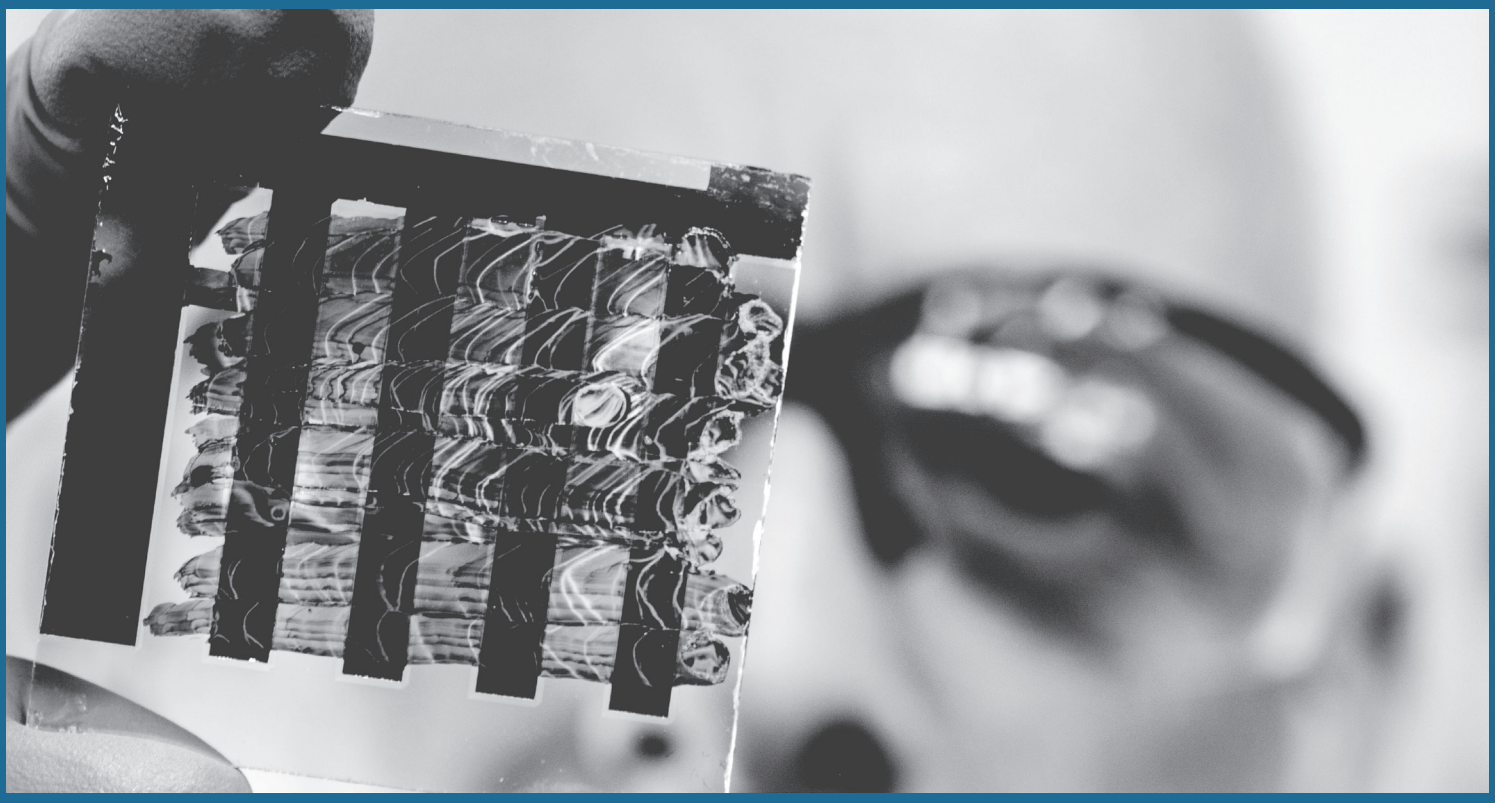
ERIC FORUM

Report on quality management and reproducibility in academic research

October 2021



ERIC Forum has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N. 823798

BACKGROUND

Reproducibility in academic research and particularly the lack thereof has been pointed out by many in recent publications as a limitation of current scientific practices. As European research infrastructures facilitating the research process, European Research Infrastructure Consortia have a role to play in providing solutions to the research community and to increase the degree of reproducible and high quality science.

APPROACHES (METHODS)

The workshop on Research Quality and Reproducibility took place virtually on February 10th and 11th 2021 and was organized as part of the H2020-funded ERIC Forum project by the European Research Infrastructure for Translational Medicine (EATRIS). The workshop brought together the Research Infrastructure community, academics, policy-makers and research funders to exchange best practices and explore challenges in the design and execution of research, and featured speakers from all scientific disciplines of the ERIC Forum. The present report summarises the main points brought up by the various speakers and the participants during presentations and panel discussions.

RESULTS

The delivery has been delayed due to the cancellation of a face-to-face workshop addressing this topic.
Special thanks to speakers for their insightful contributions and to all attendees for their active participation.

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ABOUT REPRODUCIBILITY AND QUALITY IN ACADEMIC RESEARCH: A CHALLENGE SHARED ACROSS SCIENTIFIC DISCIPLINES

Concern about the reproducibility of scientific research has been steadily rising, with reports that the results of experiments in numerous domains of science often cannot be replicated. Whereas problems in biomedical research have garnered most of the attention, concerns have touched almost every field in the biological and social sciences and beyond[1]. The term "Reproducibility Crisis" has been commonly used in the last decade across many scientific publications and the news media[2] to describe a global issue that in urgent need of attention, and that is "owned by everybody and therefore nobody".

In 2017, Marcus R. Munafò et al. (UK Reproducibility Network) published "A Manifesto for Reproducible Science"[3], a decisive call for action which described measures that can be implemented when performing research (including, for example, study design, methods, statistics, and collaboration) to increase reproducibility.

The need for more reproducible and higher quality science has also been explored by large research funders: for example, Wellcome Trust launched a ReImagine Research Campaign in 2019, not only looking at the "what", but also at the "how". More recently in December 2020, the European Commission published a scoping report on "Reproducibility of Scientific Results in the EU ", describing the factors for low reproducibility and providing concrete recommendations to the European Commission on how to increase reproducibility in three main areas: guidelines; the research grant system; and training and careers.

The workshop aimed to determine factors across several scientific disciplines that affect high quality and reproducible science. From biological and medical sciences to energy, social sciences and humanities, and astronomy, panelists drew the same conclusion about research culture and research practices, that have tended to prioritise "sexy" research results over rigorous methods.

Some of the factors mentioned by the panelists included:

- "Publish or Perish": the number of publications remains an important way to assess a researcher's competency and determine career development opportunities, which could lead to an ever-increasing volume of work published at the detriment of its quality;
- Limited access to state-of-the-art equipment and infrastructure constitutes a source of variability, thus jeoparidizing reproducible research;
- Limited access to parallel Primary Data and Metadata to reference and qualify (replication);
- Some reluctance from researchers to share ALL data generated by their research and results, including negative results;
- Need for broader uptake of Open Science practices across all scientific disciplines, e.g. systematically making research data Findable, Accessible, Interoperable, Reusable (FAIR), and providing incentives for open access publishing, will contribute to higher degree of research transparency.
- Need for training opportunities and attractive career path for staff scientists and research infrastructure managers, especially, early-career researchers, who are key agents for change in research cultures.

1: 1,500 scientists lift the lid on reproducibility - Survey sheds light on the 'crisis' rocking research, Nature, 25 May 2016. Last accessed: March 2, 2021.
2: https://www.nytimes.com/2018/11/19/science/science-research-fraud-reproducibility.html
3: Munafò et al. (2017). Nat Hum Behav, 1, 0021
4: https://op.europa.eu/en/publication-detail/-/publication/6bc538ad-344f-11eb-b27b-01aa75ed71a1

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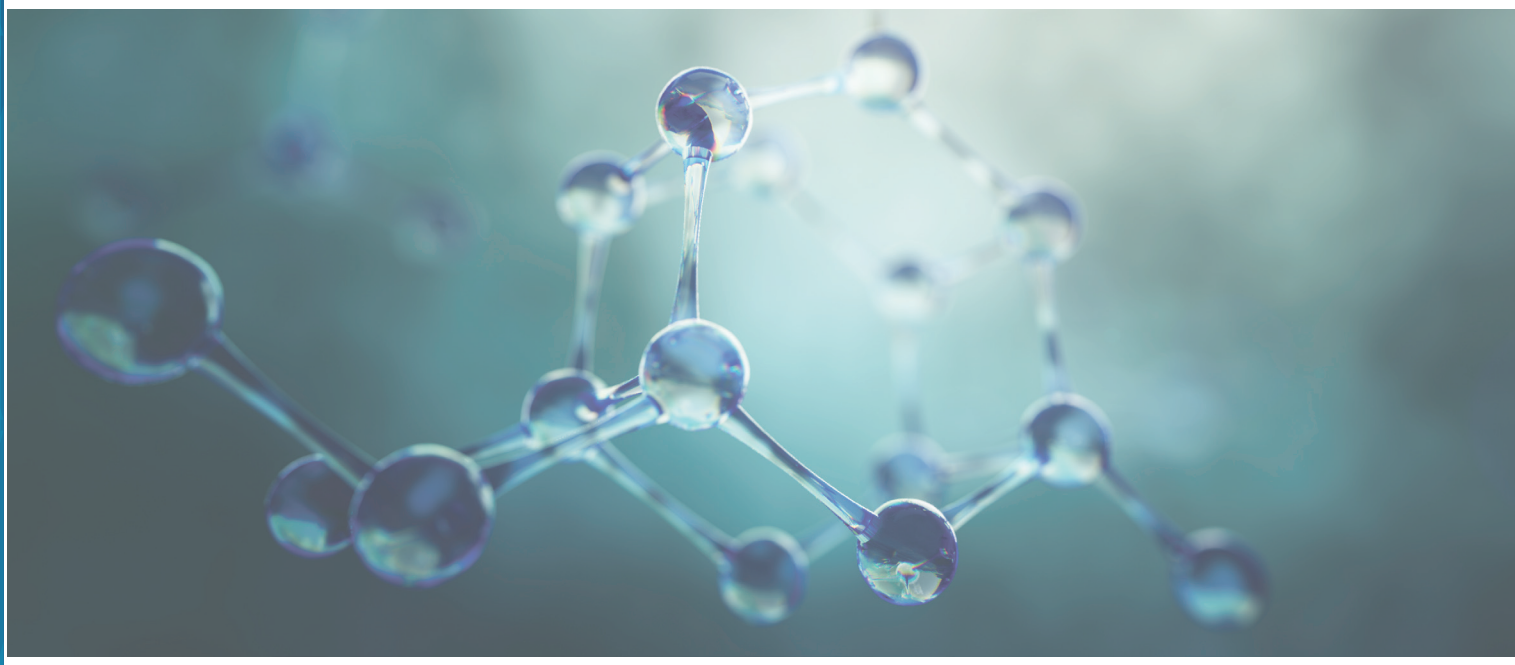
HOW CAN THE RESEARCH COMMUNITY INCREASE REPRODUCIBILITY IN ACADEMIC RESEARCH?

Improving the reproducibility of science should be all research stakeholders' responsibility. During the workshop, the speakers and panelists proposed several ways to increase research quality and reproducibility ranging from reporting, communications, quality management funding among others. These are illustrated below.



- **Better Communicate Science**
- **Publish all Research Results for the Advancement of Science**
- **Encourage pre-registrations**
- **Develop and endorse quality management tools**
- **Grow bottom-up community driven initiatives**
- **Fund reproducibility**
- **Revolutionise research assessment practices**

BETTER COMMUNICATE SCIENCE

When speaking about reproducibility at large, panelists and participants rightfully pointed out the need to re-think our narratives and the research culture. The way we speak about quality and reproducibility at large tends to be a negative narrative: "reproducibility crisis" or "the reproducibility issue", and "negative results".

To lead change, research stakeholders should adopt an uplifting approach, inspiring all to improve research culture, and revolutionise research practices for the benefit of society. More broadly, the recent COVID-19 pandemic has also given us the opportunity to accelerate change in the research culture, by translating science into policy and demonstrating the importance for science to engage with society at large.

As Francisco Colomer, workshop panelist and director of JIV-ERIC said: "We need to educate society at large about scientific methods, its limits and the context in which we are operating. Science is part of culture." Or as Raj Long, Regulatory Development and Access Strategy Expert added, "science cannot be a privilege for a few anymore."

Publish ALL research results for the advancement of science

Initiatives have recently developed to encourage researchers to publish NULL results and to raise awareness on the importance of NULL results of well-performed studies to prevent others from repeating experiments unnecessarily.

For example, in the field of biomedical sciences, the Berlin Institute of Health has launched the "QUEST Award for Null Results"[5], giving away awards of 1,000 € to first/last/corresponding authors (BIH or Charité affiliation) of preclinical or clinical research papers in which the main result is a NULL or 'negative' or in which the replication of own results or the results of others is attempted.

In humanities, REPROLANG 2020, the Shared Task on the Reproduction of Research Results in Science and Technology of Language, published a call for papers on reproduction of research results, to elicit and motivate the spread of scientific work on reproduction. Dedicated sessions have been part of the recent editions of the Language Resources (LRs) and Evaluation Conference, a major event on LRs and Evaluation for Human Language Technologies[6]. Andreas Scherer, Chair of EATRIS Quality Initiative pointed out in the panel discussion that once research results have been published, one takes quality for granted and does not question a result, only a few will through reproducibility or replication studies. Maintaining a critical view on publications is key to research culture change.

Participants noted that despite the existence of these encouraging initiatives, change in research culture proves to be slow with usually very limited publications of this type submitted by researchers, and little shown interest. As stated earlier, communicating positive narratives is particularly key in this context to educate researchers on what NULL results mean for the field and science at large.

5: https://www.bihealth.org/en/research/quest-center/calls-and-awards/quest-calls-and-awards/null-and-replication
6: https://lrec2020.lrec-conf.org/en/reprolang2020/

Encourage pre-registrations

David Mellor, Director of Policy Initiatives, Center for Open Science (COS), reported on the promising potential of pre-registrations. According to COS, pre-registering research means simply specifying a research plan in advance of a study and submitting it to a registry.

Preregistration separates hypothesis-generating (exploratory) from hypothesis-testing (confirmatory) research. But the same data cannot be used to generate and test a hypothesis, which can happen unintentionally and reduce the credibility of results. Addressing this problem through planning improves the quality and transparency of research. This helps researchers clearly report your study and helps others who may wish to build on it.

The total of Open Science Framework registrations went from 38 in 2012 to 22,751 in 2018, which demonstrates increased interest from early adopters. David Mellor explained: "There is still a perception that pre-registration locks one in a specific research plan and prevents the discovery that we are used to. By design it does (…), but it is also (…) a new way to think of how a study should be conducted. It does start a research project a little slower and takes more time for the researcher to prepare the draft.

Once people have done it once or twice, there is clear benefit". David Mellor also reported about the importance of involving journals and research funders in creating incentives for pre-registrations. Some funders[7] and 600 journals[8] already apply a pre-registration requirement and may reward the act of preregistering or sticking to that registered report with publication.

For example, the German Science ministry funds confirmatory preclinical research and has made preregistration mandatory[9].

Develop and endorse quality management tools

Solutions may also lie in the development of quality management tools and systems. The workshop also featured a presentation by Thomas Steckler, Senior Scientific Director at JANSSEN of the quality management system developed by the EQIPD project[10] (Ensuring Quality in Pre-clinical Data), funded by the Innovative Medicines Initiative, a public-private partnership aiming to speed up the development of better and safer medicines for patients.

The EQIPD quality management system supports the essential processes, procedures, responsibilities and cultural aspects for achieving quality objectives. Such a quality system helps flexible application of the guiding principles and allow to monitor performance over time in order to improve an organization's effectiveness and efficiency on a continuous basis.

Although the system was designed for the life sciences, the 18 core requirements of the EQIPD quality management system should be fundamental to any research process regardless of the research discipline and should be adapted anywhere. In addition, funders could also recommend to Principal Investigators to implement the system to increase their chances of success, the accreditation would be the proof that the system has been implemented.

EATRIS also launched an umbrella initiative in 2015, called the EATRIS Quality Initiative (EQI)[11], to support EATRIS' participation in international quality standard consortia. Since then, EATRIS has been involved in many studies where it provided expertise on quality standards, developed practical guidelines, harmonized technological processes, coordinated multisite comparative studies and led several panel discussions on Reproducibility in international fora (for example, at the World Science Forum in 2019 and the Euro Science Open Forum in 2016).

7: https://www.cos.io/initiatives/top-funders 6: https://lrec2020.lrec-conf.org/en/reprolang2020/
8: https://www.topfactor.org/
9: https://www.gesundheitsforschung-bmbf.de/de/8344.php
10:https://quality-preclinical-data.eu/
11 https://eatris.eu/eatris-quality-initiative/

Grow bottom-up community driven initiatives

Several initiatives are emerging across Europe to support reproducible research. One leading example has been the UK Reproducibility Network (UKRN)[12], founded by Marcus Munafò, one of the workshop's panelists. He stressed the importance of fixing how we address reproducibility in academic research, especially because industry will offer early-career scientists very different work cultures and may attract more future talents than academia.

The UKRN was born from the observation that no single organisation has ownership of reproducibility. It relies on local networks of researchers at grass roots level, often led by early or mid-career researchers, which connect with a stakeholder engagement group, composed of funders, publishers, learning societies and cross-sectoral organisations' representatives.

The growth of UKRN membership shows the appetite for a structure that facilitates this coordination of such community-driven activities, which include:

- the development of platforms to replace journals and papers as primary research record;
- the promotion of open research practices for recruitment and career development strategies;
- the setting up of open research working groups;
- open events led by early-career research community promoting open and reproducible research, such as ReproducibiliTea, and the sharing of best practices across research disciplines.

The network does not aim to identify a "silver bullet solution" as Marcus Munafò pointed out, rather create a culture of incentives, where behaviours evolve.

UKRN has been supporting the development of franchise models: similar Reproducibility Networks are currently being assembled in Switzerland, Germany[13], Finland. One has already been established in Slovakia.

Fund reproducibility

Panelists highlighted the currently limited funding opportunities to support reproducibility efforts on the long run. External funding is usually assigned to 3–5-year long research projects, while maintaining accessibility of data is a cost incurred after the end of the research project.

In addition, solutions and tools for reproducibility are also needed well before results and data are produced and should be part and parcel of any research project. Pilot studies are very much needed to deal with these aspects as well as to encourage researchers to carry out replication research[14]. Failure to replicate is what drives science forward.

Revolutionise research assessment practices

Research funders are an important stakeholder and potential change agents towards rethinking the academic research culture as decisions made by funders do guide researchers' behaviours.

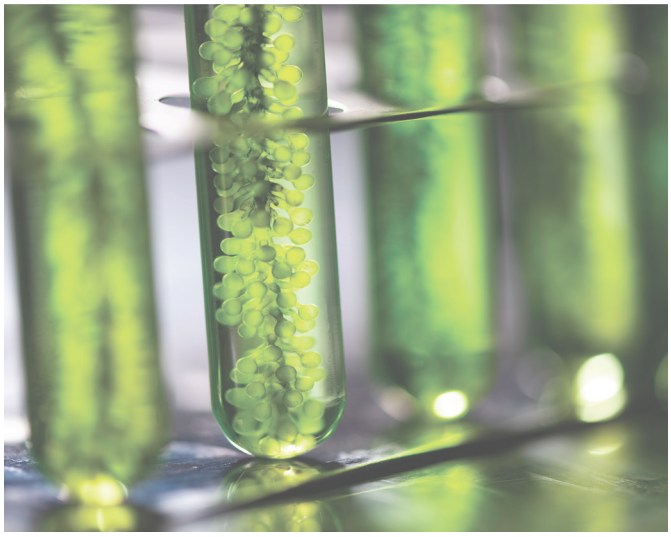
Science Europe, an association of 36 major public research organisations from 27 countries in Europe and policy organisation, has included "Research Quality (Assessment, Reward and Incentives)" as one of their roadmap priorities. Research assessments have shape d many aspects of the research landscape. They exert huge influence over how research is performed and disseminated.

In 2019, Science Europe conducted a study on Research Assessment practices[15] which are followed by its members, and published recommendations on research assessment processes[16]. 62% of the 38 organisations participating in the study reported that they do not have a formal definition for research quality.

12: https://www.ukrn.org/
13: https://reproducibilitynetwork.de/
14: NWO (Netherlands) launched a pilot programme Replication Studies (2016-2022): https://www.nwo.nl/en/researchprogrammes/replication-studies
15: https://www.scienceeurope.org/our-resources/science-europe-study-on-research-assessment-practices/
16: https://www.scienceeurope.org/our-resources/position-statement-research-assessment-processes/

Challenges faced by research organisations during assessment process include:

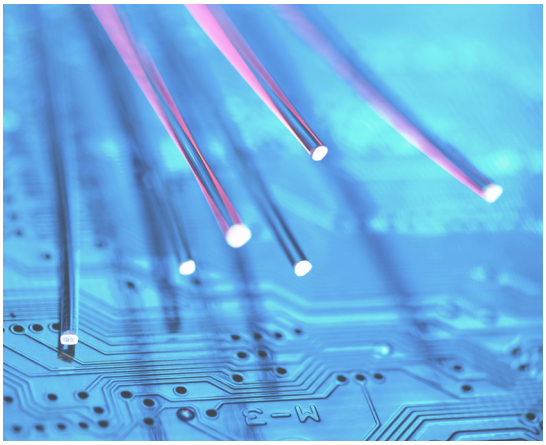
- Research organisations describe the need for continued effort in combating all forms of bias, discrimination, and unfair treatment;
- Pressure exerted on assessment systems by limited funds and/or positions makes distinguishing and ranking proposals/applicants of similar quality (particularly around funding thresholds) more difficult;
- The cost and efficiency of assessment systems is a major challenge (particularly for those that have moved towards more qualitative assessments);
- Balancing the effort and time burden of both applicants and reviewers was also a common challenge described;



The study also demonstrated that research assessment practices are evolving towards including reviews of non-scientific aspects of research, such as potential for transfer/commercial exploitation (59% of the respondents declared already using it), as well as potential contribution to public policies (55% of the respondents declared already using it). A minority of study participants has declared exploring alternative approaches for assessment, including: sandpits (8%); lotteries (3%) and open peer review (18%).
As a next step, Science Europe plans to look at the lever, i.e. look which are the most conducive conditions for change e.g., re-appraise assessment criteria as a vital component of how researchers are currently rewarded and incentivised.

The European Commission also reported at the workshop on their efforts to support the paradigm shift to Open Science, which increases the efficiency, transparency and trust of society in science and contributes to research quality and reproducibility. Although there are divergent definitions of research quality, Kostas Glinos, Head of Unit for Open Science at the Commission, stressed on what research quality is not: “where you published”. Open Science aims to improve research and innovation practices by incentivising openly accessible scholarly publications, early sharing of all research outputs, research data management plans, reproducible results, societal engagement among other priorities. Open Science practices require proper adoption of Open Science practices with appropriate metrics, appropriate skills and education, including for research integrity, and Open Science Infrastructure, such as the European Open Science Cloud (EOSC).
The European Commission also launched in 2021 a debate among policy makers, research funders, research performers and other stakeholders, on the reform of the assessment system. The objective is to reach an agreement by 2022 (such as an MoU) among funders and research performing organisations willing to reform the current assessment system.
Since 2019, the EC has been looking into reproducibility and in December 2020, the scoping report on “Reproducibility of Scientific Results in the EU” was published. The report provides a comprehensive analysis of the causes for lack of reproducible research, embedded in research culture and research assessment, and emphasizes the need to act before the publication of scientific articles, and to involve key actors to increase reproducibility (e.g. funders, publishers, scientists, research organisations and research infrastructures).

The European Commission has already acted to further align Open Science Policies and research funding rules by making data management plan mandatory under Horizon Europe funding programme.



LOOKING FORWARD

The debate around reproducibility must also engage with and target research institutions and universities, whose voice was missing from the workshop. As employers, they also hold the key to incentives, hiring criteria, and are the ones who could support change in the research culture. Although not thoroughly analysed in the workshop, training of all researchers, not only early-career scientists, on scientific conduct and rigor (particularly on study design, statistics, open science practices) is very much needed and should be incentivised by universities' management teams.
The changes implemented by research funders such as Wellcome Trust or the European Commission are showing the path for other research funders in Europe and globally. Funders have an important role to play to accompany cultural changes and motivate researchers to improve their routine practices.

Funders can for example require best scientific practice in their eligibility criteria, and make the open sharing of research outputs the new normal, thus prompting research institutions to re-consider their institutional research culture strategy or their criteria for appointment and promotion.

Finally, funders may consider funding research on research to help further identify and measure factors associated with reproducibility and the effectiveness of interventions to improve reproducibility, and fund confirmation studies. Some funders have joined forces to accelerate efforts in that direction through for example the creation of the Research on Research Institute (RoRI), a consortium of 23 funders aiming to "improve how research is funded, practiced, communicated, and evaluated, so that it works better for everybody.[17]" Another example of such efforts is the EQUATOR (Enhancing the QUAlity and Transparency Of health Research) Network[18], an international initiative that seeks to improve the reliability and value of published health research literature by promoting transparent and accurate reporting and wider use of robust reporting guidelines.

Throughout the workshop and the presentations from several European Research Infrastructure Consortia (ERIC) across many disciplines (EU-OPENSCREEN, CLARIN, JIVE, ECCSEL and EATRIS), it has become clear that research infrastructures have a decisive role to play in the future of research and should be supported accordingly by funders. As European and international access providers to state-of-the-art facilities, technologies, data, software or training for researchers, ERICs have pooled many existing research resources together and help accelerate research and innovation. Furthermore, as co-builders of the future European Open Science Cloud (EOSC), they also take a leading role in providing access to properly annotated research data and open-source software.
Finally, the workshop was also the opportunity to highlight a common challenge, which has become particularly evident from the SARS-COV-2 pandemic: the need to better communicate science to society and engage with the general public to drive science forward and ensure that the "credibility revolution" effectively happens.

17: https://researchonresearch.org/about
18: https://www.equator-network.org/

ANNEX 1: WORKSHOP AGENDA

ERIC Forum Cross-Domain Workshop on Research Quality and Reproducibility

10 and 11 February 2021

Day 1, 10 February 2021 (Afternoon)

13:30 CET	**Kick-off of the workshop: Setting the scene** Anton Ussi, Operations and Finance Director, European Infrastructure for Translational Medicine (EATRIS)
13:45	Philip Gribbon, Fraunhofer ITMP Partner site, European Infrastructure of Open Screening Platforms for Chemical Biology (EU-OPENSCREEN)
14:05	Francisco Colomer, Director, Joint Institute for VLBI ERIC (JIVE)
14:25	Andreas Witt, Professor of Computational Humanities and Text Technologies, European Research Infrastructure for Language Resources and Technology (CLARIN ERIC) and Leibniz Institute for the German Language, Digital Linguistics
14:45	**Break**
15:00	David Mellor, Director of Policy Initiatives, Center for Open Science
15:20	**Panel discussion and Q&A** Panelists: all speakers will also be joined by Raj Long, Regulatory Development & Access Strategy Expert
16:00	**End of Day 1**

Day 2, 11 February 2021 (Morning)

9:00 CET	**Welcome: summary of Day 1** Anton Ussi, Operations and Finance Director, EATRIS
9:20	Thomas Steckler, Senior Scientific Director, Neuroscience Drug Discovery, Janssen Pharmaceutica and coordinator of the EQIPD project Björn Gerlach, Partner, Partnership for Assessment and Accreditation of Scientific Practice (PAASP)
9:40	Volker Röhling, Manager of Operations and Administration, European Carbon Dioxide Capture and Storage Laboratory Infrastructure (ECCSEL)
10:00	Marcus Munafò, Chair of the UK Reproducibility Network Steering Group, Professor of Biological Psychology (University of Bristol)
10:40	**Break**
11:00	Kostas Glinos, Head of Unit Open Science, European Commission
11:20	Andreas Scherer, Chair of the EATRIS Quality Initiative, Institute for Molecular Medicine Finland (University of Helsinki)
11:40	**Panel discussion and Q&A** Panelists: all speakers will also be joined by Anne-Marie Coriat, Head of Research Landscape at Wellcome Trust
12:30	**Summary of discussions and next steps**

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