1652*	-0.1619*	0.2760*	0.1077	0.0122	0.0770	-0.0017	-0.0447	1.0000

* p<0.1

Appendix 2. Distribution of respondents by years of education

Education year	Number of respondents
1	34
2	27
3	31
4	71
5	14
6	26
Total	203

Appendix 3. Robustness check for PtI using robust ordered logit estimation

	(1)	(2)	(3)
VARIABLES	PtI		
BSSS	0.0548***	0.0589***	
	(0.0178)	(0.0160)	
Mednick	0.00776		0.00868
	(0.00781)		(0.00735)
RT_self_estim	0.630**	0.635**	0.853***
	(0.282)	(0.277)	(0.274)
Proactivity	0.0321		0.145
	(0.143)		(0.110)
Male	-0.401 ⁺	-0.452*	-0.381 ⁺
	(0.276)	(0.268)	(0.275)
Parents_educ	-0.552*	-0.518*	-0.510*
	(0.283)	(0.274)	(0.284)
N_Universities	0.457*	0.494**	0.512**
	(0.244)	(0.236)	(0.224)
Age	0.0122		
	(0.0454)		
Awards	0.0197		
	(0.325)		
Addicted	0.226		
	(0.299)		
Pseudo R2	0.0508	0.0486	0.0339
Observations	203	203	203

Robust standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1, + p<0.15

Appendix 4. Robustness check for GPA analysis in dependence on A-I groups with threshold 3

	(1)	(2)	(3)	(4)
VARIABLES	GPA			
Sample	Adaptors, PtI<3		Innovators, PtI>2	
Method	Ologit	OLS	Ologit	OLS
BSSS	-0.0317 (0.0287)	-0.0132 (0.0113)	-0.00667 (0.0217)	-0.00132 (0.00949)
Mednick	-0.0236 (0.0181)	-0.00939 (0.00785)	-0.00351 (0.00737)	-0.00188 (0.00376)
Extreme	-0.473 (0.464)	-0.227 (0.191)	-0.585* (0.344)	-0.242 (0.163)
Activity	0.136 (0.339)	0.0442 (0.145)	0.279 (0.225)	0.0955 (0.102)
Addicted	-0.606 (0.518)	-0.217 (0.211)	-0.726* (0.380)	-0.332** (0.167)
Parents_titles	0.713** (0.341)	0.228* (0.120)	-0.0205 (0.263)	-0.0182 (0.123)
Awards	1.364*** (0.518)	0.499** (0.191)	1.029*** (0.393)	0.446** (0.174)
Constant		8.120*** (0.728)		7.130*** (0.441)
Observations	63	63	106	106
R-squared		0.268		0.123
Pseudo R-squared	0.0423		0.0156	
Prob>F		0.0149		0.0333
Prob>chi2	0.0247		0.0569	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Appendix 5. Questionnaire with codes

Propensity to innovate (PtI)

Choose 1 statement that best describes you:

Statements	Score
Thinking characterized by precision, reliability, efficiency, prudence, and discipline	0
Thinking characterized by a lack of discipline, linking of unrelated ideas, and unusual thought patterns	1
Interested in finding problems to solve	1
Interested in solving problems	0
If rules do not fit, bend them a bit	1
Prefer to work within established rules	0
Solutions sought by tried and true methods	0
Use novel and revolutionary ideas in seeking solutions	1
Can maintain high level of attention for long periods of work	0
Work best for short bursts of high intensity	1
Bending the rules for one person is unfair to the rest	0
Bending the rules if necessary makes bureaucracy more human	1
Impractical, unpredictable, change-oriented type	1
Practical, predictable, take-care-of-business type	0
Command of specialized knowledge	0
Command of general knowledge	1
When involved in a project, I forget that other people are also involved and probably should be consulted	1
When involved in a project, I take in consideration my colleagues' opinions	0

Based on Bobic et al. (1999).

Sensation seeking (SS)

Rate from 1 to 7 how much do you agree with the following statements, where 1 - absolutely disagree, 7 - completely agree.

	1	2	3	4	5	6	7
I would like to explore strange places							
I get restless when I spend too much time at home							
I like to do frightening things							
I like wild parties							
I would like to embark on a trip with no pre-planned routes or timetables							
I prefer friends who are excitingly unpredictable							
I would like to try skydiving							
I would love to have new and exciting experiences, even if they are illegal							

Based on Hoyle et al. (2002).

Risk-taking to invest (RT inv)

Suppose you have 1,000 rubles at your disposal, and you are asked to choose which part of a thousand rubles you will invest. The investment will either generate an income 2.5 times higher than the original investment or zero income. How much are you willing to invest?

Based on Gneezy & Potters (1997).

Risk-taking to receive (RT rec)

You are asked to choose one of 6 games that you would like to play. In each game, there is a 50% probability of either low or high payoff. Which of the proposed games would you choose?

Choice (50/50 Gamble)	Low payoff, rub. (Probability = 50%)	High payoff, rub. (Probability = 50%)
Gamble 1	280	280
Gamble 2	240	360
Gamble 3	200	440
Gamble 4	160	520
Gamble 5	120	600
Gamble 6	20	700

Based on Eckel & Grossman (2002).

Mednick verbal creativity test adopted for adult Russians by Voronin

There are three words for which you need to find another word so that it is combined with each of the three suggested words. You can change words and use a preposition. Try to come up with the most vivid and original associations. Try to give as many answers as possible for each three words.

Example: clock, violin, unity

Answer: master (watch master, violin master, unique master)

Accidental, mountain, long-awaited

Evening, paper, wall

Back, homeland, way

Far, blind, future

Folk, fear, world

Money, ticket, free

Human, shoulder straps, plant

Singer, America, thin

Affectionate, wrinkles, fairy tale

Based on Voronin & Galkina (1994).

Creative achievements questionnaire (CAQ)

How often do you devote time to the following creative activities?

	Never	Rarely	Sometimes	Often	Always
Painting, sculpture					
Music, singing					
Dance					
Dizain, hand craft (embroidery, knitting, sewing, etc.)					
Writing					
Theater, film					
Other:					

Based on Carson et al. (2005).

Other questions

N	Variable	Question	Code
1	Age	How old are you?	
2	Gender (Female)	Choose your gender o Male o Female	0 1
3	Working	Choose your occupation <input type="checkbox"/> Student <input type="checkbox"/> Working <input type="checkbox"/> I do not study or work	0 1 0
4	Awards	Do you have any advanced academic degrees / additional qualifications / substantial awards and distinctions / titles? o Yes o No	1 0
5	Universities	How many higher education institutions have you studied at in the last 5 years? (write the number in digits in your answer)	
6	RT_self	How much do you rate your level of risk aversion? o I avoid any risky situations o I avoid unnecessary risk o I like to take risks	0 1 2
7	Activity	How active are you? o I am very active o I'm moderately active o I can be active when needed o I do not like to be active	3 2 1 0
8	Parents' education	Do your parents have higher education? o No o One of the parents o Both have	0 1 2
9	Parents' titles	Do your parents have any advanced academic degrees / additional qualifications / substantial awards and distinctions / titles? o No o One of the parents o Both have	0 1 2
10	Extreme	Do you like extreme sports? o Yes o No	1 0
11	Addicted	Do you consider yourself addicted? (smoking, gambling, alcohol, etc.) o Yes o No	1 0

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