

# HSE University Review

issue

14

2019

Research in global development, socio-economics, and more

**Researchers Propose New Approach to Post-Stroke Rehabilitation**

**Graphene Quantum Dots for Single Electron Transistors**

**HSE Scholars Propose New Method to Measure Individual Well-being**

**DNA Secondary Structures Lead to Gene Mutations That Increase the Risk of Cancer**



---

# Contents

---

## 4 NEWS

## 8 IN FOCUS

- 'If You're at a University, You're Already a Part of Scholarly Discourse'
- 13 Buildings, 3 Atriums, 78,000 Square Meters: HSE's New Complex at Pokrovka Awaits

## 12 HSE RESEARCH PROJECTS

- Researchers Propose New Approach to Post-Stroke Rehabilitation
- Stratification of Bullying
- Which Textures Bring Happiness, and Which Cause Anger
- Graphene Quantum Dots for Single Electron Transistors
- 'Green' Taxes
- Investment in LEGO Can Yield Returns of up to 600%
- Personality at Work
- HSE Scholars Propose New Method to Measure Individual Well-being
- DNA Secondary Structures Lead to Gene Mutations That Increase the Risk of Cancer

## 30 ABOUT HSE

- HSE University Today

Explore HSE University Newsletter to learn more about us



# HSE University Review

---

issue 14 2019



Andrey Kozhanov,  
Director of the HSE Centre for Student Academic  
Development

## DEAR COLLEAGUES,

Those looking to promote public engagement in science will find the university to be the best place to do so. The global trend today aims to increase the level of public understanding of science and to promote a deeper trust between science and society. A new philosophy at HSE University focuses on establishing relations between science AND society more than on bringing science TO society.

Popular science lies at the heart of a growing movement everywhere, and our sociological data show that the public's interest in science and public recognition of the academic profession in Russia are overcoming the public mistrust and indifference that existed previously. This trend is bringing about a very direct response from the academic and communication departments within HSE.

With regard to internal science communication inside our university, significant progress been made place in recent years. In early 2019, we launched the Science Republic project at HSE, which aims to promote science engagement through informal communication between students and young scholars at HSE.

Science Republic is a social platform designed for mutual communication of scientific knowledge, useful information and tools that students can use as they take their first steps toward a career in science or R&D. It ensures that support is available for students during their time at HSE, and enhances students' chances of academic success.

Science Republic is also a metaphor that describes the perfection we pursue and the creation of a communication platform to support the academic development of HSE students and early-career scholars. Members of this 'invisible college' build a commitment to science and scientific rationality within the wider student community. The promotion of interdisciplinary research at the student level is an additional effect we expect to see at HSE as a result of the project.

The university is doing everything it can to improve the infrastructure supporting students' academic development and to make the connection between science and the public more efficient and credible. In this issue of HSE Review, you will learn more about science communications at HSE and particular cases involving our early career scholars.

---

## NEWS

### HSE University to Launch First Experimental Physics Laboratories

The HSE University competition committee has announced the winners of an international competition for new physics laboratory proposals. Two projects were selected: the Laboratory of van der Waals Heterostructures, headed by Davit Ghazaryan, and the Laboratory of Nanophotonics and Functional Materials, headed by Andrey Krasavin.

In early 2019, HSE University launched an international project competition for experimental research laboratories in quantum technologies and new functional materials. Applications were accepted from young researchers who had received their PhDs within the past 15 years. Proposals were evaluated both by internationally renowned experimental physicists and leading researchers from RAS institutes that have joint departments with HSE University.

The Laboratory of van der Waals Heterostructures will study synergetic physical characteristics of various two-dimensional materials (graphene is the most widely known of them), and in particular, their electronic, nanomechanical and optical features. The Laboratory of Nanophotonics and Functional Materials will examine the interaction between light and matter, as well as new optical phenomena. The lab will focus on quantum tunnelling and its application in nanosized light sources, nanochemistry, and hypersensitive sensors.

### Times Higher Education Young Universities Summit to Be Held in Moscow for the First Time

On June 24-26, 2020, the Times Higher Education (THE) Young Universities Summit will be held for the first time at HSE University in Moscow. An official hand-off ceremony took place earlier at the University of Surrey, which hosted the event this year. It was not by chance that HSE University was selected to be next year's summit host — it is the only Russian university that consistently ranks among the THE Top 100 Young Universities, this year taking 60th place.

This will be the seventh annual THE Young Universities Summit to be held. Over the years, the event has become a global forum for university leaders, education managers and experts to discuss the future of world-class universities. The motto for next year's summit is 'Local Impact, Global Influence.' The summit will primarily be dedicated to the question of how young universities can expand their spheres of influence at both the global and local levels. In particular, university leaders will discuss prospects for strengthening their universities' reputations both in their home countries and abroad.

Phil Baty, Chief Knowledge Officer of THE, noted that 'we are delighted to confirm that we are partnering with HSE University for THE's first ever Young Universities Summit to be held in Russia. HSE University has made tremendous progress on the world stage since its foundation in 1992, rising rapidly up the World University Rankings, so it epitomizes the



HSE Vice Rector Ivan Prostakov and Managing Director of THE Trevor Barratt

type of ambitious and strategically focused institution that THE partners with.' Phil Baty added that there is an 'an excellent programme planned for Moscow in June 2020, with a particular focus on the development of an institution's social and economic impact.'

In response to the news, HSE Vice Rector Ivan Prostakov remarked, 'The decision to hold the Young Universities Summit in Moscow attests to the fact that Russian universities are fully fledged members of the global academic community and that this community is interested in developing mutually beneficial partnerships with them. The participating universities strive not only to be competitive in the global market, but also to make a significant contribution to the development of their countries and their respective national education systems. The upcoming summit in 2020 will be specifically devoted to this issue.'

### HSE Scientists Develop Mathematical Algorithm for Russian Premier League's Season Calendar

HSE University's Laboratory of Sports Studies has signed an agreement with the Russian Premier League, Russia's top professional football division, for the purpose of collaborating on the League's calendar for the 2019/2020 season.

The Russian Premier League (RPL) is comprised of 16 teams, which play each in rotation over the course of two rounds: each team must play each other in one home match and one away. The tournament calendar also indicates which teams play each other in each round. As such, the total number of scheduling combinations for a given season is practically infinite.

To compile the RPL match schedule for next season, the Laboratory of Sports Studies developed a special algorithm, which takes into account the calendar's many requirements. These requirements include clubs' participation in European Cup tournaments, stadium availability, weather conditions in various Russian regions, and broadcaster requirements, as well as those of the state institutions charged with providing event security. In addition, the most important aspect of the calendar is ensuring the schedule is balanced from an athletic standpoint.

### HSE University and UN-Habitat Sign Partnership Agreement

HSE University and the United Nations Human Settlements Programme (UN-Habitat) recently signed an agreement to conduct joint research on urban



HSE Rector Yaroslav Kuzminov and UN Under-Secretary-General Maimunah Mohd Sharif

development. HSE Rector Yaroslav Kuzminov and UN Under-Secretary-General Maimunah Mohd Sharif, who heads the UN-Habitat programme, signed the Letter of Intent at the Moscow Urban Forum, which was held in July at Moscow's Zaryadye Park.

Established about 40 years ago, UN-Habitat promotes the sustainable development of cities and settlements around the world. Its headquarters is located in Nairobi.

In fact, HSE University and UN-Habitat already have a history of collaboration. Since 2014, staff of HSE's Institute for Regional Studies and Urban Planning, headed by Irina Ilina, have participated in expert groups regarding the urban development of CIS countries. From 2017-2019, the Institute held three conferences dedicated to the topic of 'Sustainable Development Goals: Applicability for Russian Cities and Assessment Tools'.

The Letter of Intent, signed by HSE University and UN-Habitat, foresees the creation of a New Urban Agenda Research Centre at the University. The Centre will develop and carry out sustainable urban development projects in various CIS countries. Its areas of research shall include the creation of an urban prosperity index, identifying innovations to improve urban environments, creating 'smart' cities, improving quality of life, preventing climate change, improving city life, and making housing affordable.

### HSE University Expands Number of Subjects in the Shanghai Ranking

HSE University has retained its position in the Top 100 of the Global Ranking of Academic Subjects 2019, otherwise known as the Shanghai Ranking, in sociology and mathematics. The university improved in political science and has also placed in the same group in economics. At the same time, HSE moved to the next group in management and entered new subject areas – psychology and business administration.

#### Shanghai Ranking's Global Ranking of Academic Subjects, 2019

Subject	2019 globally	in Russia
Sociology	51-75	1
Mathematics	76-100	1-2
Political Science	151-200	1
Economics	151-200	1
Management	301-400	1
Business Administration	301-400	1
Psychology	401-500	1

### HSE in the Young Universities and QS World Rankings

In 2019, HSE University climbed from 84th to 60th place in the Time Higher Education (THE) world ranking of young universities. HSE University is the only Russian university to place in the top 100 of this ranking.

HSE University also improved its position in the QS institutional ranking by 21 places this year, taking 7th place among Russian universities. The advancement follows a significant improvement in academic reputation and assessment of university graduates by employers.

HSE recently placed 39th in the QS Top 50 'Under 50' ranking, thus maintaining its position in the Top 40 despite increasing competition in this special academic category. Furthermore, HSE is still the only Russian university to appear in this ranking.

### HSE University Signs Cooperation Agreement with Russian Academy of Sciences

The document, signed by HSE Rector Yaroslav Kuzminov and RAS President Alexander Sergeev, formalizes agreements on joint work in education, the training of future researchers, and the support and promotion of research.

HSE University and the Russian Academy of Sciences (RAS) have cooperated closely in several areas. The Academy institutes have opened three joint faculties with HSE University: the Faculty of Physics, the Faculty of Chemistry, and the Faculty of Biology and Biotechnologies.

'This is a "projection" of RAS on our university,' said Yaroslav Kuzminov. 'Our colleagues from RAS have the opportunity to "tailor" the educational process to their needs and, from the very beginning, teach students by involving them in research. Each student has a mentor. This is a brilliant tradition, and we are happy to see how these faculties are developing.' According to Kuzminov, HSE University is currently negotiating with one more Academy institute about opening a Faculty of Geography at HSE.

The official cooperation agreement not only formalizes joint projects already in place between HSE University and RAS, but it also outlines new areas for cooperation.

RAS President Alexander Sergeev believes that one promising field for collaboration is the advancement of the state neuroscience programme. 'I am aware that HSE University devotes serious attention to this scientific field, and the research is supported with cutting-edge equipment,' he said. It is important that the neuroscience programme at the national level 'has the same status as the recently approved programme in genetics.'



**HSE Rector Yaroslav Kuzminov and RAS President Alexander Sergeev**

### HSE Takes Grand Prix in 2019 Communication Laboratory Award

At the 3rd National Forum of Science Communicators, HSE University was awarded the Grand Prix of the Communication Laboratory Award for its excellent performance in all aspects of science communication.

The Communication Laboratory is Russia's first award in science communication. This year, the forum was hosted by last year's Grand Prix winner, ITMO University. Over 300 participants came to St. Petersburg, from large universities and smaller research institutions alike. This event traditionally concludes with the Communication Laboratory award ceremony.

#### The award is given in three categories:

- **Experiment:** for best practices in offline communications;
- **Participation Effect:** for best promotion of scholars in the media;
- **Superflow:** for the best management of one's own communication channels.

The **Small and Big Grand Prix** are awarded based on a university's total number of achievements in these categories.

HSE University already won prizes at the Communication Laboratory Award in the past. For instance, in 2018, it took second place in the Grand Prix category, and two years ago, it placed first in the Experiment category for the best offline project – HSE Open University. This year, HSE University was awarded the main prize, the Grand Prix, for its high standards of communications in all fields. Therefore, next year's Fourth National Forum of Science Communicators will take place at HSE.

### HSE and Ca' Foscari University Pursue Productive Partnership

As part of the International Partners Week, a ceremony for the establishment of the Ca' Foscari University Information Corner at HSE University was held on June 19.

The official delegation of the Venice-based university, headed by Michele Bugliesi, the Rector of Ca' Foscari, visited Moscow to discuss further plans for collaboration and take part in HSE's International Partners Week. During the visit, they met with HSE Rector Yaroslav Kuzminov, who stressed the importance of



Opening ceremony for Ca' Foscari University Information Corner at HSE University

broader information exchange and the involvement of young faculty and students in joint research initiatives.

The two universities signed a cooperation agreement back in 2012, and, since 2013, they have been offering exchange programmes. Furthermore, academic and research collaborations are also on the partnership agenda.

In February 2018, HSE Rector Yaroslav Kuzminov, together with an HSE delegation, visited Ca' Foscari to celebrate its 150th anniversary. Both sides then agreed to further their cooperation and promote bilateral representation – the Ca'Foscari Information Corner at HSE and the HSE University Information Corner in Venice. These corners contribute to further sharing of information about initiatives, cultural and educational events, academic programmes and joint research activities.

Dr. Bugliesi, Rector of Ca' Foscari University, noted that the Information Corner is the logical continuation of the two universities' successful research and academic interaction. For instance, HSE students who are interested in potentially studying in Venice can learn more about Ca' Foscari. He added that the administration of the university hopes to see the involvement of HSE Lyceum students in wider collaboration.

Other future plans include working with HSE's School of Asian Studies to develop a double degree programme in contemporary Asian Studies and joint research in such fields as digital humanities and computer science.

# ‘If You’re at a University, You’re Already a Part of Scholarly Discourse’

The Science Republic, which brings together young researchers, was founded at HSE University in March 2019. Andrey Kozhanov, Director of the Centre for Student Academic Development, spoke with the HSE News Service about the project, as well as about how to explain your research to your grandma.



Andrey Kozhanov, Director of the HSE Centre for Student Academic Development

## On the Centre for Student Academic Development

Since January 2019, my colleagues and I have been working on implementing ideas to support and develop HSE students' involvement in research in general and in their own academic fields in particular.

Our main task is to help students become more scholarly minded and interested in producing quality research, and from there, to encourage them to be

a part of the university's scholarly community and academic profession. After all, bachelor's and master's degrees are academic degrees, even if they are conferred in areas that are applied or administrative.

The third level of 'enlightenment' is to try to develop within a specific field of research and particular scholarly community—'the thought collective', as Ludwik Fleck said.

## On What They Plan to Do

We are not going to try to make students inclined to something or force them to love research. That's probably the most effective way to ruin the whole thing. Rather, we invite students to think about whether life at HSE University can be connected with an academic project.

It's funny to read in student surveys that some of them believe that research is not for them. To use a metaphor from a discussion about the sociology of science, you might say it's like flying in an airplane at an altitude of 10,000 meters and not acknowledging the laws of aerodynamics. It's too late. If you're at a university, you're already a part of scholarly discourse. I'm not saying you're a scholar of 'great discoveries'; rather, you are engaged in certain enclaves of academic expertise.

## On the Science Republic

While creating the Science Republic, we considered many options. We rejected the idea of imitating someone's project when we looked around and didn't see anything that would suit us given our objectives and the specifics of HSE University, with its large number of bachelor's programmes in many areas.

From the history of science, we knew that there are two basic models – science as a vertical academic hierarchy and science as a horizontal ‘invisible college’. However, we associate any hierarchy and culture of status veneration with nomenclature and bureaucracy, including numerous attempts to organize student research societies at HSE University. Therefore, we invited HSE students from all programmes and levels to participate in the horizontal model of the Science Republic.

### The Science Republic Now

The project was launched in March and now has 145 members, who met the strict criteria in order to join.

The Science Republic has become a platform for HSE students to hone their academic skills. The following programmes help to develop these skills: funding for student travel to research events, student conference support, the HSE student blogger competition, and the school of wiki editors for research scientists. We still have a lot of ideas, and we intend to develop them next academic year.

### How Do You Explain What You Do to Your Grandma?

I find it easy to speak about research or the university. The biggest problem is explaining what sociology is. And if we’re talking about sociology of science and scientific knowledge, then you’ve got a complicated situation on your hands.

You can talk about it in clichés (for example, ‘sociology is the science of society’). However, people get annoyed with these explanations. On the contrary, you can talk about the things you don’t do – for example, you don’t stand with questionnaires at the cash desk in a supermarket.

Now I think I can explain what I do to anyone, but it took years of practicing and coming to understand two important areas for a social scientist – sociolinguistics and the sociology of science communication.

The first area teaches us to translate information from jargon into ordinary language. The second involves understanding how the goals and motives of the audience shift with the transition to different institutional contexts. Talking about research with academics and talking about it with non-academics are two different things.

I would start by saying that there is a social problem that my field of study solves. For example, the sociology of expert knowledge determines how and why people trust expert opinion, which we rely upon so strongly.



Launch of the Science Republic Project in March 2019

Even sociologists studying Wittgenstein face real problems: the rules by which a person exists in culture and society have a dual nature of formal prescriptions and a lack of clear instructions for their implementation. This becomes immediately clear when the sociologist applies this to real life: traffic, rules in public transport – any situation of ordered chaos.

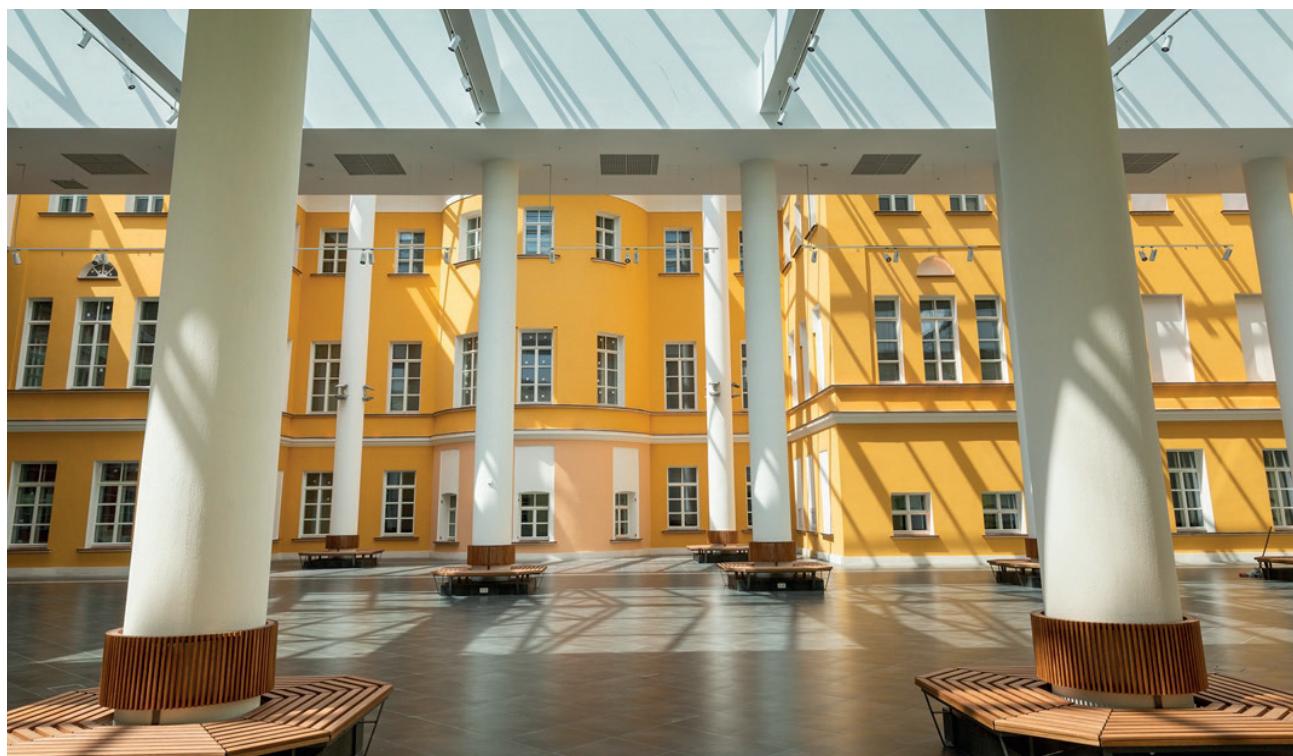
### On Crowning Moments of His Academic Career

I don't dream about crowning moments. In terms of what I would like to achieve in academic work, right now I am focused on developing quality studies of science communication in Russia – i.e., the communicative interaction between academia and the general public – people of all backgrounds.

For a long time, Russian sociology of science was dedicated exclusively to internal research of academic profession and scientometrics. I am interested in the perception of scientific knowledge and technology in society, the formation of trust in the institutions of expertise and science, and the dialogue between academic communities and involved groups of social activists.

# 13 Buildings, 3 Atriums, 78,000 Square Meters: HSE's New Complex at Pokrovka Awaits

On July 25, HSE University's new Pokrovka complex opened its doors. Located at 11 Pokrovsky Boulevard, the complex is HSE's largest and most modern Moscow campus. Classes will begin there in September.



The new building will house the Faculty of Economic Sciences, the International College of Economics and Finance and the Faculty of Computer Science. The faculties will be moved to the new building by September 1. A significant number of the classes of the Faculty of Communications, Media and Design, which is located across the street, will also be held there. In recent years, admissions to these programmes have grown significantly, which has created a need for larger auditoriums.

Pokrovka (named after the street on which it is located) is now HSE's largest complex, consisting of 13 buildings that are joined together by three atriums.

Now you can get to and from different parts of Pokrovka (the complex's convenient above-ground area is 78,000 square metres) any time of the year.

The complex has everything students need not only for a comfortable work environment, but also for extracurricular activities: a modern cafeteria with 300 seats, three student cafes, HSE's largest library, and a cultural centre. The building that holds the large auditoriums along with a complex of seminar and language classrooms was rebuilt.

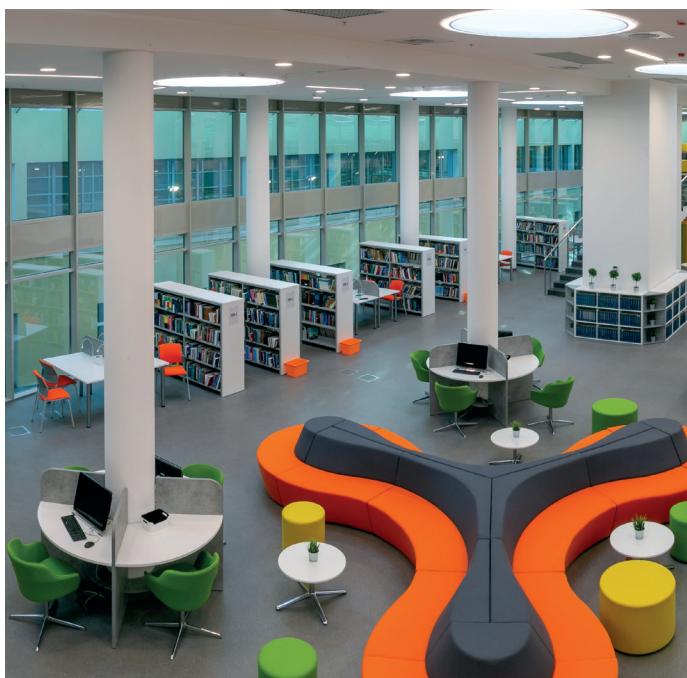
The new complex meets all requirements for a barrier-free environment. When the campus becomes accessible to individuals who are visually impaired and

hard of hearing thanks to the latest technology, HSE will be the only university of Russia to offer this kind of accessibility.

Two conference rooms and spaces for student extracurricular activities located in the cultural centre in the complex have been updated. However, the main area that will hold many HSE events and attract students and staff alike will undoubtedly be the central

atrium, which boasts an area of more than 2,000 square metres surrounded by historic building facades.

The construction of the new complex began in 2012. Pokrovka's 13 buildings also include a cultural heritage site, the Durasov Manor House. This is one of the few buildings in Moscow that survived the fire of 1812. It will be open to visitors as part of cooperation agreement between the university and the city.



# Researchers Propose New Approach to Post-Stroke Rehabilitation

The existing approach to brain stimulation for rehabilitation after a stroke does not take into account the diversity of lesions and the individual characteristics of patients' brains. This was the conclusion made by researchers from HSE University and the Max Planck Institute of Cognitive Sciences in their article, 'Predicting the Response to Non-Invasive Brain Stimulation in Stroke.'

Among the most common causes of death worldwide, stroke ranks second only to myocardial infarction (heart attack). In addition, a stroke is a chronic disease that leaves patients disabled for many years.

In recent decades, non-invasive neuromodulation methods such as electric and magnetic stimulation of various parts of the nervous system have been increasingly used to rehabilitate patients after a stroke. Stimulation selectively affects different parts of the brain, which allows a person to functionally enhance activity in some areas while suppressing unwanted processes in others that impede the restoration of brain functions. While this is a promising means of rehabilitation after a stroke, its results in patients remain highly variable.

The study's authors argue that the main reason for the lack of effectiveness in neuromodulation approaches after a stroke is an inadequate selection of patients for the application of a particular brain stimulation technique.

According to the authors, the existing approach does not take into account the diversity of lesions after a stroke and the variability of individual responses to brain stimulation as a whole. Researchers propose two criteria for selecting the optimal brain stimulation strategy. The first is an analysis of the interactions between the hemispheres. All patients, regardless of the severity of injury after a stroke, are currently offered a relatively standard treatment regimen. This approach relies on the idea of interhemispheric competition.

'For a long time, it was believed that when one hemisphere is bad, the second, instead of helping it, suppresses it even more,' explains Maria Nazarova,



Maria Nazarova, Research Fellow at HSE Institute for Cognitive Neuroscience

one of the authors of the article and a researcher at the HSE Institute of Cognitive Neurosciences. 'In this regard, the suppression of the activity of the "unaffected" hemisphere should help restore the affected side of the brain. However, the fact is that this particular scheme does not work in many patients after a stroke. Each time it is necessary to check what the impact of the unaffected hemisphere is — whether it is suppressive or activating.'

The second criterion is one that scientists call the neuronal phenotype. This is an individual characteristic of the activity of the brain, which is 'unique to each person like their fingerprints.' Such a phenotype is determined, first, by the ability of the brain to build effective structural and functional connections between different areas (connectivity) and, second, the individual characteristics of neuronal dynamics, including its ability to reach a critical state. This is the state of the neuronal system in which it is the most plastic and capable of change.

Only by taking these criteria into account, the authors posit, can neuromodulation methods be brought to a new level and be effectively used in clinical practice. To do this, it is necessary to change the paradigm of the universal approach and select methods based on the individual characteristics of the brain of a particular person and the course of his or her disease.



Vadim Nikulin, [Leading Research Fellow at HSE Institute for Cognitive Neuroscience](#)

### STUDY AUTHORS:

#### **VADIM NIKULIN,**

[Leading Research Fellow  
at HSE Institute for Cognitive  
Neuroscience](#)

#### **MARIA NAZAROVA,**

[Research Fellow  
at HSE Institute for Cognitive  
Neuroscience](#)

#### **SMADAR OVADIA-CARO,**

[Department of Neurology, Max Planck  
Institute for Human Cognitive and Brain  
Sciences](#)

#### **AHMED KHALIL,**

[Department of Neurology, Max Planck  
Institute for Human Cognitive and Brain  
Sciences](#)

#### **BERNHARD SEHM,**

[Department of Neurology, Max Planck  
Institute for Human Cognitive and Brain  
Sciences](#)

#### **ARNO VILLRINGER,**

[Department of Neurology, Max Planck  
Institute for Human Cognitive and Brain  
Sciences](#)

# Stratification of Bullying

Social inequality increases the risks of school bullying, and low-income youth tend to be more vulnerable. However, in schools where many students come from less fortunate backgrounds, such as low-income, poorly educated, single-parent or dysfunctional families, their less deprived classmates may be at risk of bullying.

## Conflict of Statuses

Socioeconomic factors have been found to contribute significantly to school bullying. The risk of victimisation is associated with family income: teenagers from deprived families are more likely to be bullied, according to Arthur Rean, Head of the HSE Institute of Education Laboratory for Prevention of Antisocial Behaviour, and Maria Novikova, Research Fellow with the Laboratory. Deprived families are often those in which one or both parents are unemployed.

However, socioeconomic inequality can sometimes have an opposite effect. Schools in disadvantaged neighbourhoods with a high ratio of deprived children often create higher bullying risks for children from non-deprived backgrounds, and many students are affected by the adverse psychological climate in such schools.

The researchers examined the socioeconomic causes of school bullying based on findings from a survey of 890 high school students (average age: 16 years) in five federal districts of Russia.

## Switching Roles from Victim to Aggressor

School bullying is a recurring situation in which one student (or group of students) intentionally causes harm to another – usually, someone who is less popular in the group. Teenage aggression is often driven by an urge to raise or maintain one's status among peers or to claim superiority over others (including teachers).

According to the researchers, an important characteristic of involvement in bullying is 'changeability of roles': those who have been bullied are more likely to show aggression towards someone who is weaker. This is confirmed by the high correlation of data indicating bullying involvement in different roles that was found by the study.

Aggressive behaviour can occur as a reaction to humiliation or provocation. When asked about the reasons why they had got into a fight, young men often responded that they had been insulted (70%) or 'forced to defend themselves' (50%), etc.

## Different Types of Bullying

Several types of bullying can be distinguished: physical – attacks or fights; verbal – insults or threats; social – ignoring or leaving someone out of peer interactions, spreading rumours and gossiping about them; cyberbullying – using digital technology to bully someone, e.g. by posting offensive comments and videos on social media or in messaging apps, etc.

A meta-analysis of bullying prevalence reveals that 35% of school students worldwide are involved in traditional bullying (both as perpetrators and victims) and that 15% have been involved in cyber forms of bullying.

Bullying is common in Russian schools. According to Rean and Novikova, the proportion of respondents who have been involved in a bullying situation at least once recently ranges from one third (as a victim or perpetrator) to one half (as a witness).

Most often, respondents witnessed bullying behaviour (65% of respondents witnessed bullying at least once and 13% witnessed it more than three times in the previous month), while being a victim of bullying or a perpetrator was less common (5% of respondents reported being victims and 3% reported being perpetrators three or more times during the studied period).

Verbal and social aggression are the most common forms, including rude and offensive comments, offensive gestures and demonstrative rejection, e.g., refusing to talk to a person or work together on a school project.

Of all high school students surveyed, 35.7% reported having practiced social bullying once or twice and 60% reported never engaging in it. Verbal bullying was practiced once or twice by 35.4% of respondents, while 57% of students reported never engaging in it.

Physical attacks were perpetrated once or twice by 20% of respondents and never by 75.2%. As for cyberbullying, the figures are 26.8% and 69.3% of respondents, respectively.

## Stratification of Vulnerability

The prevalence of bullying varies by type, with social and verbal bullying being the most common.

Social bullying on more than two occasions was reported by 7.9% of respondents; 36.5% had experienced it once or twice and 55.6% had never experienced it. The numbers for verbal bullying are 10.4%, 44.5% and 45.1%, respectively.

6.1% of respondents had suffered physical bullying more than three times, 31.4% had faced it once or twice, and 62.5% had never experienced it. The numbers for cyberbullying are 3.6%, 26.2% and 70.2%, respectively.

Students at the highest risk of victimization were those who responded to the survey question about their family's financial situation by choosing 'There is enough money for everyday expenses, but we have difficulty buying clothes'. Such students were more likely to experience social bullying (being excluded from peer interactions, having rumours spread about them, etc.), verbal bullying and cyberbullying.

Boys in this category were much more likely to be both victims and perpetrators of physical bullying, while girls often witnessed social, verbal and cyberbullying. More bullying victims and perpetrators were found in those cities with fewer than 500,000 inhabitants, as well as in cities with a population greater than 1 million.

## Causes and Triggers

The big question that remains, however, is what causes bullying? A recent study reveals that parental behaviour can be a strong factor in determining whether children will be involved in bullying their peers.

Perpetrators often come from families with an authoritarian parenting style associated with a lack of nurturing and neglect of children's needs.

Family relations have been found to influence the likelihood of bullying, especially conflicts, pressure, power hierarchy (between parents and children and between siblings), refusal to discuss issues openly, and others.

## STUDY AUTHORS:

**ARTHUR REAN,**  
Head, HSE IOE Laboratory for Prevention  
of Antisocial Behaviour



**Maria Novikova, Research Fellow, HSE IOE Laboratory for Prevention of Antisocial Behaviour**

Family composition also plays a role. 'Having a sibling, regardless of whether older or younger, significantly increases the chances of involvement in school bullying as a perpetrator or a witness,' according to Rean and Novikova, who also suggest that 'suboptimal parenting strategies' may be the cause. A teenager who competes with siblings for parental attention but feels neglected may 'use bullying behaviour at school to assert him or herself'.

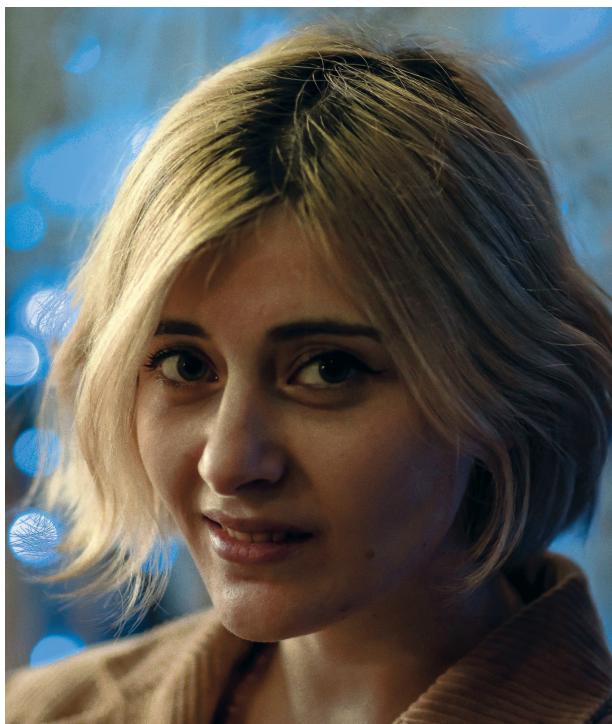
Generally, teenage aggression can have multiple causes and triggers, such as a low level of trust in society (causing youngsters to perceive the world as a hostile environment), pressure from schoolteachers, problems with learning, teenage crises, health problems, and others.

Zero tolerance for bullying in schools can help stop this behaviour. It has been found that school classes where students and teachers find aggressive conduct unacceptable tend to face less bullying and fighting. Countries that have implemented anti-bullying programmes – such as the UK, the US, and Nordic countries – have reported a decrease in teenage aggression. The researchers conclude that Russia also needs comprehensive bullying prevention programmes that should target students, parents, and teachers, as well as school psychologists and administrators.

**MARIA NOVIKOVA,**  
Research Fellow, HSE IOE Laboratory  
for Prevention of Antisocial Behaviour

# Which Textures Bring Happiness, and Which Cause Anger

Touching different types of surfaces can result in certain emotions. This was the conclusion made by psychologists in a recent empirical study. Previously, emotional perception was generally studied in relation to visual and audial modalities.



Marina Iosifyan, Senior Lecturer at the HSE School of Psychology

The researchers looked at how humans react to what they see or hear. This fresh research has helped to create the first ever database of textures, the tangible perception of which is associated with happiness, fear, surprise, disgust, anger, or sadness. The study's results were published in the *Consciousness and Cognition* journal.

To carry out their analysis, Marina Iosifyan and Olga Korolkova invited 108 people ranging in age from 18

to 47. Each participant was blindfolded and asked to touch different unknown surfaces one after another with one hand. After touching each of the textures, respondents were asked to rate their association to each texture with six basic emotions on a scale of 0 to 5.

The psychologists analysed people's basic universal emotions: happiness, fear, disgust, anger, surprise, and sadness.

A total of 21 textures were used in the experiment: brick, granite, glass, glass seashells (texturized), plasticine, leather, rabbit fur, metallic kitchen sponge, rubber, velvet, natural silk, polished wood, a spiky acupressure mat, an unpolished wooden block, tile, glass pebbles (smooth), sandpaper, polished marble, concrete, toy slime and clay.

After the respondents answered the questions, they took a test to check their alexithymia levels. Alexithymia is a trait related to difficulties in identifying, describing and communicating emotions to others. The higher the alexithymia level, the more difficult it is for a person to identify and explain tactile sensations.

The results of the research demonstrated that soft surfaces are generally associated with pleasant emotions, while rough surfaces signify unpleasant feelings. However, this is not always true. For instance, plasticine is soft, but is associated with disgust. And while glass pebbles might be hard, they are actually associated with happiness.

Each of the textures offered to the respondents was usually associated with several emotions. For example, the kitchen sponge was associated with fear, disgust, and anger. Furthermore, almost all of the surfaces were perceived with a feeling of surprise, which the

psychologists attributed to the effect of the blindfolds. Moreover, the sound that appears when a person touches the surface may also impact emotional associations.

The researchers noticed variations in the intensity of the participants' emotions. For example, sadness, if associated with tactile sensations, only scored 2 out of 5.

People with high levels of alexithymia tended to have more intense negative emotions. As compared with other respondents, they were highly sensitive to disgust, anger and sadness.

In terms of application, the findings on emotional associations with certain textures have the potential for use in product design and marketing.



---

**STUDY AUTHORS:**

**MARINA IOSIFYAN,**  
Senior Lecturer at the HSE School  
of Psychology

**OLGA KOROLKOVA,**  
Brunel University London, Moscow State  
University of Psychology and Education

# Graphene Quantum Dots for Single Electron Transistors

HSE scientists help develop new technology for assembling graphene based high-quality single-electron transistors.

Experts from HSE University, Manchester University, the Ulsan National Institute of Science & Technology, and the Korea Institute of Science and Technology have developed a new means of technology, which combines the fabrication of planar and vertical heterostructures for the purpose of assembling graphene-based high-quality single-electron transistors. This innovation could considerably expand the scope of research on two-dimensional materials through its introduction of a broader platform for investigating various devices and physical phenomena. An article on this recent development was published in *Nature Communications*.

In the study, high-quality graphene quantum dots (GQDs), regardless of whether they were ordered or randomly distributed, were successfully synthesized in a matrix of monolayer hexagonal boron nitride (hBN). Here, the growth of GQDs within the layer of hBN was shown to be catalytically supported by platinum (Pt) nanoparticles distributed in-between hBN and supporting oxidized silicon (SiO<sub>2</sub>) wafer, when the whole structure was treated by the heat in methane gas (CH<sub>4</sub>). It was also shown that, due to the same lattice structure (hexagonal) and small lattice mismatch (~1.5%) of graphene and hBN, graphene islands grow in hBN with passivated edge states, thereby giving rise to the formation of defectless quantum dots embedded in the hBN monolayer.

Such planar heterostructures, which may be incorporated by means of standard dry-transfer as mid-layers into the regular structure of vertical tunneling transistors (Si/SiO<sub>2</sub>/hBN/Gr/hBN/GQDs/hBN/Gr/hBN; here Gr refers to monolayer graphene and GQDs refers to the layer of hBN with the embedded graphene quantum dots) were analyzed through tunnel spectroscopy at low temperatures (3He, 250mK). The study therefore demonstrated where the manifestation of well-established phenomena of the Coulomb blockade for each graphene quantum dot as a separate single electron transmission channel may occur.



Davit Ghazaryan, Associate Professor at the HSE Faculty of Physics

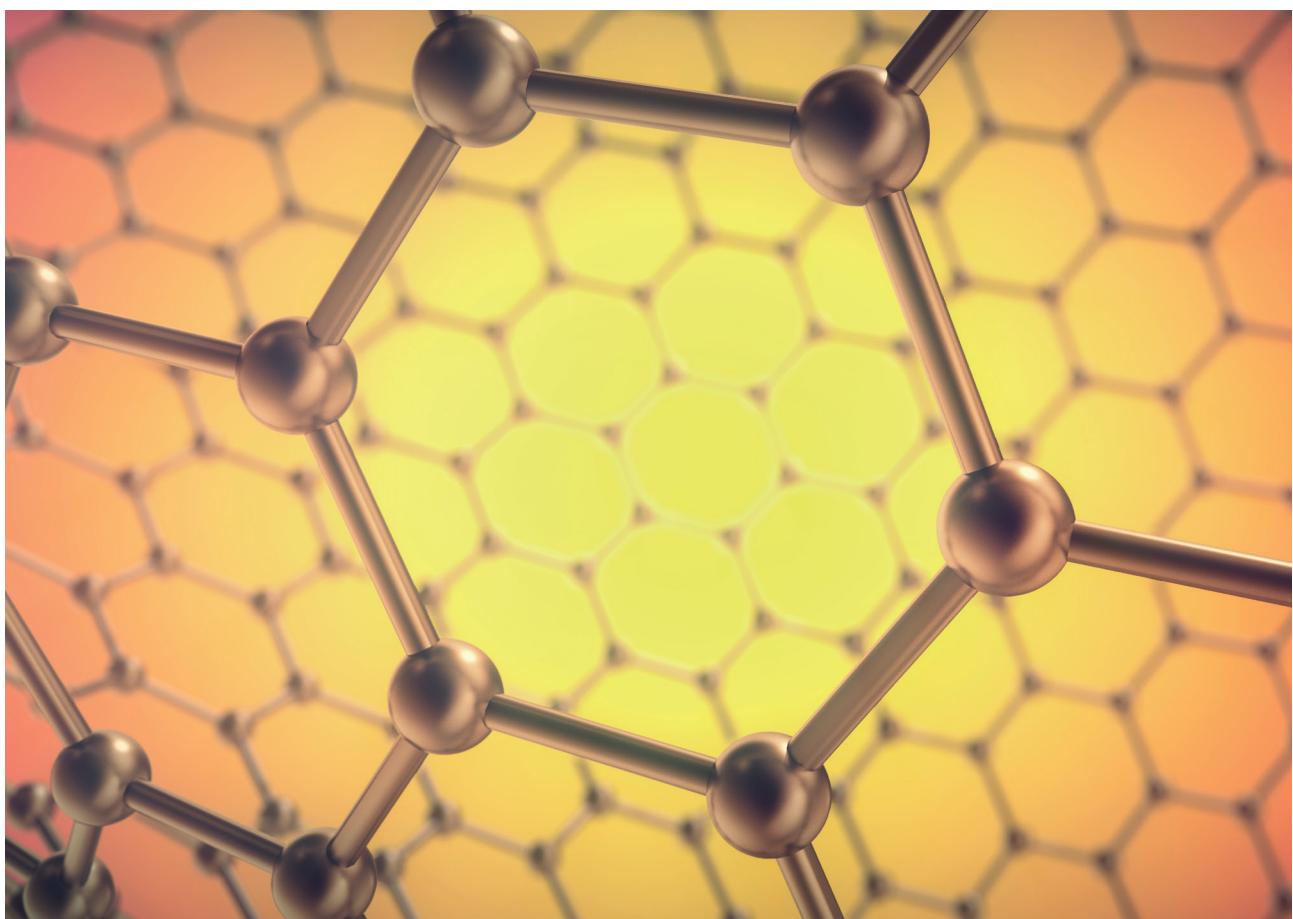
**Davit Ghazaryan,  
Associate Professor at the HSE Faculty  
of Physics.**

He will head the Laboratory of van der Waals Heterostructures.

The Laboratory will study synergistic physical characteristics of various two-dimensional materials (graphene is the most widely known of them), and in particular, their electronic, nanomechanical and optical features.

“

**‘THE OUTSTANDING QUALITY OF OUR SINGLE ELECTRON TRANSISTORS COULD BE USED FOR THE DEVELOPMENT OF FUTURE ELECTRONICS,’ NOTED THE STUDY’S CO-AUTHOR DAVIT GHAZARYAN, ASSOCIATE PROFESSOR AT THE HSE FACULTY OF PHYSICS, AND RESEARCH FELLOW AT THE INSTITUTE OF SOLID STATE PHYSICS (RAS). HE ADDED: ‘THIS WORK IS MOST VALUABLE FROM A TECHNOLOGICAL STANDPOINT, AS IT SUGGESTS A NEW PLATFORM FOR THE INVESTIGATION OF PHYSICAL PROPERTIES OF VARIOUS MATERIALS THROUGH A COMBINATION OF PLANAR AND VAN DER WAALS HETEROSTRUCTURES.’**



**STUDY AUTHOR:**

**DAVIT GHAZARYAN,**  
Associate Professor, HSE Faculty of Physics

## ‘Green’ Taxes

It is believed that carbon dioxide emissions into the atmosphere are mainly regulated by ‘direct’ economic instruments - the carbon tax and the Emissions Trading System (ETS). However, a comparative analysis has shown that ‘indirect’ instruments, such as excise taxes on motor fuel and other energy taxes, have not yielded any lesser impact than their ‘direct’ counterparts, and, over time, have been even more effective. This is the conclusion drawn by HSE researcher Ilya Stepanov in his article, ‘Taxes in the Energy Sector and Their Role in Reducing Greenhouse Gas Emissions.’



Ilya Stepanov, Junior Researcher Fellow of the HSE Centre for Comprehensive European and International Studies

### Context

In 2015, 197 countries signed the Paris Agreement (with the majority already having ratified it), thereby enacting the world community’s pledge to move towards low-carbon development. This transition marks a major change for the energy sector, which is responsible for two thirds of the world’s greenhouse gas emissions. The efficiency of energy production is gradually increasing, and conditions of inter-fuel competition are changing in favour of low-carbon energy sources.

A widely held belief in the scientific literature is that the price of carbon plays a major role in climate policy. It is determined either by an appropriate

tax or through the Emissions Trading System (ETS). Both methods are considered ‘direct’ economic instruments of climate policy, but they appeared relatively recently.

Initially, the use of fossil fuels was regulated exclusively by energy taxes. The first duties on gasoline appeared in Denmark and Sweden in 1917 and 1924, respectively. Since 1957, fiscal policy has extended to other types of hydrocarbons, including petroleum products and coal. The main purpose of energy taxes was to regulate the import of energy resources, as well as to ensure stable revenue for the state budget. Environmental motives began to appear only in the 1980s. European countries are the world’s leaders of ‘green’ taxation. At first, the emphasis in fiscal regulation was made on combating

local air pollution, and later on global climate change. Carbon regulations were first implemented in the 1990s, but they have seen widespread adoption only in the last decade.

The first carbon tax was introduced in Finland in 1991. Today, the tax is collected in 16 European countries. The world's first emissions trading system was launched in 2005. Initially it covered 24 European countries; now it includes 31.

### Indirect vs Direct Instruments

The fundamental difference between energy taxes and a carbon tax or the ETS is that energy taxes only indirectly contribute to reducing greenhouse gas emissions. While the 'direct' rate is calculated per unit of emissions, the 'indirect' rate is set in proportion to the amount of energy used and not the proportion of carbon contained in it.

'Indirect' taxes are applied much more widely than 'direct' taxes, covering more sectors of the economy and sources of emissions. If energy tax rates were to be changed, the impact on reducing greenhouse gas emissions might be greater than that of 'direct' regulatory measures.

In the EU, most of the energy taxation comes from the transport industry. Taxes and excise taxes on motor fuels (diesel, gasoline, kerosene, fuel oil, etc.) form the bulk of tax revenue from the 'indirect' regulation of greenhouse gas emissions.

**The role of taxes on energy products in the EU has a fundamental impact on the development of the industry. 'The share of excise taxes on gasoline and diesel in the final cost of production amounts to more than 30% on average, and for some European countries it is above 50%', the author writes.**

For most European countries, 'indirect' measures generate more tax revenue than direct ones. In Norway, they generate almost 1.5 times more; in Sweden, almost twice more; and in Denmark, more than 5 times more. This is due to the fact that 'direct' regulatory instruments still have

relatively limited coverage. On average, in European countries, the carbon tax covers no more than 25% of carbon dioxide emissions, and the ETS covers only 45%.

### The Study

To understand which fiscal instrument is more effective in reducing greenhouse gas emissions, Ilya Stepanov analysed panel data for 30 European countries from 1995 to 2016.

He first calculated the so-called 'explicit' carbon price for each country. It consists of a carbon tax, the ETS and a collection of other energy charges. He found that the greatest tax burden on carbon dioxide emissions from burning fossil fuels is in Sweden, Finland, Denmark and Malta. In these countries, the 'explicit' carbon price reaches 96 to 117 euros per tonne of CO<sub>2</sub>. The lowest fiscal burden was found in Poland (37 euros per tonne), Bulgaria (27 euros/tonne) and Hungary (4 euros/tonne).

**'Countries with a low fiscal burden on greenhouse gas emissions have GDPs with a high carbon intensity, while countries with a high 'explicit' carbon price have the opposite,' the author observes.**

Stepanov analysed how changes in different components of the 'explicit' carbon price affected carbon dioxide emissions. The results showed that both 'direct' and 'indirect' price signals negatively affect the carbon intensity of a country's GDP. Thus, an increase in 'direct' fiscal instruments by 1% during 1995–2016 led to a reduction in the carbon intensity of a country's GDP by 2.3% on average. For comparison, an increase of 1% in 'indirect' price signals resulted in a 4% reduction in the carbon intensity of GDP.

However, when comparing the results of an analysis of the periods of 1995 to 2016 and 2005 to 2016, the difference in the impact of 'indirect' and 'direct' fiscal instruments becomes less significant. Stepanov associates this with the introduction of the European Emissions Trading System in 2005 and the spread of the carbon tax to a greater number of countries.

### STUDY AUTHOR:

**ILYA STEPANOV,**

**Junior Research Fellow of the HSE Centre for Comprehensive European and International Studies**

# Investment in LEGO Can Yield Returns of up to 600%

Economist from the School of Finance of HSE University Victoria Dobryninskaya analysed secondary market prices of the world-famous toy construction sets released from 1987 to 2014.

Their research showed that the resale of unopened sets on average yielded a return of 11% per year. However, this number varies depending on the size of the construction set and its series, and it may range from (-50) to up to 600%.

The most profitable sets were those consisting of up to 350 pieces. Their average profit margin exceeded 22%. The next most profitable sets were those consisting of 1,200-6,000 pieces; they yielded a return of up to 12% on average. The least profitable were mid-sized LEGO sets, which yielded a return of around 6.8-10%.

In terms of the product's various series, the most profitable was LEGO Ideas, which were released from 2010 to 2014. Owners who resold their LEGO Ideas sets made an average return of up to 64%. Coming in second was LEGO Seasonal (2006-2014); its average resale profit was 58% per year. Rounding out the top three was LEGO Super Heroes (2011-2014), which yielded an average resale profit of 51%. Meanwhile, investment in The Simpsons series (2014) turned out to be unprofitable, with collectors losing more than 3.5% annually on resale.

The top five most profitable LEGO construction sets included Darth Revan from the Star Wars series (yielding an average annual return of 613%), the Elves' Workshop from the Seasonal series (with a profit margin of 590%), Seal's Little Rock from the Friends series (527%), TC-4 from the Star Wars series (502%), and Ice Skating (Seasonal; 425%). These were all released in 2014.

The researchers also evaluated the risks of similar investments and concluded that economic fluctuations and market volatility did not have a strong effect on the profitability of LEGO sets. Moreover, in comparison with other collectibles assets, such as pieces of art, precious stones and metals, and rare coins, investment in LEGO yields greater returns.



Victoria Dobryninskaya, Assistant Professor of the HSE School of Finance at the Faculty of Economic Sciences

## About the School of Finance

The HSE School of Finance is the leading Russian competence centre in the field of corporate finance, business valuation, banking, stock market, risk management and insurance, accounting, and audit.

Our university is the only one in Russia in QS - World University Rankings by Subject in the subject area of Accounting and Finance. Moreover, the university is the 1st in Russia in THE World University Rankings by Subject in the subject area of Business & Economics.

The School of Finance brings together specialists with unique intellectual capital who conduct research in finance in the Russian environment and make comparative studies of foreign financial practices. Furthermore, there are teachers, researchers and practitioners who develop and implement world-class academic and applied degree programmes.



STUDY AUTHOR:

**VICTORIA DOBRYNSKAYA,**

Assistant Professor of the HSE School of Finance at the Faculty of Economic Sciences

# Personality at Work

The way one thinks, feels and acts in certain circumstances can determine career opportunities in terms of employment and pay. For the first time in Russia, Ksenia Rozhkova has examined the effect of personality characteristics on employment.

## Not Just Intelligence

Traditionally, a person's cognitive (intellectual) abilities are believed to determine productivity, career advancement and pay. However, differences in productivity or income cannot be attributed solely to varied levels of intellectual ability.

Other factors include non-cognitive psychological characteristics, which can be assessed using the 'Big Five' personality test (also called *FFM, or the five-factor model*), namely:

**conscientiousness** – refers to characteristics such as perseverance, meticulousness, diligence, commitment and striving for order;

**extraversion** – refers to directing one's energy and interest towards the outside world rather than one's subjective experience (sociability, enthusiasm, emotional warmth, propensity for adventure, and activity);

**neuroticism** – refers to emotional (in)stability (anxiety, impulsivity, insecurity, irritability, vulnerability to stress, and hostility);

**openness** – refers to creativity, curiosity and good imagination;

**agreeableness** – refers to being friendly and willing to compromise (being accommodating, cooperative, altruistic, trusting and modest).

Rozhkova's study, 'Returns on Non-cognitive Characteristics in the Russian Labour Market,' is based on data from the 2016 RLMS-HSE, including detailed information on the sociodemographic indicators, skills, income and workplaces (industry, occupation, type of company) of 5,300 men and women aged 20 to 60, as well as their responses to 24 questions about their psychological traits. Her main finding is that such returns are real and personality traits are indeed associated with career advancement and can account for differences in pay in various sociodemographic and professional groups.

## Premiums and Penalties

Openness and conscientiousness are consistently associated with earnings: someone who is disciplined, ambitious, creative, inquisitive and hardworking, and who has a good imagination and strives for achievement is more likely to see their pay increase.

In contrast, neuroticism has an inverse relationship with their expected amount of pay: people who are emotionally unstable, vulnerable to stress, insecure and who overthink the consequences of their actions are at a disadvantage in the workplace.

Taken together, the 'Big Five' personality traits account for a difference in pay of approximately 5%, which is comparable to the effect of having received a higher education.

Conscientiousness is particularly important during the employment-seeking phase. By integrating characteristics that are essential for job performance, it serves as a gateway to employment and increases the chances of being hired by an average of 6%.

## Gender Effects

Factors such as gender, age, occupation and type of employment can have an effect on whether and how non-cognitive skills contribute to a person's employment opportunities and expected pay.

For example, openness, conscientiousness and neuroticism are significant for both men and women, but women also face penalties for agreeableness (cooperation, compromise, modesty and trust), which tends to lower their expected pay by approximately 2%.

Women with such characteristics often agree to stay longer hours and do work for others and generally attach too much importance to teamwork as opposed to their own career advancement. According to Rozhkova, women tend to be less assertive in salary negotiations: they either avoid raising the issue or underestimate the required pay level.

On average, according to RLMS-HSE, women rank relatively high in each category of the 'Big Five'. Compared to men, they tend to be more open, conscientious, sociable, friendly and neurotic.

### Make Way for Extraverts

After controlling for workplace characteristics (industry, professional category, company size and ownership), being extraverted – open to the world and to other people – is a particularly important characteristic for 30 to 39-year-olds. One can assume that at this age, their careers have already reached a stage where they manage other people and therefore 'require sociability and well-developed leadership and negotiation skills.'

Extraversion associated with advanced communication skills is valued in executive positions and in workplaces that involve contact with customers (sales and service). Executives, office workers and frontline employees tend to be the most outgoing, while unskilled workers across industrial sectors rarely, if ever, describe themselves as sociable.

### Neurotics Not Welcome

Openness has a positive effect on the salaries of highly qualified specialists (almost a 7% premium) and is also important for pre-retirement age employees, serving as a reflection of their ability to adapt to new economic realities and explore new technology.

Higher qualification levels are associated with more openness and conscientiousness and lower neuroticism. The highest degrees of neuroticism are observed in unskilled workers, while senior managers and highly qualified specialists whose jobs involve advanced responsibilities and require emotional stability and resilience tend to be the least neurotic of all.

### Across Borders

These Russian research findings are consistent with those of similar studies in developed countries. As in Russia, a relationship between openness and



**Ksenia Rozhkova, Research Assistant of the HSE Laboratory for Labour Market Studies**

pay dynamics has been reported in Germany and the US, agreeableness comes with a penalty in Germany, the US and the Netherlands, and the effect of neuroticism on pay is negative across cultures.

Cultural and geographic proximity contributes to similar findings between countries.

'Shared perceptions, symbols and meanings that form a "national character" have a bearing on people's economic behaviour. The average ratings of the Big Five personality traits differ between countries. However, Western cultures share certain characteristics among them but not with Asian or African countries,' Rozhkova notes.

Individualist cultures, such as the US, impose a penalty for agreeableness, while collectivist cultures, such as Japan, reward it. Societies with predominantly male values (Japan, Austria) emphasize career and pay advancement, while countries where female values are strong (Sweden) give priority to teamwork and social guarantees of employment.

Geography also matters in that economic cooperation between neighbouring countries 'may lead to a common market and, consequently, to similar market responses to certain non-cognitive traits of employees.' The expansion of transnational companies and higher labour mobility due to globalization can further contribute to these trends.

### STUDY AUTHOR:

---

**KSENIA ROZHKOVA,**  
**Research Assistant of the HSE Laboratory for Labour Market Studies (LLMS)**

# HSE Scholars Propose New Method to Measure Individual Well-being

Researchers at HSE University have applied an emotion recognition method to measure the subjective well-being of individuals.



Petr Parshakov, Deputy Head at the HSE International Laboratory of Intangible-driven Economy

Their initial tests were carried out to measure the emotional state of football fans. It turned out that uncertainty about a match result can increase the probability of unhappiness by 13.6% on average. The results of this study were published in the *Journal of Happiness Studies*.

The scholars took a sample of 10,000 photos, which were published on the official VK accounts of football clubs over the 2014/15–2017/18 seasons. More specifically, accounts that received significant attention on social media were chosen: Spartak, CSKA, Dynamo, Rubin, and Zenit. The authors employed emotion recognition software to analyse fans' photos of stadiums and compared them with team stats.

On average, uncertainty about match results negatively impacted fan happiness, increasing the probability of them feeling unhappy by 13.6%. This factor tended to impact males less than females. Furthermore, uncertainty even increases the probability of men being extremely happy, which was not found to be the case with women.

Some of the results were predictable, such as a win reducing the probability of fans being unhappy, and this effect becomes stronger for the later rounds of national championships. However, it turned out that a change in happiness following a home team win is stronger for males even though they may be less inclined to express their emotions openly. The study

also showed that men may be happy even if their team loses. Finally, it is interesting to note that Spartak fans tend to express happiness 25% more often than Dynamo fans.

'Football is part of the entertainment industry. Therefore, it's very important to understand what generates positive emotions among fans,' notes Iuliia Naidenova, Junior Research Fellow at the HSE International Laboratory of Intangible-driven Economy. 'Emotional analysis based on photos means that we can objectively detect fan preferences, while also determining what kind of performance they want to watch. We also believe that monitoring fans' emotions has the potential to serve as a basis for new analytics in football.'

The method used at HSE University to measure subjective well-being may be useful for different types of happiness studies, since emotional recognition is more reliable and less costly. It could also be used for self-assessment surveys. As for sports professionals, this approach may help them recognize violent fans in real time, which can help prevent fights and other incidents.



Iuliia Naidenova, Junior Research Fellow at the HSE International Laboratory of Intangible-driven Economy

## STUDY AUTHORS:

---

**IULIIA NAIDENOVA,**  
Junior Research Fellow at the HSE International Laboratory of Intangible-driven Economy, HSE Campus in Perm

**PETR PARSHAKOV,**  
Deputy Head of the HSE International Laboratory of Intangible-driven Economy, HSE Campus in Perm

**SOFIIA PAKLINA,**  
Research Assistant at the HSE International Laboratory of Intangible-driven Economy, HSE Campus in Perm

# DNA Secondary Structures Lead to Gene Mutations that Increase the Risk of Cancer

Researchers have used machine learning to discover that the two most widespread DNA structures — stem-loops and quadruplexes — cause genome mutations that lead to cancer. The results of the study were published in *BMC Cancer*.



Maria Poptsova, Head of the HSE Laboratory of Bioinformatics

In the early 2000s, researchers invented a new method to obtain the nucleotide sequence of DNA and RNA — Next-Generation Sequencing, NGS. This technology allows several million genome regions to be read simultaneously, which had been impossible with earlier sequencing methods. Now, the human genome (genetic information) can be recorded in a text file weighing about 3.2 Gb.

‘Cancer is a genome disease,’ explains Maria Poptsova, Head of the HSE Laboratory of Bioinformatics and one of the study’s authors. ‘When we sequence the genome in a tumour tissue, we see a spectrum of different mutations. There may be point or large-scale mutations. For example, in point mutations, one nucleotide disappears and is replaced by another. We looked at large-scale mutations where parts of the

genome (from several to millions of nucleotides) were deleted, reversed, copied, and inserted in a different place. As a result of these rearrangements, genome breakpoints appear.

HSE University researchers investigated the influence of two types of DNA secondary structures — stem-loops and quadruplexes — on genome breakpoints with the use of machine learning. In analysing half a million breakpoints in over 2,000 genomes of ten types of cancer, the researchers looked for genomic hotspots, considering breakpoint hotspots to be the regions with frequent and recurrent rearrangements — in other words, risk zones. It appears that the stem-loop-based model best explains blood, brain, liver, and prostate cancer breakpoint hotspot profiles, while the quadruplex-based model has higher performance for bone, breast, ovary, pancreatic, and skin cancer.

The appearance of breakpoints cannot be explained exclusively by the impact of DNA secondary structures, but their contribution is at least 20-30%. The analysis demonstrates that the impact of stem-loops and quadruplexes on breakpoint evolution depends on the type of tissue, which is determined by epigenetic factors.

'These are the kind of markers that distinguish different kinds of tissues over the genome,' said Maria Poptsova. 'We are actively studying the correlation between secondary DNA structures and epigenetic marks. English researchers have already looked at the impact of DNA secondary structures and epigenetic marks on point mutations. We focused on breakpoint hotspots and are the first to determine the contribution of the two most widespread genome structures — stem-loops and quadruplexes.'

According to the study's authors, quadruplexes may be used as therapeutic targets in the future. If drug therapy makes them more stable, the telomerase enzyme won't be able to work in cancer cells, and they will become vulnerable.

### Laboratory of Bioinformatics

The Laboratory of Bioinformatics was created in 2018 to develop the field of bioinformatics at the Faculty of Computer Science. Due to the revolution in high-throughput technologies, bioinformatics became Big Data Science in Genomics. The laboratory is engaged in fundamental research in the area of DNA secondary structures and their role in genome functioning, chromatin organization and DNA-protein interactions. The laboratory works on deciphering "the code of DNA secondary structures", which together with the code of primary genome annotation by sequence elements (genes, exons, introns, regulatory motifs, and others) and the epigenetic code constitutes another genome annotation layer.

Also the laboratory works in the area of research of the spatial chromatin structure - how it changes in different experimental conditions and how it is connected with the epigenetic code and the code of DNA secondary structures. In particular, there are tasks of comparing different methods to determine topologically associated domains (TADs), and application of deep learning methods to find the characteristic genomic functional elements at the TAD boundaries.

Another area of research is devoted to determining physical and chemical properties of DNA structures that participate in protein interactions. We develop the NPIDB database — an open resource to study DNA-protein interactions, which provide a big collection of DNA-protein complexes. The resource extracts and analyzes information from the other well-known bioinformatics databases such as PDB, SCOP and Pfam. There is an ongoing research on classification of DNA-protein complexes and solving the problem of ascribing novel structures to the existing structural families.

### STUDY AUTHOR:

**MARIA POPTSOVA,**  
Head of the HSE Laboratory of Bioinformatics

# HSE University today:



National Research University Higher School of Economics (HSE University) is the largest centre of socio-economic studies and one of the top-ranked higher education institutions in Eastern Europe. The University efficiently carries out fundamental and applied research projects in such fields as management, sociology, political science, philosophy, international relations, mathematics, Eastern studies, and journalism, which all come together on grounds of basic principles of modern economics.

HSE professors and researchers contribute to the elaboration of social and economic reforms in Russia as experts. The University transmits up-to-date economic knowledge to the government, business community and civil society through system analysis and complex interdisciplinary research.

Higher education studies are one of the University's key priorities. This field consolidates intellectual efforts of several research groups, whose work fully complies with the highest world standards. Experts in economics, sociology, psychology, and management from Russia and other countries work together on comparative projects. The main research spheres include analysis of global and Russian higher education system development, transformation of the academic profession, effective contract in higher education, developing educational standards and HEI evaluation models, etc.

# HSE University issue 14 2019 Review

## HSE UNIVERSITY TODAY

3,700 teachers, 40,000+ students, and 72,000+ alumni.

Basic and applied research – from history to space engineering.

Agreements on cooperation, exchange programmes, and double degrees with leading universities around the world.

More than 100 research institutes and centres and around 40 international laboratories headed by leading foreign scholars.

## EXPERT ACTIVITY

HSE University is the **leading centre** of expert analysis for the **Russian government** and the **President of Russia**.

It takes part in drafting laws, as well as federal and regional **programmes and strategies**.

HSE provides analytical support to the Russian government. Twenty-three representatives of the university belong to the Government Expert Council, which gives HSE the largest representation among other organizations providing such support.

Our experts have prepared a **long-term foresight of scientific and technological development of Russia until 2030**, which has been approved by the government as the core document for further elaboration of strategic development plans.

## HSE IN GLOBAL ACADEMIA

200+ foreign teachers from 25 countries.

HSE University is involved in several international projects in scientific and technical cooperation (IncoNet EECA, ERA.Net RUS, BILAT-RUS, INCONTACT) and is a partner of organizations such as the OECD, G20, BRICS, UNESCO, and UNIDO.

**Nobel Laureate Eric Maskin** heads the International Advisory Committee, which consists of eight leading foreign experts in economics and education and which oversees the implementation of HSE's development strategy.

The annual **International Academic Conference** on Economic and Social Development is attended by the world's leading scholars, public figures from Russia and other countries, heads of the world's largest companies, and representatives of international organizations. At the 20th conference in 2019, **more than 1,500 people attended in 239 subject-related sessions**.





NATIONAL RESEARCH  
UNIVERSITY