2020

# Open science as a framework for psychological research

Smederevac Snežana

University of Niš, Faculty of Philosophy, Department of Psychology

International Conference

DAYS OF APPLIED PSYCHOLOGY

# 15th DAYS OF APPLIED PSYCHOLOGY
# - PSYCHOLOGICAL RESEARCH AND PRACTICE -

Niš, Serbia, September, 27th & 28th 2019

## International Thematic Proceedia

УНИВЕРЗИТЕТ У НИШУ
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Дани Примењене Психологије
Days of Applied Psychology

PSYCHOLOGICAL RESEARCH AND PRACTICE

International Thematic Proceedia

https://doi.org/10.46630/dpp.2020

**International Thematic Proceedia**

**15th Days of Applied Psychology**

# PSYCHOLOGICAL RESEARCH AND PRACTICE

Niš, Serbia, September 27th & 28th 2019

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**Nikola Ćirović**, Research Assistant, Center for Psychological Research, Faculty of Philosophy, University of Niš, Serbia

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# Plenary lecture

**Snežana Smederevac**
*University of Novi Sad,*
*Faculty of Philosophy, Serbia*

UDC 159.923.2:001.9
Research paper

# OPEN SCIENCE AS A FRAMEWORK FOR PSYCHOLOGICAL RESEARCH[1]

**Abstract**

One of the basic principles of modern science is taking responsibility for the dissemination of scientific results. Open science has become the most important goal in contemporary scientific community, whose achievements would contribute to the visibility of scientific results, significant social and economic benefits, as well as to supporting the development of new research. In this study, some of the basic principles of open science, such as citizen science, open data and open access, were applied. The main objective of this behavioral genetics cross-cultural study was to examine the contribution of genetic and environmental factors to the Five Factors Model (FFM) dimensions across three cultures – Croatian, German and Serbian. Contributing to the development of citizen science, 1006 monozygotic and 710 dizygotic pairs of twins from Croatia, Germany and Serbia participated in the research. Results of quantitative behavioral genetic modelling, based on previously collected open data, showed that the relative contributions of genetic and environmental factors to the variance of all FFM dimensions have almost identical patterns in the German, Croatian and Serbian samples. The dataset from this study was deposited in the Open Science Framework (OSF) platform. The published results have been deposited in the institutional repository in accordance with the green open access policy. General goal of open science is to create a network of knowledge and information that will make scientific achievements transparent, visible and reusable.

**Key words:** open science, behavioral genetics, personality traits, cross-cultural study

## Introduction

### Basic principles of open science

The traditional approach to scientific research has faced a number of challenges in recent decades, stemming primarily from the requirement that the scientific process be adequately valued and more transparent. Open science provides an opportunity to redefine social roles and responsibilities of publicly funded research and to rethink the entire scientific system (Miedema, Mayer, Holmberg, & Leonelli,

[1] Corresponding author: snezana.smederevac@uns.ac.rs

2018). Whereas the traditional research design has implied defining research goals, data collection, data analysis and publishing (Breakwell, Smith, & Wright, 2012), open science introduces new academic skills, related to open access, open data, pre-registration research, replication research, open reviews, citizen science and many other topics. Although provoked primarily by the business model of large publishers, which generate huge profits from the publication of scientific results (Larivière, Haustein, & Mongeon, 2015), the open science movement is slowly changing the classical paradigm of access to research and arts.

The introduction of purely quantitative indicators in the evaluation of scientific performance has contributed to a huge increase in the number of scientific papers and scientific journals. There are over 2000 scientific publishers worldwide, between 25,000 and 40,000 scientific journals, while 2.5 million articles are published annually (Ware & Mabe, 2015). Elsevier, Springer and Wiley cover 42% of scientific publications. Those big publishers make a large profit due to the fact that they receive both scientific results, funded by national or international resources, and reviews from other researchers, for free. Moreover, researchers have to pay for access to the same published results. In 2012, the "Cost of Knowledge" (The Cost of Knowledge, 2012) campaign started to protest against Elsevier's business model, provoking a boycott of its journals, review processes and subscriptions. The boycott named the beginning of an "Academic Spring". Until now, several university libraries simply cancelled all Elsevier subscriptions, while universities created repositories to deposit the results of scientific work.

Accelerated publication of scientific papers has also contributed to more frequent poor research practices. Plagiarism is probably the oldest example of bad science, but bad research practices include HARKing (defining goals and hypotheses only after looking at research results) (Kerr, 1998) or salami publishing (publishing a large number of papers from only one study) (Wawer, 2018). Many other challenges have also contributed to the demand for a change in the traditional science approach. According to Nature, 70% of scientific results cannot be replicated, while more than 50% of researchers fail to replicate the results of their own studies (Baker, 2016). The replication crisis in science has raised a number of issues that are related to a general lack of trust in science and scientific results. Journals have begun to promote new publishing policies rapidly and changed their initial view on wanting to publish only original scientific papers into the view that all types of replication studies are welcome (Ball, 2018). Psychologists have a major role in pointing to the replication crisis (Nosek, Cohoon, Kidwell, & Spies, 2016).

Although citation is considered to be a basic indicator of the scientific impact (Bornmann & Daniel, 2008), results of previous studies have shown that a large number of scientific papers have never been cited (Hamilton, 1991). The citation trend in all sciences has been increasing in recent years, as a result of a number of journals, more intensive international scientific cooperation and generally more intensive scientific activity, whereas the number of non-cited papers in social sciences and humanities is still very high (Larivière, Gingras, & Archambault, 2009). Much evidence suggests that increasing the visibility of scientific results contributes to more citations (Lawrence, 2001).

In the traditional approach to scientific research, many activities, such as collecting data, peer reviewing, methodological aspects, are also invisible. Open science contributes to a gradual change in approach to scientific work, by increasing transparency and adequate evaluation of all aspects of empirical research. Open access, as one aspect of open science, enables researchers to make their results freely available online to anyone interested in reading them. Open data refers to the process of depositing collected empirical data in institutional or thematic repositories, in accordance with good academic practice, copyright and data protection, and the basic open data principles (Wilkinson et al., 2016), whose acronym is FAIR (Findable, Accessible, Interoperable, Reusable). Deposited data obtained DOI and can be cited as any scientific work. Research data has the same value as research results, and the introduction of data citation practices is very important for scientists. Detailed instructions for depositing datasets in thematic repositories and creating a data management plan can be found in the Open Science: Practice and Perspectives manual (Smederevac et al., 2020b). For example, in psychological research, anonymization and protection of the identity of the participants are extremely important. Coding personal data into numeric values or allowing access to dataset only for researchers who previously signed a confidentiality agreement are safe ways to maintain high ethical standards in research.

Open methodology refers to preregistration of research, using Open software, such as The R Project for Statistical Computing (R Core Team, 2013), Open items, such as International personality item pool (IPIP; International Personality Item Pool, 1999), and Open research, such as the SAPA project (Revelle, 2015). Open peer reviews facilitate scientific communication, through open communication during the evaluation of scientific works.

As a consequence of the changing scientific environment, requests for improving the quantitative criteria applied in the evaluation of scientific work are becoming more common. Some of the basic recommendations of the Leiden Manifesto (Hicks, Wouters, Waltman, de Rijcke, & Rafols, 2015) relate to the strategy of introducing quantitative criteria in addition to qualitative and taking into account differences between scientific fields in the publication and citations practice. For example, top-ranked journals in mathematics have an impact factor of about 5, and in microbiology of about 30. Therefore, normalized indicators for a specific area, not groups of fields, are needed to evaluate scientific impact (Waltman, 2016). Alternative quantitative indicators of scientific impact can be divided into three categories: access and download (e.g., number of views or full text downloads), mentions (e.g., on Twitter, Wikipedia articles or blogs) and application (e.g., application of presented theories and models in new research) (Haustein, Bowman, & Costas, 2016).

Repositories of scientific results play an important role in open science. In addition to institutional ones that serve to deposit publications, there are thematic repositories, which also allow the deposit of data. Different scientific disciplines have their own repositories, the most famous being CERN's Zenodo, Open Science Framework (OSF), Figshare or Mendeley repositories. Leading journals, during article submission, require researchers to answer questions about whether the work is pre-registered, whether it is the result of a replication study, and in which repository the data will be deposited. All these processes require new academic skills, which must become an integral part of the curriculum of scientific research methodology.

As a result of the BEOPEN project (BEOPEN, 2016), in which the Ministry of Education, Science and Technological Development of the Republic of Serbia and all state universities in Serbia have participated, the aforementioned Ministry adopted the view that openness to solving social problems is the backbone of basic missions of universities and scientific institutions, and in 2018 continued to adopt the National Open Science Platform. The platform stipulates that all researchers must deposit the results of scientific research work in institutional repositories, supporting so called green open access, which implies the use of institutional repositories for deposit of research results. Also, the Platform recommends that researchers deposit their datasets in open repositories. In 2019, all state universities have adopted open science policies and are developing institutional repositories to deposit research outputs. In other words, researchers have the legal support and technical infrastructure to apply the principles of open science. National Open Science Portal (NAPON, 2017) contains relevant information on the existing legal framework, licenses, repositories, data treatment plan and other topics relevant to open science.

## Open science in behavioral genetic research – Serbian twin registry

Behavioral genetics is a scientific field that studies the contribution of genetics and environmental influences to behavior. In quantitative behavioral genetic models, phenotypic variance is decomposed into a genetic and environmental component. Gene variance of the phenotype can be explained by additive – A and non-additive – D effects, while environmental variance can be explained by shared environmental variance – C and nonshared environmental variance and measurement error – E. Additive genetic influence (A) describes the effect of multiple genes on behavior, while non-additive genetic factors (D) describe the interactive effects of different alleles and include genetic dominance, such as within locus interaction and epistasis. Shared environmental impacts refer to the family and contextual experiences common to all family members, while the non-shared environment includes the environmental factors unique to each twin, as well as the measurement error. Correlation between traits of monozygotic twins is 1, since they share 100% of same genes, while for dizygotic twins is .50, since they share 50% of the same genes. Monozygotic and dizygotic twins share 100% of the common environmental impact, while nonshared environmental factors, according to core quantitative behavioural genetic model assumptions, do not correlate (Neale & Maes, 2004). These assumptions represent the base for quantitative behavioural genetic models, which provide evidence for different patterns of genetic and environmental influences on the observed phenotypic variance.

Behavioral genetics is a fairly young scientific discipline in Serbia that has been developing for less than a decade. The Serbian Twin Registry (STR) was created in 2011 as a part of the research project *Psychological Foundations of Mental Health: Hereditary and Environmental Factors,* granted by the Ministry of Education, Science, and Technological Development of the Republic of Serbia. The members of the interdisciplinary team participating in the study are from the Department of Psychology of the Faculty of Philosophy and from the Faculty of Medicine, at the University of Novi Sad. This team founded the Center for Behavioral Genetics in 2014. Although there are 1658 twins and their relatives in the Serbian Twin Registry, only 564 twins have passed the full examination so far. The basic goal is to create a database for further research in psychology, medicine and biology. The entire procedure for testing and collecting data is described elsewhere (Smederevac et al., 2019). An examination usually takes several hours and includes an assessment of cognitive abilities, executive functions, personality traits, family environment, medical examination, an interview about life events and specific habits, DNA sampling etc. Buccal swab is the basis for DNA analysis, conducting at John Jay College of Criminal Justice in New York and Faculty of Medicine in Novi Sad. These analyses include estimation of zygosity, molecular genetics and epigenetic data.

The research team of this project is dedicated to replicating previous findings in behavioral genetics and respecting the basic principles of open science – open access, open data, open methodology, citizen science etc. All articles published in Open Access (Čolović, Branovački, & Zgonjanin Bosić, 2018; Dinić, Nikolašević, Oljača, & Bugarski Ignjatović, 2018; Jovanov & Zgonjanin Bosić, 2018; Milovanović, Sadiković, & Kodžopeljić, 2018; Milutinović et al., 2019; Sadiković, Smederevac, Mitrović, & Milovanović, 2018), or their preprint versions are deposited at the institutional repository (Smederevac et al., 2019). Datasets from publishing studies can be found at the Open science Framework (OSF): https://osf.io/j4vqx/ or https://osf.io/5shdy/ and Mendeley https://data.mendeley.com/datasets/bbxb7yxkzj/2. Center for Behavioral Genetics is set to open access all questionnaires created by the research team (http://www.cbg.ff.uns.ac.rs/upitnici.php).

In order to popularize the Serbian Twin Registry, raise awareness about the importance of twin studies, and engage community members in research, all activities are continuously being promoted through various public campaigns, events, lectures, and TV appearances. One of the key events of this kind is the National Twins Day, organized annually by the Center of Behavioral Genetics at the University of Novi Sad which takes place in the first week of June. The event includes different activities, such as presenting research results, organizing workshops for parents and children, art performances, prize games, as well as recruiting new participants. Twin participants in research receive the results of their personality profiles, cognitive abilities, general health and zygosity. Besides the twins and their families, National Twins Day gathers the members of the academic and public community.

### Open science and cross-cultural behavioral genetic study of personality traits

Application of the same methodological principles in data collection enables the implementation of cross-cultural studies. One of them was a study based on the Five-Factor Model (FMM) which examined cultural differences in genetic and environmental influences across German, Croatian and Serbian cultures (Smederevac et al., 2020a). An additional aim was to examine whether there are cross-cultural specificities in the hierarchical personality structure by examining possible genetic and environmental influences at different hierarchical levels of FFM personality trait.

## Method

**Participants**

1021 monozygotic (MZ) and 722 dizygotic (DZ) pairs of twins participated in the study, all were general-population volunteers from Croatia, Germany and Serbia. Table 1 provides detailed data about the sample. The dataset and data instructions for this article are available online at OSF platform: https://osf.io/5shdy/.

Table 1
*Twin sample characteristics*

| | zygosity | pairs | gender: male | gender: female | gender: different gender | age: mean | age: SD |
|---|---|---|---|---|---|---|---|
| Germany | MZ | 737 | 322 (21.8%) | 1153 (77.7%) | | 31.694 | 13.138 |
| | DZ | 396 | 242 (30.55%) | 548 (69.45%) | 113 | 31.598 | 11.766 |
| Croatia | MZ | 105 | 76 (36.2%) | 134 (63.8%) | | 18.44 | 2.24 |
| | DZ | 234 | 218 (46.6%) | 250 (53.4%) | 114 | 18.58 | 2.308 |
| Serbia | MZ | 179 | 84 (23.46%) | 274 (76.54%) | | 24.997 | 7.904 |
| | DZ | 92 | 73(39.66%) | 111 (60.34%) | 36 | 22.804 | 5.845 |

(Smederevac et al. 2020a)

**Instruments**

*NEO Five-Factor Inventory* has been used in the study (NEO-FFI: Costa & McCrae, 1992; Croatian version: Marušić, Bratko, & Eterović, 1996; German version: Borkenau, & Ostendorf, 1993; Serbian version: Costa & McCrae, 1992; Sinapsa adaptation, 2019), a short version of NEO Personality Inventory, comprising of 60 items. NEO-FFI consists of five scales: Neuroticism (N), Extraversion (E), Openness (O), Agreeableness (A) and Conscientiousness (C).

**Data analysis**

In the first step, quantitative behavioral genetic models of hierarchically organized phenotypic trait factors were considered: five traits at a lowest level of the trait hierarchy representing NEO-FF domains (N, E, O, A and C); Big Two (DeYoung, 2006) factors: Stability (loading N, A and C) and Plasticity (loading E and O) at the next level; and GFP (Musek, 2017) at the highest level of the trait hierarchy (Big Two + GFP). The reduced model is nested in the full model, allowing both the two-factor (Big Two) and GFP direct paths to the Big Five solution.

In the next step, common factor(s) – common pathways multivariate models (Rijsdijk & Sham, 2002) were applied in order to estimate additive genetic effects (A), non-additive genetic effects (D), shared environmental (C), and non-shared environmental (E) effects. In all models there were specific (s) and common (c) genetic and environmental sources of variance (see Figure 1). Nested models were compared by using the $\chi^2$-difference test; the Akaike Information Criterion (AIC); Comparative Fit Index and the Tucker-Lewis Index (CFI and TLI – optimal values higher than .95, acceptable higher than .90); the Root Mean square Error of Approximation (RMSEA – optimal values lower than .05, acceptable lower than .08); the Standardized Root Mean Square Residual (SRMR, with acceptable value below .08) and Bayesian information criterion (BIC) with a lower value indicating a better fit (Smederevac et al. 2020a).

## Results

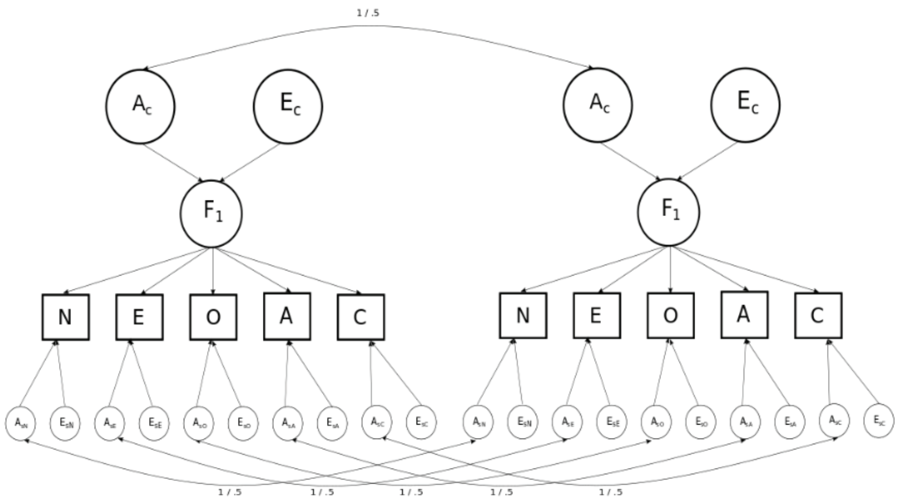


*Figure 1.* ACE common factor common pathway model.

*Note.* Common pathways model for one pair of twins; Ac, Ec – common genetic/environmental factors; As, Es – specific genetic/environmental factors; F1 – latent factor; N – Neuroticism, E – Extraversion, O – Openness to experience, A – Agreeableness, C – Conscientiousness; genetic correlations among MZ twins – 1; genetic correlations among DZ twins – .50 (Smederevac et al., 2020)

The best fitting biometric models for all three samples were common factor – common pathways AE models, indicating that a single-latent genetic and environmental factor solution best explains the sources of variance in personality traits. This result suggests that genetic and environmental covariance across the FFM could be explained by a single underlying latent factor. However, this factor does not include all dimensions of the FFM model, and thus provides important information about common and specific sources of variance in personality traits.

## Discussion

The high common genetic and environmental effects for Neuroticism in all three cultures, with lower specific effects, indicate that emotional tension is an important aspect of many different behaviors. On the other hand, the lowest common genetic and environmental effects for Openness in all three cultures indicate its greater dependence on specific genetic and environmental contributions.

High similarities among genetic and environmental correlation patterns in three cultures illustrate a limited effect of culture on the genetic and environmental interrelatedness of personality traits. Namely, results suggest that there are no cross-cultural differences in the genetic basis of personality traits, although, at the most specific level, subtle differences between cultures may contribute to how synergy of personality traits will respond to the specificities of a particular culture. This result may be due to subtle differences between cultures, which may contribute to specific emotional and cognitive responses to different environments. Different cultures shape specific lifestyles, family rules and everyday routines that affect the attitude towards education and upbringing, interpersonal relationships and the structuring of leisure time. However, they can be influenced by highly specific factors, such as subtle differences in item translation, measurement error, differences in testing conditions etc.

This study illustrates the importance of open science practice in scientific research. Cross-cultural studies provide important insights into the behavioral genetic basis of behavior in different environments. Such types of comparisons are only possible if data from previous research is open and accessible. Therefore, our data is deposited in the OSF, allowing other researchers to use them in the future. Moreover, citizen science practice is an attempt to extend the process of scientific knowledge to the community. At the beginning of open science in Serbia, the main goals should be to introduce open science into curricula, so that all researchers become familiar with new academic skills that enable collaboration with scientists from other cultures and other scientific fields.

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**Snežana Smederevac**
*Univerzitet u Novom Sadu,*
*Filozofski fakultet, Srbija*

# OTVORENA NAUKA KAO OKVIR ZA PSIHOLOŠKA ISTRAŽIVANJA

**Apstrakt**

Jedan od osnovnih principa savremene nauke je preuzimanje odgovornosti za diseminaciju naučnih rezultata. Otvorena nauka postala je najvažniji cilj savremene naučne zajednice, čija dostignuća mogu doprineti vidljivosti naučnih rezultata, značajnom društvenom i ekonomskom napretku, kao i razvoju novih istraživanja. U ovoj studiji primenjeni su neki od osnovnih principa otvorene nauke, poput volonterske nauke (eng. citizen science), otvorenih podataka i otvorenog pristupa. Glavni cilj ove kroskulturalne bihejviorlano genetičke studije bio je ispitivanje doprinosa genetskih i sredinskih činilaca dimenzijama Petofaktorskog modela ličnosti (FFM) u tri kulture – hrvatskoj, nemačkoj i srpskoj. Doprinoseći razvoju volonterske nauke, u istraživanju je učestvovalo 1006 monozigotskih i 710 dijazigotskih parova blizanaca iz Hrvatske, Nemačke i Srbije. Rezultati kvantitativnog bihejvioralno genetičkog modela, zasnovanog na prethodno prikupljenim otvorenim podacima, pokazali su da relativni doprinosi genetskih i sredinskih faktora varijanci svih dimenzija FFM imaju gotovo identične obrasce u nemačkom, hrvatskom i srpskom uzorku. Skup podataka iz ove studije deponovan je u platformi Open Science Framevork (OSF). Objavljeni rezultati deponovani su u institucionalnom repozitorijumu u skladu sa politikom zelenog otvorenog pristupa. Opšti cilj otvorene nauke je stvaranje mreže znanja i informacija koje će naučna dostignuća učiniti transparentnim, vidljivim i ponovo upotrebljivim.

**Ključne reči:** otvorena nauka, genetika ponašanja, osobine ličnosti, međukulturalna studija