

# Statement



Interdisciplinary Commission for Pandemic Research,  
Deutsche Forschungsgemeinschaft (DFG, German  
Research Foundation)

## **The Sciences and Humanities in the Coronavirus Pandemic**

Insights, knowledge and action gaps, and conclusions  
for the preparedness for future pandemics

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# 1 Summary: Starting points from which to improve the preparedness for future pandemics

As a result of the coronavirus pandemic, the sciences have received much attention and have been involved in the events of the pandemic in many ways. The DFG's Interdisciplinary Commission for Pandemic Research has deliberated on its members' experiences and observations in this connection so as to identify gaps in knowledge and action and to set out what needs to be done to prepare for future pandemics and other crises.

The sciences and humanities have dealt with the causes and consequences of the pandemic in great subject-specific breadth and will have to continue to do so for a long time to come. Interdisciplinary dialogue is of particular importance here, and this is reflected in the composition and work of the Commission for Pandemic Research.

The "Lessons Learnt" set out here are addressed to the research community, research organisations and research funders, as well as policy-makers, administrators and media representatives. They identify key starting points and resilience strategies for improved preparedness for future pandemics in three areas:

- I. Research accomplishments, science support structures and funding policy measures in the coronavirus pandemic
  1. **Continue to strengthen knowledge-oriented basic research in the future:** The basis for a rapid response to future, unpredictable crisis situations remains free, curiosity-driven basic research that produces a broad-based store of knowledge and a sound basis for judgement. Here lies the key to overcoming crises and the financial burdens they impose. For this reason, such research must not be weakened in the future compared to programme-oriented funding with a predefined focus.
  2. Provide support for the national and international networking of the sciences and humanities as a building block in crisis management: When opportunities for travel and physical contact are limited, institutional and personal researcher networks and collaboration in the sciences and humanities are particularly crucial for crisis management given the global nature of pandemics. Effective collaboration requires thoroughly prepared and to some extent previously established support structures and international coordination in order to allow the joint development, harmonisation and use of study protocols, survey instruments, endpoints for clinical intervention studies and data sets.

3. **Strengthen appropriate formats for interdisciplinary cooperation:** Interdisciplinary approaches continue to be vital when it comes to tackling and overcoming complex crises. Many researchers cooperated in the pandemic in new ways across academic disciplines, going beyond their traditional subject-specific environment. Research funders are called upon to pick up on this development and leverage the potential of wide-ranging interdisciplinary research based on appropriate funding formats and processes.
  4. **Avoid the “Covidisation” of academic research:** The temporary concentration of funding on current crises is understandable and necessary. However, longer-term concentration of funding must be avoided in order to continuously fill the store of knowledge for future and unforeseen pandemics and other crises. Similarly, work on crisis-related issues does not provide a reliable basis for the development of academic careers.
  5. **Provide sustainable funding for capacity to address pressing research questions in the short term:** The timely availability of highly qualified staff is essential for the flexible and short-term handling of new and urgent research topics. This requires the building of additional staff capacity (qualification level: postdoc) for research that is not financed from third-party funds. It will create greater stability in crisis situations while at the same time allowing for greater responsiveness within the research system itself.
  6. **Research and understand the cascading consequences of the COVID-19 pandemic in the long-term:** Research into the pandemic must not finish when the pandemic “comes to an end”: the long-term effects of this watershed moment also have to be recorded and integrated into strategies to prepare for future pandemics. There is still a need for long-term research in almost all research fields so as to analyse the consequences of the pandemic for healthcare systems worldwide, the education sector, the manufacturing economy, trade and indeed society as a whole.
- II. Challenges posed by the pandemic to the process of scientific production
7. **Strengthen the digital infrastructure of the research system:** A pandemic not only generates a great need for knowledge, it also has a massive impact on the production of scientific knowledge itself. Resilience must be improved through the digitalisation of science administration and research infrastructures.
  8. **Adjust funding measures to ensure equal opportunity in the research system:** Funding measures aimed at ensuring equal treatment should be re-evaluated in order to preventively counteract the unevenly distributed negative effects of a pandemic on scientific productivity due to the loss of care structures for children and relatives requiring care – especially on female researchers and in particular those in early career phases.

- 9. Establish new forms of quality assurance in the academic publication process:** In order to be able to publish swiftly on time-critical topics while at the same time ensuring quality, a culture of pre-publication is needed in as many research areas as possible, also including peer commentary or open peer review, and established through academic training. Incentive structures provided by research organisations and funding agencies must be aligned in such a way that academic reputation can also be achieved via these forms of publication.
  - 10. Clearly convey the limits of scientific evidence in communication:** Pandemics require a rapid response. The basis for decisions made regarding the measures of pandemic management should be clearly communicated by those with political responsibility. A clear distinction must be drawn between what is scientific knowledge, what is conjecture and what is “common sense” and extrapolation.
  - 11. Create structures for knowledge-based recommendations for action:** Supranational bodies that formulate recommendations for action in crisis situations based on interdisciplinary criteria and synthesised evidence are the prerequisite for an efficient, targeted response that gives rise to as few undesirable societal side effects as possible.
  - 12. Improve access, availability and linkage of data as a matter of urgency:** Scientific (health) research in Germany operates on a limited data basis, which has at least delayed urgent analyses and studies. Building digital structures and improving access to public administration data sets (e.g. social security data, tax data, education data, health data, data about businesses) and their linkability across institutions, federal states and state borders is therefore essential for research on the social and economic implications of the pandemic and measures to address its consequences in Germany.
- III. Science communication and scientific advice for policymakers and administration
- 13. Enable scientists to communicate science:** Science and the humanities are not yet well equipped for communication to society. Researchers who are actively engaged in communication need both resources and qualification programmes to improve their media competence and their knowledge of the media system. They also need advice and support from their institutions. This is especially true in highly dynamic times and when their personal and academic integrity is under attack.
  - 14. Develop and strengthen journalists’ understanding of science and the humanities:** In scientific reporting, the journalistic principle of balancing positions carries the risk of a distorted perception of the evidence among the public and decision-makers in politics and administration, with potentially detrimental consequences for the handling and management of the pandemic. Familiarity with scientific knowledge production and the research

system are therefore essential for good media communication relating to science and the humanities.

- 15. Create a central communication structure for effective health and crisis communication:** In order to improve the implementation of knowledge while at the same time counteracting misinformation and disinformation, as well as strengthening trust throughout society at large, communication to the public requires a central communication structure that is able to answer urgent questions about the current state of knowledge and make information publicly and comprehensibly accessible.
- 16. Investigate the conditions of implementation for evidence-based health communication:** Further (implementation) research and its translation into guidelines for future use is needed in order to achieve improved transformation of “lessons to be learnt” into “lessons learnt”.
- 17. Formulate clear rules for scientific policy advice:** Policy advice by science and the humanities requires bodies (e.g. expert councils, committees) that are bound by rule-based and transparent procedures, structures and processes regarding staffing and decision-making, and they also need the appropriate resources to enable an academic approach to the issues. Scientific advice is supported by the appropriate structures for rapid evidence generation and synthesis.

## 2 Introduction

In the current pandemic, the sciences and humanities have provided an invaluable service. They were well prepared in Germany in that a broad base of knowledge-oriented research and the relevant research structures were already in place. For example, it was possible to develop vaccines so quickly due to the years of basic research and academic cooperation that went on beforehand. This also led to a powerful and positive public perception of science [1] and therefore to high expectations.

The purpose for this paper is to illustrate the specific contributions and fields of action of the sciences and humanities in the current pandemic by way of examples and to outline the structural adjustments required to enable greater capacity for action in future pandemics and other crises. After all, the coronavirus pandemic has occurred at a time of multiple complex global crises (climate change, loss of biodiversity and related ecosystem resilience functions, armed conflict, etc.) in which we benefit considerably from scientifically validated knowledge, scientific structures and resources.

This paper by the DFG Commission for Pandemic Research is a synopsis of observations and insights from the various phases of an ongoing pandemic from the perspective of the researchers involved. It does not claim to fully represent the diverse range of research and funding activities in the German research system as a whole and beyond. Rather, it seeks to exemplify “lessons learnt” based on concrete examples. At the same time, the conclusions are consistent with and link up to publications issued by other scientific bodies on this topic [2]. This synopsis also identifies further research needs and describes the development of frameworks that are required to translate these into effective action. The aim is to strengthen future pandemic preparedness<sup>1</sup> through the interaction of the various scientific disciplines. This interaction also characterises the work of the Interdisciplinary DFG Commission on Pandemic Research. In accordance with its statutes, the DFG serves science and the humanities in all its branches. Based on this philosophy, the pandemic was understood from the outset as a challenge to research that must involve virtually all fields of science and scholarship, and this is reflected in the Commission’s membership. This led to a profitable interdisciplinary exchange on pandemic-related research needs and the requirements of the sciences and humanities. This paper summarises the status of the discussions as of summer 2022.

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<sup>1</sup> WHO: Pandemic preparedness is a continuous process of planning, exercising, revising and translating into action national and sub-national pandemic preparedness and response plans. A pandemic plan is thus a living document which is reviewed regularly and revised if necessary, for example based on the lessons learnt from outbreaks or a pandemic or from a simulation exercise [3].

### 3 The sciences and humanities in the coronavirus pandemic

In the very early months of 2020, researchers in Germany reacted to the onset of the coronavirus pandemic simultaneously by engaging in intense research activity and demonstrating a high level of commitment to providing scientific advice to policymakers and administrators, as well as providing the public with information in the form of comprehensive reports on the current state of research at any given time. Parallel to this, the institutions of the research system created the scope for research to be conducted into the manifold direct and indirect problems and consequences of the pandemic.

#### 3.1 Research accomplishments, science support structures and funding policy measures in the coronavirus pandemic

In Germany, research and communication initially focused on virology/infectiology, clinical medicine and the mathematical modelling of infection dynamics. Even at the beginning of the pandemic, it was possible to draw on a broad knowledge base and the relevant research structures, and this was immediately put to use in the new situation. For example, the DFG has been funding research for many years on biological aspects of coronaviruses and other zoonotic viruses as well as on preclinical and clinical issues in infections with coronaviruses and other pathogens that lead to diseases with pandemic potential [4]. In addition, DFG-supported projects are dedicated to a wide range of fundamental questions that may be relevant to pandemics, for example in the field of biodiversity research, science and health communication, economics and education.

Immunotherapies are an outstanding example of the long-term value of knowledge-oriented basic research and its funding. The use of research findings emerging from this field enabled the rapid development of SARS-CoV-2-specific vaccination strategies and formed the basis for the mRNA vaccine platform used by the Mainz-based company BioNTech for its COVID-19 vaccine developed jointly with the US pharmaceutical company Pfizer. This goes back to preliminary work carried out from 2006 to 2008 as part of a DFG-funded Collaborative Research Centre dedicated to cancer research at the University of Mainz.

#### Lesson Learnt: **Continue to strengthen knowledge-oriented basic research in the future**

1. The basis for a rapid response to future unpredictable crisis situations remains free, curiosity-driven basic research that produces a broad-based store of knowledge and a sound basis for judgement. Here lies the key to overcoming crises and the financial burdens they impose. For

this reason, such research must not be weakened in the future compared to programme-oriented funding with a predefined focus.

The research-funding institutions responded swiftly to the enormous increase in national and worldwide research activities and the high level of demand for research into the novel coronavirus. Efforts included activities on the part of the various private and public funding institutions and the involvement of various ministries and departments in covering the breadth of the challenge posed by the pandemic. The programmes launched included measures dedicated to topic-related, project-based research funding as well as the targeted development and expansion of research structures.

One example of this is the Netzwerk Universitätsmedizin (NUM) established by the BMBF in March 2020. With the aim of networking and coordinating medical research into COVID-19, a structure was established between the 36 university hospitals in Germany under which thirteen topics relating to pandemic-related clinical care and research are currently being worked on in nationwide, multi-site projects. The NUM supports nationwide coordination and exchange among all university hospitals in order to meet the challenges posed by SARS-CoV-2. By pooling resources, competencies and research activities, data and findings are to be collected and evaluated as completely, comprehensively and promptly as possible [5].

From the very start of the pandemic, it was obvious that there was a need for a global perspective and international comparative research. Accordingly, in its call for proposals for interdisciplinary research on epidemics and pandemics (see below), for example, the DFG explicitly encouraged cooperation with international researchers and made it possible to apply for the necessary funding. Another DFG call for proposals under COVID-19 Focus Funding entitled “Impacts of the Coronavirus Pandemic in the Global South: Health Systems and Society” (see below) targeted research projects with international partners in the Global South [6]. These international/transnational and in some cases personal (bottom-up) networks formed an essential pillar – not only for a successful proposal submission but also for joint research that remains viable even under pandemic-related restrictions.

The Sino-German Center for Research Promotion (CDZ) – a joint institution run by the DFG and the National Natural Science Foundation of China (NSFC) – published a call for proposals in May 2020 in order to support joint research efforts between China and Germany in the field of COVID-19 research. 20 German-Chinese research projects are currently being funded within this framework [7]. Initiatives to establish entirely new cooperative ventures were only fruitful to a limited extent. For example, members of the Commission for Pandemic Research were actively involved

in the digital workshops run by Science-Europe and the National Natural Science Foundation of China (NSFC) in 2021. The aim here was to bring together European and Chinese researchers working on COVID-19 and initiate new research collaborations. However, concrete joint research on a significant scale hardly emerged from this and also failed to materialise within other initiatives, not least because it was not possible to exchange data, for example because Chinese institutions do not share their infection figures.

The joint statements issued by the national academies of the member countries for the 2022 G7 Summit emphasise the importance of better integrated, interdisciplinary, international and trans-disciplinary cooperation in science from an international perspective, as well as international coordination in the harmonisation of clinical trials, for example, with a view to ensuring improved global pandemic and health preparedness [8].

**Lesson Learnt: Provide support for the national and international networking of the sciences and humanities as a building block in crisis management**

2. When opportunities for travel and physical contact are limited, institutional and personal researcher networks and collaboration in the sciences and humanities are particularly crucial for crisis management given the global nature of pandemics. Effective collaboration requires thoroughly prepared and to some extent previously established support structures and international coordination in order to allow the joint development, harmonisation and use of study protocols, survey instruments, endpoints for clinical intervention studies and data sets.

Very early on in the pandemic, it became clear that addressing the pressing scientific questions required diverse expertise drawn from different disciplines. For this reason, the DFG facilitated the submission of supplemental and follow-up proposals for consortia projects such as Collaborative Research Centres and Research Units already in receipt of funding, and pandemic-specific research questions were taken up and addressed within already funded Coordinated Programmes wherever possible. On this basis, for example, researchers on Transregio TRR 266 “Accounting for Transparency” published statements and reports as early as March 2020 dealing with pandemic-related liquidity problems and other challenges facing numerous companies, also assessing support measures [9]. These received attention in the legislative process, for example.

In addition, the DFG responded with a large-scale, interdisciplinary call for new research projects into epidemics and pandemics at the end of March 2020 [10]. The aim was to promote a broad spectrum of research projects, ranging from the medical and biological foundations, including preventive and therapeutic measures, to questions of epidemiology, economics, logistics and communication, as well as the social, psychological, cultural, legal and ethical implications.

Furthermore, the DFG established COVID-19 Focus Funding in August 2020 – a new, streamlined and accelerated funding opportunity to work on scientific issues that the Interdisciplinary Commission for Pandemic Research, established in 2020 by the DFG Executive Committee, had identified as particularly urgent. In this way, seven calls for proposals were issued between August 2020 and May 2021 covering a wide thematic spectrum and aiming to respond as quickly as possible to the need for knowledge generated by a dynamic pandemic [11]. Numerous national and global funding agencies proceeded in a similar way.

A statistical report by the DFG on funding activities in the context of the COVID-19 pandemic illustrates the subject and thematic diversity and breadth of the research projects submitted to the DFG between 2020 and 2021 under the above-mentioned calls for proposals and funding programmes that were not subject to topic restrictions. During this period, decisions were issued for a total of 907 funding proposals for research into epidemics, pandemics and COVID-19 with a total funding volume of around €343 million. Of these, 242 proposals were approved with a funding volume of some €80 million. Proposals covered all academic disciplines and research areas, with a particular focus on the life sciences and on the social and behavioural sciences. The analysis of proposal topics contained in the report indicates that the pandemic is perceived by the applicants as a multidimensional challenge and is dealt with both on an interdisciplinary basis and broken down according to subject specialisations [12].

Examples of the exceptionally broad networking and interdisciplinary cooperation between the academic disciplines in the pandemic include the network “Aerosol particles and their dispersion” [13], the nationwide study CORONA-MONITORING [14] and the project LOKI [15]. In order to support interdisciplinary exchange under COVID-19 Focus Funding, the network “Aerosol particles and their dispersion” was established in 2021 on the initiative and under the leadership of a member of the Pandemic Commission. One particular area of investigation here were questions concerning the formation of aerosol particles during breathing, speaking, coughing, sneezing and their evaporation kinetics and dispersion dynamics in connection with efficient removal of aerosol particles from indoor air. Only by engaging in interdisciplinary research into fluid mechanics, process engineering and medicine is it possible to generate new insights into the infectiousness of aerosol-borne viruses and their control. For the nationwide study CORONA-MONITORING, biosamples were collected as part of a special survey run by the Socio-Economic Panel (SOEP) in collaboration with the Robert Koch Institute to examine them for SARS-CoV-2 IgG antibodies and SARS-CoV-2 RNA with regard to a past or current infection. By linking this with existing longitudinal personal and household data collected by the SOEP, it is possible to identify additional social and health-related differences in infection status and their socioeconomic consequences over time. The first findings were published as a preprint at the end of 2021 [16]. Another example

of wide-ranging interdisciplinary cooperation is the project LOKI coordinated by the Helmholtz Centre for Infection Research (start: 1 July 2022), in which a total of five Helmholtz Centres are collaborating with healthcare institutions on an application-oriented basis. The structures to be developed will serve to prepare for future pandemics and establish an infrastructure within the public health authorities that will enable a local response that is optimised in terms of the working environment and demographics of the districts and district-free cities. This includes an early warning system for rapid response and the recommendation of measures in the event of local outbreaks.

In terms of interdisciplinary cooperation, the linking of perspectives from clinical and natural science with those of the social sciences and not least jurisprudence still remains a desideratum, although precisely this combined perspective is of key importance when it comes to the question of the feasibility and practicability of what appears necessary from an epidemiological and virological point of view in combating a pandemic, for example.

Positive examples include the following: collaboration to combine epidemiological and economic modelling for data-based simulations in a pandemic [17], and the use of economic tools to analyse the installation and follow-up costs of indoor air filters for individually optimised fitting [18]. However, obstacles to interdisciplinary cooperation exist in particular due to the differing disciplinary cultures; given its lower funding requirement overall, for example, the subject area of law still makes comparatively little use of third-party funding and when it does, then mainly in collaboration with other humanities. Another hurdle lies in the structures for the review of projects and the awarding of funds if the projects are organised in a very discipline-oriented manner based on a logic of their own, making any interdisciplinary perspective difficult or indeed impossible. For this reason, suitable funding formats have to be evolved to promote far-reaching interdisciplinary collaborations.

**Lesson Learnt: Strengthen appropriate formats for interdisciplinary cooperation**

3. Interdisciplinary approaches continue to be vital when it comes to tackling and overcoming complex crises. Many researchers cooperated in the pandemic in new ways across academic disciplines, going beyond their traditional subject-specific environment. Research funders are called upon to pick up on this development and leverage the potential of wide-ranging interdisciplinary research based on appropriate funding formats and processes.

While the focus of the research community on pandemic and epidemic research was necessary and still is, the potential risks of a crisis-driven “covidisation of academic research” were discussed as early as April 2020 [19]. This means that there has been a strong focus by funders and

researchers on infection research at the expense of other topics, including health research in areas such as non-communicable diseases and the consequences of climate change [20].

There is no doubt that thematic funding is justified and has been initiated by many agencies, including the DFG. However, the COVID-19 pandemic has also shown how quickly the results of basic research can be put to use to address concrete problems of global relevance. These are research outcomes from projects that were identified as relevant by the research community itself – and not based on a benefit-oriented funding logic.

**Lesson Learnt: Avoid the “Covidisation” of academic research**

4. The temporary concentration of funding on current crises is understandable and necessary. However, longer-term concentration of funding must be avoided in order to continuously fill the store of knowledge for future and unforeseen pandemics and other crises. Similarly, work on crisis-related issues does not provide a reliable basis for the development of academic careers.

Ultimately, it was only possible to a limited extent within the existing research structures to use funding available at short notice to pursue urgent research questions in a prompt manner: this is because many researchers in their qualification phase are involved in third-party funded projects dedicated to specific topics, where rapid reorientation is not readily possible.

In view of this, the Commission for Pandemic Research carefully assessed the urgency of a research question when identifying research topics in connection with calls for proposals under COVID-19 Focus Funding. Here, for example, it assessed the Long COVID syndrome as a multidisciplinary challenge that could not be addressed based on short-term impulses. Instead, there is a long-term need for research here that can be targeted under regular DFG funding formats (e.g. Priority Programmes, Clinical Research Units). For this reason, the Commission’s statement on Long COVID addresses the need for research while at the same time linking this to the possibilities of research funding [21].

**Lesson Learnt: Provide sustainable funding for capacity to address pressing research questions in the short term**

5. The timely availability of highly qualified staff is essential for the flexible and short-term handling of new and urgent research topics. This requires the building of additional staff capacity (qualification level: postdoc) for research that is not financed from third-party funds. It will create greater stability in crisis situations while at the same time allowing for greater responsiveness within the research system itself.

**Where understanding begins: future research needs relating to the COVID-19 pandemic**

The COVID-19 pandemic marks a turning point in many respects, so in retrospect, a number of areas in society will be divided into “before” and “after” the pandemic. The pandemic has brought about and accelerated fundamental processes of change – often in conjunction with other sudden upheavals. One example here is the change in the working world: the nature and consequences of this have to be assessed in the future. This is something that could only occur in conjunction with digitalisation. A second example is societal discourse on the pandemic. Here again, analysis in retrospect will be essential in order to gain an understanding of the pandemic and learn from it. A third example is the increase in inequality – between and within countries: this has resulted in setbacks in the achievement of global development goals such as reducing poverty and hunger [22]. A fourth example is the impact of the pandemic on supply chains: during a pandemic, the disruption of supply impacts on the economy and society as a whole. It will be crucial to tap into existing funding formats and raise their visibility with a view to promoting specific topics in these areas, or if necessary create new funding formats for this purpose.

There is also a need for scientific research into the effects of pandemic control measures and measures for support in the various sectors of society, for example in the economic domain. Here, differentiating cost-benefit analyses of alternative packages of measures will be important when it comes to preparing for future crises. How sustainable are the comprehensive measures to support the economy in the long term, or in the case of recurring/new pandemics, how can the administrative costs and misuse of the various programmes be assessed, who uses these programmes, what are the distributional effects in the population, which sectors benefit, which lose out? What are the consequences of the pandemic for supply chains, for the labour market, for sustainability and for the resilience of the economy overall? What impact does pandemic policy have on trust in the state, and how does the uncertainty caused by pandemic and ambiguous measures affect entrepreneurship as a whole? This list of questions can easily be extended and expanded to include other areas.

The study of the causes and effects of the COVID-19 pandemic will be key to understanding social processes in many areas – firstly in terms of understanding concrete changes and secondly in order to understand how social systems function at different scales, from the local to the global level. Making it possible to learn from the pandemic in this way – not just while it is in progress but also after it comes to an end – is fundamental to understanding the scale of its impact. A whole range of academic disciplines can contribute here, including educational studies, sociology, history, economics, geography, area studies and social and cultural anthropology.

**Lesson Learnt: Research and understand the cascading consequences of the COVID-19 pandemic in the long term**

6. Research into the pandemic must not finish when the pandemic “comes to an end”: the causes and long-term effects of this watershed moment also have to be recorded and integrated into

strategies to prepare for future pandemics. There is still a need for long-term research in almost all research fields so as to analyse the consequences of the pandemic for healthcare systems worldwide, the education sector, the manufacturing economy, trade and indeed society as a whole.

## 3.2 Challenges posed by the pandemic to the process of scientific production

The sciences and the humanities continue to provide fresh insights into the coronavirus pandemic. At the same time, the pandemic has a powerful impact on the research system itself and the scientific production process beyond the thematic areas described above.

Since autumn 2021, a DFG Senate working group has been looking into the consequences of the pandemic for all academic disciplines and will present its findings and recommendations successively in the course of 2022 and 2023. For example, there were and still are many restrictions on field access in empirical social science research and for researchers working internationally, such as in the context of ecosystem and biodiversity research and area studies. Furthermore, at times there has been only limited access or none at all to research laboratories, literature and archives as well as non-digitised research objects and materials. In the area of health-related research, research opportunities continue to be hampered due to lack of field access and pandemic-related protective measures. Obstacles of this nature also apply in prevention research and in the area of data collection from patients in the outpatient, inpatient and rehabilitative sector as well as in the area of long-term care. Recruitment in ongoing clinical trials is slowing down noticeably, too, and newly starting trials are subject to significant delays.

Where access to the “field” has been severely restricted by the pandemic, it has been possible to pursue alternative research approaches in some cases. There were considerable obstacles to primary social science data collection at times, combined with a simultaneous pressing need for research in this area: this was taken into account in the drafting of the COVID-19 Focus Funding “Education and COVID-19: Impact of the Coronavirus Pandemic on Educational Processes in the Life Course”, which called for use to be made of quality-assured data sets available from longitudinal studies [23].

The pandemic created and exacerbated structural bottlenecks at research institutions that continue to have an obstructive impact on research projects; these include the slowing down of administrative processes in the area of staff recruitment as well as the procurement and accessing

of equipment. Structures for handling ethical approval and data protection requests likewise continue to be overburdened. As a consequence, there were usually delays in the capacity of ethics committees to deliberate on proposals that were not of direct relevance to COVID-19.

According to the Senate Working Group, such restrictions have a particularly powerful impact on the setting up of new projects and on researchers in early career stages. The Senate Working Group has prepared a paper on the impairments inflicted on research projects and academic careers by the pandemic: this explains to applicants the possibility of highlighting pandemic-related restrictions in DFG proposals, also due to individually exacerbated family and personal circumstances during lockdown; it also raises reviewers' awareness of this issue [24].

**Lesson Learnt: Strengthen the digital infrastructure of the research system**

7. A pandemic not only generates a great need for knowledge, it also has a massive impact on the production of scientific knowledge itself. Resilience must be improved through the digitalisation of science administration and research infrastructures.

**Lesson Learnt: Adjust funding measures to ensure equal opportunity in the research system**

8. Funding measures aimed at ensuring equal treatment should be re-evaluated in order to preventively counteract the unevenly distributed negative effects of a pandemic on scientific productivity due to the loss of care structures for children and relatives requiring care – especially on female researchers and in particular those in early career phases.

In addition to the limitations mentioned above, the pandemic continues to be a period that has seen significant momentum in terms of knowledge gain. Rapid political decisions became necessary in order to counter the exponential dynamic of the pandemic, and these had to be made on a data basis that was as reliable as possible. Here, there was an increasing conflict between the considerable pressure of time and the quality of the findings. The scientific production process was accelerated and altered to some extent, too, especially in the life sciences. For example, the pandemic led to a massive increase in the pre-publication of study results via preprint servers in this field – without such results being subject to systematic quality control. At the same time, the review of journal articles without relevance to COVID-19 slowed down significantly in some cases. Rapid availability of data and information was crucial, especially in the early phase of the pandemic, but this sometimes involved a loss of quality [25, 26].

**Lesson Learnt: Establish new forms of quality assurance in the academic publication process**

9. In order to be able to publish swiftly on time-critical topics while at the same time ensuring quality, a culture of pre-publication is needed in as many research areas as possible, also including peer commentary or open peer review, and established through academic training. Incentive structures provided by research organisations and funding agencies must be aligned in such a way that academic reputation can also be achieved via these forms of publication.

It became apparent that there is a lack of sound structures for collating empirical knowledge from studies into evidence syntheses: among other things, this would improve information and advice for policymakers and society. In this connection, a round table discussion on rapid evidence generation during the COVID-19 pandemic was held in January 2021 at the initiative of the Commission. It became apparent that the challenge for science and the humanities in a pandemic is to review new findings in the short term, assess them comprehensively and subsequently to update them continuously (so-called living systematic reviews) in order to synthesise evidence relating to complex problems. This process involves significant methodological demands and a need for research on new methodological approaches such as realist reviews [27]. Unlike conventional forms of evidence synthesis, which are concerned with the effectiveness of interventions, realist reviews ask how, why and for whom such interventions are effective. This explicitly focuses on the role of context in terms of mechanisms for achieving specific outcomes. Such an approach would be helpful in understanding why vaccination campaigns have been more successful in some settings than others, for example. Further issues to be resolved are prioritisation and the avoidance of redundancy. In the medium term, the establishment of such structures could also support the sciences and humanities with regard to identifying research potential and gaps in knowledge.

One point which is ultimately impossible to resolve entirely is that effective pandemic control requires the rapid introduction of measures [28] even though these cannot always be introduced based on well-supported evidence. For this reason, it will be crucial to undertake an ex post assessment of the measures taken during the COVID-19 pandemic that can inform guidelines for future pandemic preparedness. Also: only in the future will it be possible to find out how viable analyses were of recent social events and processes, given that these analyses were conducted at great speed. Some judgements and decisions had to be made – and are still being made – based on knowledge drawn from the application and transfer of general theories (e.g. about human behaviour and social processes) as well as empirical evidence from other research contexts or from experience of similar situations (e.g. historical knowledge of previous pandemics). In the

early months of the SARS-CoV-2 pandemic, for example, there was no specific evidence on whether it was possible to reduce infection rates by having people constantly wear masks in schools. Knowledge was available that could be adapted and applied analogously, however: infection occurs via the aerosol route and is facilitated by loud speech and lack of spacing; masks can be effective in reducing aerosol transmission indoors.

**Lessons Learnt: Clearly convey the limits of scientific evidence in communication**

10. Pandemics require a rapid response. The basis for decisions made regarding the measures for pandemic management should be clearly communicated by those with political responsibility. A clear distinction must be drawn between what is scientific knowledge, what is conjecture and what is “common sense” and extrapolation.

**Lesson Learnt: Create structures for knowledge-based recommendations for action**

11. An efficient, targeted response with as few undesirable societal side effects as possible requires supranational bodies that formulate recommendations for action in crisis situations based on interdisciplinary criteria and synthesised evidence.

Throughout the pandemic to date, there has been a significant demand for health-related data, whether to evaluate specific interventions or to assess outbreak events. Two central, interlinked problem areas are digitalisation and also the lack of (health) data, the fact that such data is not machine-readable, and that it is too slow to access or is only linkable to a limited extent. These long-known problems that impede or prevent necessary improvements in the healthcare system and the planning of prevention measures became even more apparent during the pandemic. Despite current efforts under the NUM, for example, this data is still very inadequately accessible in Germany compared to other countries and is difficult to link. There are significant organisational and legal hurdles here. Lack of access, lack of machine readability and difficult linkability – of health data and data from official registers, for example – are key barriers that prevent urgently needed progress in health-related research [29, 30]. The Commission for Pandemic Research discussed the structural problems in February 2021, including the lack of access to routine data, the lack of nationwide registers and the only very cursory data contained in the electronic health record. In doing so, the Commission found that Germany lags far behind now established standards compared to many countries in Europe and globally, causing problems in all scientific disciplines. Improved availability of standardised data would therefore be a great desideratum for research as well as for the medical care of the insured in Germany. With regard to the pandemic, it was almost impossible – or only with a delay – to answer questions on transmission, risk factors in relation to the severity of the disease, and also vaccination reactions, especially in comparison

to other European countries. The DFG's Interdisciplinary Commission for Pandemic Research has issued a statement on this subject which identifies five fields of action<sup>2</sup> that are to enable better accessibility and linkability of health-related data [31].

Similar challenges apply in other fields, for example in the social sciences and economics with regard to questions of the economic and social implications of protective measures and measures to support the economy in the pandemic environment. There are great opportunities to be gained if access to public administration data and the linkability of different data sets can be improved in federal Germany, including across the borders of the federal states – also going far beyond pandemic research, e.g. in the area of the targeted development of public health measures.

Another issue that has emerged in the context of the pandemic is the collection, registration and transparency of ongoing studies on non-pharmaceutical public health interventions (NPIs). This concerns studies on information and education programmes, the restriction of mass events, testing and screening strategies and hygiene management. In reviews, it is often assumed that such NPI studies are centrally recorded in clinical registries, e.g. at ClinicalTrials.gov or on the WHO International Clinical Trials Registry Platform, in the same way as pharmaceutical Interventions and other clinical trials [32]. However, NPI studies are in fact conducted in very different disciplines (including sociology, education, psychology, economics), and the studies are registered with the various subject-specific associations or institutions. Systematic reviews and other reviews should do even more to take this multidisciplinary nature into account in the future.

**Lessons Learnt: Improve access, availability and linkage of data as a matter of urgency**

12. Scientific (health) research in Germany operates on a limited data basis, which has at least delayed urgent analyses and studies. Building digital structures and improving access to public administration data sets (e.g. social security data, tax data, education data, health data, data about businesses) and their linkability across institutions, federal states and state borders is therefore essential for research on the social and economic implications of the pandemic and measures to address its consequences in Germany.

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<sup>2</sup> These include the following: i) set up a systematic consent concept that ideally follows an “opt-out” approach for consent to data collection; ii) ensure clarity and use existing data so as to avoid duplication; iii) establish a central data integration office that enables both legal and organisational data access, also acting as a trustee in enabling the linkage of different data sets; iv) introduce uniform federal regulations so as to create legal certainty for research as a requirement for access to and the linking of health-related data. In the Commission's view, Germany requires research data legislation for this purpose. v) for the linking of different items of personal data, the introduction of a “unique identifier” appears to be expedient, acting as a central factor for the harmonisation and merging of data.

**Excuse: Field of activity “Quality in clinical research”**

Clinical trials are the central interface of translational research. Yet in the course of the last two years, the implementation of such studies in Germany has particularly been seen to exhibit weaknesses, as was previously pointed out by the DFG [33], the German Science and Humanities Council [34] and the BMBF’s health research forum [35]. Rapid implementation of clinical trials was barely possible given the existing framework conditions. In order to be able to exploit the existing potential in the medium term, investments in infrastructure and network-building are required that enable and support the implementation of academically initiated clinical trials. All decisions on the funding of infrastructures, networks and clinical studies should always be quality- and science-driven and should be subject to an institutionally independent procedure.

### 3.3 Science communication and scientific advice for policymakers and administration

A pandemic is an unexpected event but it is also an initially poorly understood event that nevertheless requires explanation. This poses a particular challenge for researchers, since they need time to conduct research in order to gain understanding as quickly as possible, thereby limiting resources allocated to science communication and outreach. In addition, they often lack experience of dealing with the media. In the case of socially controversial topics, there is also the risk that representatives of the sciences and the humanities are publicly criticised or even attacked for their statements relating to specific problems. This issue was already addressed in detail in a position paper published by the German Science and Humanities Council in 2021 [36]. The members of the DFG Commission for Pandemic Research have also contributed in a variety of ways to relaying the knowledge available at the given time on a wealth of pandemic-related topics. Even though public trust in science and research has increased significantly in the context of the coronavirus pandemic and scientific information is regarded as very important by the public [37], individual researchers have nonetheless suffered severe personal attacks in certain media and from the public, and not least from representatives of their own academic community, too. The Alliance of Science Organisations reacted to this in December 2021 with a “Call for greater objectivity in crisis situations” [38].

**Lesson Learnt: Enable researchers in science communication**

13. Science and the humanities are not yet well equipped for communication to society. Researchers who are actively engaged in communication need both resources and qualification programmes

to improve their media competence and their knowledge of the media system. They also need advice and support from their institutions. This is especially true in highly dynamic times and when their personal and academic integrity is under attack.

Since the emergence of the SARS-CoV-2 virus and the outbreak of the COVID-19 pandemic at the beginning of 2020, there has been an ongoing need for readily available scientific information that is comprehensible to the non-expert. Under pressure of time, researchers developed levels of knowledge that – given the novelty and sheer momentum of this pandemic – were often fraught with uncertainty and quickly outdated or only moderately evidence-based, yet were made available and communicated as quickly as possible nonetheless. For example, NDR-Info broadcast the first *Coronavirus Update* with Christian Drosten as early as 26 February 2020: over the course of two years, this programme provided a regular response to the generally high level of demand for information in a very dynamic situation, always putting the information available appropriate into perspective. The changes in the publication process that arose as a result of the dynamic of the pandemic – as explained above – meant that findings from scientific papers that had not undergone peer view were also discussed in the press. This increased the risk of a false balance in the media, i.e. the equal treatment of minority and majority scientific positions. The risk of a false balance was high anyway, since many journalists applied the principle of balanced reporting on social issues to scientific issues, providing a mouthpiece for those representing points of view that were opposed to consensual scientific positions.

The “infodemic” [39] that accompanied the pandemic, i.e. the abundance of both good and bad information, underlines the need for evidence-based communication that pre-filters this wealth of information and presents it in a way that is geared towards action and user consumption [40]. In the run-up to the approval of the novel mRNA vaccines in Germany, for example, the Commission for Pandemic Research foresaw an urgent need for rapid, nationwide education and information to strengthen vaccination readiness and behaviour, and in January 2021 published the dossier *Know more, make informed decisions* on the subject of vaccinations against SARS-CoV-2 [41]. Nonetheless, information provided in this way was no substitute for targeted communication by a competent institution, nor was this its intention.

**Lesson Learnt: Develop and strengthen journalists’ understanding of science and the humanities**

14. In scientific reporting, the journalistic principle of balancing positions carries the risk of a distorted perception of the evidence among the public and decision-makers in politics and administration, with potentially detrimental consequences for the handling and management of the pandemic. Familiarity with scientific knowledge production and the research system are therefore essential

for good media communication relating to science and the humanities.

**Lesson Learnt: Create a central communication structure for effective health and crisis communication**

15. In order to improve the implementation of knowledge while at the same time counteracting misinformation and disinformation, as well as strengthening trust throughout society at large, communication to the public requires a central communication structure that is able to answer urgent questions about the current state of knowledge and make information publicly and comprehensibly accessible.

Since human beings in particular influence the emergence of zoonoses with pandemic potential and are also hosts to the virus, understanding human behaviour is highly relevant when creating protective measures and the relevant communication measures. For this purpose, it is important to collate existing [42] and crisis-generated data on attitudes, behaviours and other crisis-related parameters such as trust or stress [43]. Research in these areas is helpful for crisis, risk, and health-communication, as well as in connection with handling of misinformation in the media. Pre-pandemic research findings are already available, as well as guidelines that apply the insights gained (issued by health organisations such as the WHO [44] or by academics, e.g. The Debunking Handbook [45]). It is also known that drawing on the findings of research conducted in the area of psychological and communication science into health and crisis communication can have positive effects on compliance with protective measures and the public's trust in health authorities in the context of political action and health communication [46]. The implementation of such findings and principles was often lacking, however, not least due to the fact that no structures were in place (see Lesson Learnt 15). There is clearly a need for research into the conditions that are required for existing knowledge in the area of social and behavioural science to be applied in establishing the relevant political structures and crisis communication. For example, there is a lack of relevant research into practical implementation and political science relating to the conditions, structures and processes that are required for this type of evidence to take effect. A comparison with other countries can be useful here; some have made use of "Behavioural Insights Units", for example, and the WHO advises creating this type of structure (47), too – yet the effect of such structures in enabling the implementation of insights from social and behavioural science is not yet known.

**Lesson Learnt: Investigate the conditions of implementation for evidence-based health communication**

16. Further (implementation) research and its translation into guidelines for future use cases is needed in order to achieve improved transformation of “lessons to be learnt” into “lessons learnt”.

From the very beginning, politics and administration were advised by scientific experts. However, it was often not transparent according to which criteria the individual voices of science were being listened to or by which entire panels were assembled. In its final report, the Swiss National COVID-19 Task Force – which spent 24 months advising Swiss policymakers and informing the public – draws attention to four key points [48]: Firstly, there are no established processes for the composition of an interdisciplinary scientific body, raising questions of legitimacy and operational procedures. For this reason, academic institutions had a key role to play in the nomination and selection process in Switzerland. Secondly, a clear mutual understanding of the roles of the individual actors is crucial in order to be able to clearly distinguish between the consultation process and the decision-making process – and this must be communicated to the public, too. Another point highlighted by the Task Force is coordinated communication. Scientific findings can be disseminated to the public in a rapid, transparent and uncomplicated manner, especially if there is consensus among members. In addition, participation in the Task Force requires a high level of voluntary commitment as well as the support of additional specialised staff. Similar observations were made by the scientific panel convened by the federal and state governments in Germany in December 2021 to develop recommendations for pandemic response. The federal government’s Council of Experts on COVID-19 is made up of academics from various disciplines. The nomination procedure for this body requires the greatest possible transparency, as does the work done by it. For this reason, the Council of Experts set out its tasks and processes in a set of procedural regulations, which was then published [49]. Another example is the guide published in 2014 by the National Academy of Sciences Leopoldina on the general principles behind its science-based policy advice, in which it outlines its working methods and the principles that inform the preparation of its statements [50].

**Lesson Learnt: Formulate clear rules for scientific policy advice**

17. Policy advice by science and the humanities requires bodies (e.g. expert councils, committees) which are bound by rules and transparent procedures, structures, staffing and decision-making processes, and they also need the appropriate resources to enable an academic approach to the issues. Scientific advice is supported by the appropriate structures for rapid evidence generation and synthesis.

## 4 Appendix

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