IfD Allensbach
Institut für Demoskopie Allensbach

Leopoldina
Nationale Akademie
der Wissenschaften

January 2015 | Discussion No. 3

The Public Understanding of Synthetic Biology

Considerations in the context of science-based advice to policy-makers and the public

Public opinion plays an exceptional role in society's willingness to accept new research fields and technologies. But what about those research areas which are scarcely known outside the labs in which they are studied? This paper uses a representative population survey to analyse the level of knowledge and attitude of the German population to innovative technologies, using the example of synthetic biology. The paper presents the results of the survey, as well as the thoughts of a group of experts on improving communication on synthetic biology.

The authors aim to encourage debate on the – as yet – unexploited opportunities for scientific communication. At the same time, the empirical data provides initial insights into the perception of synthetic biology by the population, journalists and researchers.

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Contents

Part I
Considerations on the Communication of Synthetic Biology

Jörg Hacker
Bärbel Friedrich
Alfred Pühler
Stefan Artmann
Henning Steinicke
Julia Klabuhn
Michael Kraft
Caroline Wichmann

1. Introduction

Public opinion plays a vital role in society's willingness to accept new research fields and technologies. This particularly applies to relatively new areas of research like synthetic biology. For the first time, the Institut für Demoskopie (IfD) Allensbach – Gesellschaft zum Studium der öffentlichen Meinung mbH (Allensbach Institute), and the German National Academy of Sciences Leopoldina have joined forces to conduct a survey exploring both the level of knowledge and the attitude of the German public to synthetic biology in the context of their opinions on innovative technology. The results of this survey are presented here, as are the initial considerations put forward by a group of Leopoldina experts on improving communication on this field of research and technology.[1]

1.1. The Field of Synthetic Biology

In its statement titled *Synthetic Biology* (2009), the Leopoldina, together with the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) and acatech, the German Academy of Science and Engineering, pointed out the tremendous significance of synthetic biology, which combines approaches from chemistry, the life sciences, biotechnology and engineering. "The defining trait of synthetic biology is that it fundamentally changes biological systems and, in some cases, combines them with chemically synthesised components to create new entities. This creates characteristics which have, hitherto, been unknown in naturally occurring organisms."[2] A large section of the life

1 For information on the design and execution of this project, see Section 1.3, p. 8, and the appendix.

2 Deutsche Forschungsgemeinschaft (DFG, German Research Foundation), German Academy of Science and Engineering – acatech, German National Academy of Sciences Leopoldina – 2009, Synthetic Biology, Wiley-VCH, Weinheim: 7. Downloadable from: http://www.leopoldina.org/uploads/tx_leopublication/2009_NatEmpf_synthetische_biologie-DE.pdf – last downloaded on 04.08.2014.

sciences – including pharmacology, protein biochemistry, breeding research and stem cell research – are already using methods from this field of research and technology. The 2009 statement lists, for example, opportunities for new research approaches in the life sciences – here we will mention only the development of new medications based on cellular processes modified using synthetic biology – and also highlights the economic potential that could be achieved if the German Federal Republic were to assume a leading role in synthetic biology. At the same time, the statement also points out the potential risks, for example in biosecurity. The development of this field of research since 2009 has confirmed that synthetic biology is highly relevant to society and may, in some cases, require changes in legislation.[3]

1.2. Study Aims and Objectives

Against this backdrop, it is important that reliable information and transparent evaluations of the opportunities, challenges and risks posed by synthetic biology should increasingly be included in opinion-shaping and democratic decision-making processes. As the German National Academy of Sciences, the Leopoldina has made this its mission – both in its science-based political advice services and when it comes to informing the general public.

In order to achieve the most objective communication possible regarding the current state of research, its potential and uncertainties, and to propose alternative courses of action, the public's current opinion of synthetic biology must be understood. The positions held by important opinion leaders are also highly relevant. Thus far, there have been no detailed empirical studies on synthetic biology. The survey carried out by the Allensbach Institute therefore represents the first source of such empirical data.

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3 Compare Bundesamt für Verbraucherschutz und Lebensmittelsicherheit 2012, Monitoring der Synthetischen Biologie in Deutschland. 1. Zwischenbericht der Zentralen Kommission für die Biologische Sicherheit. Downloadable from: http://www.bvl.bund.de/SharedDocs/Downloads/06_Gentechnik/ZKBS/01_Allgemeine_Stellungnahmen_deutsch/01_allgemeine_Themen/Synthetische_Biologie.pdf?__blob=publicationFile&v=3 – last downloaded on 12.12.2012.

1.3. Study Format

In a joint project funded by the German Federal Ministry of Education and Research (BMBF), the Allensbach Institute and the Leopoldina used a representative survey to determine the level of knowledge and the attitude of the German population towards synthetic biology in the context of their attitudes to innovative technologies.

The survey comprised 23 in-depth interviews with researchers from different fields, a quantitative survey of 106 researchers and 103 journalists, as well as a survey of 2,350 people who formed a representative cross-section of the German population aged 16 and over.[4]

The Allensbach Institute made the survey results, detailed in Part II, available to a group of experts from the Leopoldina, who then provided the initial evaluations presented here on how to improve communication on synthetic biology.

4 See also Part II, Section 8, p. 106 and the appendix, p. 110.

2. Overview of the Survey Results

2.1. The Innovation Climate and the Population's Trust in Science

As the results of the survey show, researchers and journalists, as well as the general population, consider Germany as an open and friendly environment for research and innovation. This particularly applies to those areas of research that are significant to the population's daily lives. The more relevant an area of research is to people's everyday lives, the greater their interest in and knowledge of it. In addition, a large percentage of the population places a great deal of trust in science generally.

Having said that, however, it is difficult to make generalised assessments of the innovation climate. For controversial fields that are strongly in the public's focus, assessments can also be negative. This pertains to both the perception of a particular research field by the public and the effects of public debate on research, for example with respect to decisions on research funding and regulation.

2.2. Levels of Knowledge of Synthetic Biology and Public Perception

The public's interest in synthetic biology is low. It is perceived by those surveyed as an abstract field with little everyday relevance. Both the researchers and journalists surveyed mentioned synthetic biology as being one of the most difficult topics to communicate.

Opinions on little-known research fields like synthetic biology are expressed largely through spontaneous reactions, regardless of one's level of knowledge or consideration of the fields' potential risks and assumed benefits. As the survey shows, potential insecurities and risks are more likely to be tolerated by the public if the specific potential of

new research areas to solve significant everyday problems is considered high. Synthetic biology achieves the greatest level of acceptance if it is represented in a medical or economic context.

2.3. Communication Between Researchers and Journalists

Communicating their research content is part of researchers' work and is particularly expected of researchers at publicly-funded facilities. Researchers are supported in this by the press and public relations departments at the respective research institutions. As the results of the survey show, however, scientists also maintain direct contact with journalists. Both researchers and journalists call for greater commitment in communicating scientific material to the public.

Journalists play a central role in framing public debates. Indeed, they select the topics to be explored, evaluate them, and present them to their target audiences in a comprehensible manner. As such, journalists can help the public understand new technologies, highlight their potential benefits, and point out any risks. As the survey shows, many researchers perceive reporting to be focused on risks. Researchers react to this by attempting not to conceal risks, but rather to communicate them transparently. Journalists confirm this indirectly in the survey by the very high level of credibility they bestow upon researchers from independent research institutions. This level of credibility is much lower when it comes to researchers associated with corporations.

2.4. The Role of the Various Media in Scientific Communications

According to the survey results, the most important medium for communicating scientific information is by far television, followed by newspapers, magazines, radio and the Internet. For those under 30, the Internet is the second most important medium after television. Publications issued by scientific organisations have a very small audience. These usage habits do not reflect each medium's credibility, however.

The Internet is heavily used, but not considered trustworthy, whereas publications by scientific organisations are considered reputable by all respondents. Until now, social media has played almost no role in scientific communication. This perception is shared by researchers, journalists and social media users alike.

The more credibility a specific medium enjoys, the more likely the survey respondents are to agree with the way that particular medium evaluates the topics it presents. Journalists on television, in newspapers, magazines and radio are therefore particularly trusted to make credible assessments of scientific content.

3. Considerations on Communicating Synthetic Biology

3.1. Framework Conditions: The Influence of Public Opinion on the Innovation Climate and the Population's Trust in Science

In trying to understand the relevance of public discussion for the future development of research fields, the presumed influence of public opinion on the innovation climate in general is an important starting point. This influence is held in extraordinarily high esteem by both researchers and journalists. The social environment is considered by both groups to be particularly significant, both for the innovation climate and for making decisions on research policy (89 percent of researchers and 68 percent of journalists).[5]

There are, however, differences in the precise assessment of this relevance for different research fields. In particular, the innovation climate for controversial areas is, according to the survey, heavily influenced by public opinion. Instead of making sweeping generalisations about the innovation climate in Germany, it therefore seems necessary to separately consider individual areas of research. This makes it more difficult to compare different locations internationally. If, however, you ask researchers and journalists to evaluate the general innovation climate in Germany compared to abroad, half of those surveyed are convinced that the general framework conditions in Germany are more favourable.[6] Greater freedoms for research and innovation are, however, not perceived.

5 See p. 28: Figure "Tremendous Influence by the Public".

6 See p. 31: Figure "…Partly in Comparison to Other Countries".

Both researchers and journalists consider the social environment in Germany as open and not hostile to innovation. This perception corresponds to the trust that a large part of the population, according to the survey, places in science.

The majority of the population (60 percent) also acknowledges that scientific progress is an important basis for Germany's future. It is also apparent that those under 30 believe that mastering modern technology plays a decisive role in their own future prospects. Although the population tends to place a large amount of trust in science, not everyone perceives science as either all good or all bad. At least 14 percent of those surveyed also consider scientific progress as problematic.[7]

3.2. Starting Point: The Remoteness of Synthetic Biology from Everyday Life

Interest in scientific issues and research results is very unevenly divided among the different population sectors in Germany. Just a small part of the population is generally interested in scientific topics. The survey divided participants into two groups according to their vastly differing opinions: the first group comprised those who were fundamentally interested in scientific topics, while the second was fundamentally disinterested in science.[8]

When presented with the fairly new – and, at first glance, alien – field of synthetic biology, the overwhelming majority of those surveyed knew either nothing or very little about it. The term was unfamiliar and there was no great interest in this branch of research (82 percent knew nothing or next to nothing about it).[9] This is in contrast to the very high

7 See p. 39, 1st paragraph.

8 Furthermore, those population groups who were fundamentally interested in science could be further categorised by their specific interests. In controversially discussed fields, in particular, there are well informed and, to a large extent, organised sections of the public, who must be specifically addressed. The survey topic itself, however (technology fields with which the general public are unfamiliar) argues against a further division of these two groups. As knowledge of these research fields is, by definition, low, a further division of the two population groups mentioned would not have been useful.

9 See p. 42: Figure "Most Perceive Own Level of Knowledge Realistically As Low".

level of interest in those fields that are relevant to our daily lives, including research into age-related diseases, general medical research, and research into energy efficiency.

> The more concretely relevant an area of research is to people's everyday lives, the greater the population's interest in and knowledge of it.[10] As the relevance of synthetic biology to our everyday lives is not recognised, general interest in it is low. Both researchers and journalists are aware of this.[11]

3.3. Guiding Strategy: Enable the Most Specific Cost-Benefit Analysis Possible

When it comes to the social environment and shaping public opinion, the levels of knowledge and interest among the public are not the only defining factors. Independent of knowledge or interest, the population is not prepared to take chances in research. Indeed, 42 percent of the population are in favour of abandoning research fields if even low risks are possible.[12]

How entirely new research fields are linked to risks depends considerably on how that particular field is perceived. The majority of the population react spontaneously negatively to the term "synthetic biology".[13] This is noteworthy due to the fact that this assessment relates to a field that was completely unfamiliar to the overwhelming majority of respondents before they took part in the survey. Only the term "genetic engineering" is reacted to less positively.[14] When participants were presented with various terms and asked to associate them with the term "synthetic biology", the chosen terms frequently included "interfering with nature" or "risk and danger".[15]

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10 See p. 39, last paragraph.

11 See p. 40/41.

12 See p. 46: Figure "Risk Aversion".

13 See p. 43: Figure "Spontaneous Emotional Reactions to Key Terms".

14 ibid.

15 See p. 45: Figure "Associations for 'Synthetic Biology'".

It is particularly interesting to examine the population group that reacted spontaneously positively to the term "synthetic biology". This group of people assess the risks at a similar level to those who reacted negatively. There is, however, an important distinction in their assessment of the field's benefits. These are perceived as being considerably higher by those respondents who reacted positively. In this respect, this group's reaction is less emotional and more rational.[16]

> The public's spontaneous reactions to terms like "synthetic biology" or "genetic engineering" considerably influence their attitude to these research fields, independent of their level of knowledge. This is particularly significant for the acceptance of largely unknown research fields. People's spontaneous reactions to a research field are determined not only by their assessments of its potential risks, but also by the assessment of its potential benefits. In communications relating to synthetic biology, therefore, it is particularly important to communicate the potential benefits, as well as the risks and uncertainties.

Information about specific applications can strongly influence the perception of new research fields. This not only affects people's personal levels of interest in these fields, but also their perception of their economic significance, their fundamental attitudes towards them, and ultimately their acceptance of new research areas. This can be clarified using synthetic biology as an example. The overall very low level of interest in this research field was, in some instances, increased almost six-fold during the study by specifying its benefits. Just 10 percent of those surveyed have a significant interest in synthetic biology; 58 percent are, however, interested in its potential to produce artificial cells to fight disease.[17]

Potential emotional involvement triggered by specific usage examples is of decisive significance here. If synthetic biology is presented in the context of combating disease, it is met with greater public interest

16 See p. 45: Figure "Associations for 'Synthetic Biology'".

17 See p. 48: Figure "Reactions to Specific Applications of Synthetic Biology" and p. 49: Figure "Considerably Greater Interest when Specifying Benefits".

than when it is presented in the context of producing plastics or textiles.[18] Here, too, medical applications trigger the most hope. People's fundamental attitudes to synthetic biology change from 'fraught with risk' to 'full of hope' when they are informed of its specific benefits.[19] When an abstract description of the research field is given, fears associated with synthetic biology tend to dominate.

> Potential uncertainties and risks are more likely to be tolerated by the public if the specific potential of new research areas to solve significant world problems is considered high.

Independent of the hope evoked by its medical applications, a field's economic significance is also particularly relevant for shaping public opinion. Examples such as the potential role of synthetic biology in creating fuels by using modified algae or cyanobacteria increase the public's assessment of the economic relevance of synthetic biology.[20]

Researchers and science journalists, who usually study new technologies very intensively before they report on them, often share the same assessments of the benefits of innovations and new research areas. Specifically communicating the benefits of synthetic biology to the public helps reconcile the perceptions of researchers and journalists on the one side, and those of the wider population on the other.

> The great significance of stating a field's relevance to everyday life and specifying application examples in scientific communication are underestimated by sections of the scientific community. Not only must complex relationships be explained using examples, but they must be simplified as much as possible. High levels of detail and abstraction pose obstacles to successful communication. It is also important to avoid using technical terms which, although commonplace for researchers, may not even be understood by researchers outside the field in question.

18 See p. 48: Figure "Reactions to Specific Applications of Synthetic Biology".

19 See p. 53: Figure "Specific Applications Change Basic Attitudes Considerably".

20 See p. 56: Figure "Assessment of the Economic Significance of Research Fields".

The opportunities for effective, comprehensive communication on their own research field are described by almost all researchers as being great or very great.[21] This also applies to topics that are difficult to communicate to a lay audience. Journalists share this opinion, but assess the researchers' abilities to explain complex relationships to a lay audience much more critically than the researchers themselves.[22]

3.4. The Heart of the Matter: Communication between Researchers and Journalists

When assessing the potential uses of synthetic biology, researchers and journalists do not always agree. It is interesting to note that the researchers' positive assessments of the benefits differ strongly from the general public's negative assessments, especially in those research fields that are also considered less beneficial by journalists. This could, on one hand, be due to the fact that the journalists in these cases are no better informed than the general public, and cannot therefore be counted as part of a well-informed section of the public. It is, however, much more probable that the journalists have more information than the general public, but do not consider it as persuasive as the researchers intended. This shows that journalists are not merely translators or brokers of scientific content, but that they also evaluate scientific content and communicate it accordingly.

> The selection and effective presentation of application examples that illustrate the potential benefits of research seem to be more important than the level of communication between researchers and journalists.

Researchers are aware of the need for public relations work and now consider it a matter of course (96 percent consider scientific communication important or very important).[23] All the journalists surveyed share

21 See p. 73: Figure "Optimism Relating to the Communicability of Your Own Specialist Area…".

22 See p. 76: Figure "Communication with Scientific Laypersons" and p. 78: Figure "…Very Different Impressions from Journalists".

23 See p. 60: Figure "Consensus: Informing Public of Research Results is Important".

this opinion.[24] Both groups believe that communication can increase both interest in and understanding of research fields. Direct communication with the public plays only a minor role in the everyday lives of the majority of researchers.[25] At research institutions such tasks are usually performed in collaboration with the press and public relations departments. Researchers and journalists do, however, engage in direct contact, at least occasionally. This is considered important or very important by an overwhelming majority of researchers (86 percent).[26] Independent of their assessment of its relevance, this direct partnership is met with mixed feelings by researchers, who assess journalists' competence as both high and low.

Although a large number of researchers write popular scientific articles from time to time, they do not consider public relations work to be one of their core tasks. This does not mean that researchers consider communication with the public irrelevant. Instead, it is almost impossible for researchers to find the time for such activities. In addition, popular scientific articles are seldom considered career-advancing by the scientific system.

Both researchers and journalists believe that there is still room for improvement in communication, with both groups calling for more commitment in this area. Interestingly, researchers consider communication more relevant for the acceptance of research areas than even journalists do. Indeed, the majority of researchers (58 percent) attribute the acceptance problems of genetic engineering in agriculture to a lack of effective communication. Only a minority of journalists (36 percent) share this opinion.[27]

Journalists see themselves as mediators between science and the public, and the requisite avoidance of highly complex concepts and jargon in journalistic reporting may be one of the reasons for the researchers' critical assessment of journalistic competence. This assessment is somewhat mitigated by a predominating trust in the correctness of the factual content of journalistic articles. It is interesting to note that

24 See p. 60, 2nd paragraph.

25 See p. 71.

26 See p. 87: Figure "Contact with Journalists is important".

27 See p. 70: Figure "Dissention between Scientific Experts and Journalists".

researchers from public research institutions place considerably more trust in journalists than their colleagues from private institutions.[28] Whereas just half of the latter believe in the factual accuracy of journalistic reporting, two-thirds of researchers working in public institutions are convinced of it.[29] This could be due to the fact that, for the vast majority of journalists, the economic potential of innovations is of secondary importance. Instead, most journalists are interested in generating interest in new areas of research and possibly communicating any risks involved. For corporations, of course, the economic potential is much more significant.

It is also interesting to see journalists' assessments of researchers from independent research institutions compared to researchers associated with corporations. Indeed, 85 percent of the journalists surveyed consider researchers from independent research institutions, like universities or other publicly funded institutions such as the Max-Planck-Gesellschaft (MPG, Max Planck Society), to be reliable sources. On the other hand, just 17 percent of journalists consider researchers associated with corporations to be equally reliable.

Just like the wider population, however, journalists generally place a high level of trust in science. This high level of credibility can, of course, also lead to negative side effects. The exploitation of experts is considered by both researchers and journalists to be a widespread phenomenon. Researchers are, of course, not only exploited by journalists; in their turn, researchers also attempt to exploit journalists for their own ends. Many journalists report that such attempts are particularly prevalent when it comes to topics of economic interest. Many researchers are entirely aware of this issue and mention objectivity and balance as the most important prerequisites for good scientific communication. Conversely, one-sided portrayals, over-emphasising potential opportunities, and concealing both disadvantages and risks are considered particularly serious errors in scientific communication.[30]

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28 See p. 92: Figure "Conclusions on Reporting on Your Own Research Field" and p. 93: Figure "Bias of Reporting in Your Own Research Field".

29 See p. 93: Figure "Bias of Reporting in Your Own Research Field".

30 See p. 81: Figure "Errors in Scientific Communication".

Researchers have a perception that journalists focus on communicating risks, which leads them to evaluate the tenor of such reporting as being very mixed. Depending on their own research fields and potentially their own motives, researchers often perceive scientific reporting as one-sided. Just one-third of the researchers surveyed do not see this problem.[31]

> Although researchers often perceive public debate as risk-focused, this does not change their opinion of the necessity of communicating risks. This attitude is acknowledged by journalists in the very high level of credibility they attribute to researchers, particularly those from independent research institutions.[32]

Irrespective of their fundamental attitude towards science, the public perceives no negative bias when it comes to reporting on new scientific topics.[33]

3.5. Media Selection: The Disparity between Credibility and Usage Patterns

When it comes to communicating scientific content to the public, the various media used to communicate this content should be individually examined, as should the different areas of research. If we look at the population as a whole, television plays the biggest role in conveying scientific information, followed by newspapers, magazines and radio.[34]

The Internet has a particular relevance for survey respondents under the age of 30.[35] The diverse opportunities for communication using this media lead, however, to the Internet's credibility issues.[36] Whereas 45 percent of the total population use the Internet for information on

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31 See p. 94: Figure "One-Sided Reporting?".

32 See p. 97: Figure "Assessment of Reliability of Information Sources".

33 See p. 95: Figure "Assessment of Media Tenor".

34 See p. 85: Figure "Sources of Information on Research Topics".

35 ibid.

36 See p. 86: Figure "Usage of and Trust in Information Sources".

scientific content, just 21 percent consider it reliable. It is the primary medium for targeted information searches, however. For the visibility of individual researchers or institutions, this has enormous potential. For the most important opinion leaders – the journalists – the Internet is, however, just one of many helpful media used in obtaining and communicating information. Researchers also see the Internet as improving the opportunities for obtaining information, but believe that television has a particularly high communication potential.

Although publications from scientific organisations and researchers reach only a minority of the public who are strongly interested in science, they should not be considered irrelevant. Indeed, this medium enjoys a high level of credibility. Although a large number of respondents (41 or 43 percent) consider publications by universities and scientific organisations to be particularly credible sources, just one-third of respondents use them for information.[37]

> The respondents' level of media usage does not reflect a medium's credibility rating. The Internet is considered unreliable but is heavily used; universities and scientific organisations enjoy a high level of credibility, but are seldom used as sources of information. Since the successful communication of a scientific topic depends only partly on its communicability and the abilities of its researchers, this is an important insight.

The public's acceptance of an information source is hugely significant. Objectivity and the credibility of the information source play as large a role as the research's comprehensibility. This also applies to the communication of uncertainties and potential risks.

The journalistic evaluation of content seems decisive for the public's perception of a medium's credibility. Although this evaluation also takes place on the Internet – often in even more detail in scientific blogs than in other media – television, newspapers, magazines and radio are, with their editorials, perceived as containing more credible assessments of scientific content.

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37 See p. 86: Figure "Usage of and Trust in Information Sources".

The Internet's social media provide a platform for direct dialogue between researchers and individual members of the public. Despite such opportunities for dialogue, the Internet is still perceived by all involved as primarily a targeted-search medium. The enhanced communication options provided by social media, which go beyond this function, apparently play little role in current scientific communications.

4. Conclusions

The survey carried out by the Allensbach Institute highlights several factors that decisively influence both communication on synthetic biology and the public debate on new research and technology. These factors should be specifically taken into account during scientific communications and science-based political advice.

4.1. Creating Everyday Relevance

As the study has shown, the everyday relevance of a research area is the deciding factor when it comes to attracting the public's interest. The great significance of stating a field's relevance to everyday life and specifying examples of its use in scientific communication are still underestimated by parts of the scientific community. Synthetic biology is to a large extent still perceived by the respondents as an abstract topic, far removed from everyday reality. In order to clarify its relevance, it is important to specify the most relevant links possible to people's everyday lives. This is essential for increasing the public's interest and knowledge and facilitating informed public debate on synthetic biology. Mentioning potential uses, for example in developing new medicines, can be as helpful as providing data on the economic potential of this field.

4.2. Providing Transparent and Unbiased Information

The survey shows that for a new research and technology field to be accepted, it is important to weigh both the risks and potential benefits, even for respondents with little understanding of the topic. Both the potential benefits and risks should be communicated transparently and in an unbiased manner. As the survey proves, the credibility of research-

ers depends to a large extent on how transparently they present the potential risks of new research and technology fields. Uncertainties and open issues should be addressed.

4.3. Communicate Comprehensibly and Target-Group-Appropriately

Synthetic biology is perceived as an abstract topic by the majority of respondents. This makes comprehensible communication of the content particularly relevant. The state of research, conclusions and application examples must be formulated appropriately for the target group.

All successful communications have the following items in common:

- Avoidance of jargon when explaining complex relationships.
- A low level of abstraction when citing potential uses.
- Simple explanation of relationships.

4.4. Accounting for the Role of the Media

The survey proves that certain media with high levels of usage and credibility shape public debate on new research and technology fields. This applies primarily to television, which turned out to be the most used and most trusted medium. At the same time, the survey showed that high levels of usage by no means translated into high levels of credibility, and vice versa. Researchers should take both this and the role of journalists as opinion leaders into account when communicating their content. Journalists not only “translate” topics for their specific audiences, but also – as the survey shows – consider it their core mission to select topics, to evaluate them, and to promote or even trigger public debate.

Part II
The Prerequisites and Opportunities of Scientific Communication – Documentation from the Study Performed by the Institut für Demoskopie Allensbach

Renate Köcher

Introduction

The following section documents the results of the empirical study on the communicability and acceptance of scientific innovation using the example of synthetic biology. The survey was carried out by the Institut für Demoskopie Allensbach in cooperation with the German National Academy of Sciences Leopoldina. The study comprises three modules:

- 23 in-depth interviews with researchers who work in the field of synthetic biology or closely related research fields.
- A quantitative survey carried out among 106 scientific experts and 103 journalists who often cover scientific topics.
- A population survey based on approximately 2350 interviews with a representative cross-section of the population aged 16 and over.

All the interviews were conducted in 2013. The first phase comprised the in-depth interviews as a preparation for the quantitative study, while the second phase, which was carried out between September and November 2013, comprised the representative population survey and the quantitative survey of researchers and journalists. The composition of the study sample is documented at the end of this study report.

1. Major Influence of Public Opinion on the Framework Conditions of Scientific Research

For natural scientists, there is no question that the social innovation climate and society's level of openness towards research or scientific and technical progress heavily influence a country's development. In this, there is a far-reaching consensus between scientists and those journalists who explore science-related topics in their work. Indeed, 92 percent of the researchers surveyed and 87 percent of the journalists consider the social innovation climate very important, while the rest consider it important.

Consensus: Society's Openness Towards Science and Innovation Is Important

Question: *"In your opinion, how important is it for the further development of Germany that society is open and accepting towards research and innovation? Would you say that it is ... for Germany's future development ..."*

	Scientific experts	Journalists
	%	%
"Very important"	**92**	**87**
"Important"	**8**	**12**
"Less important"	**–**	**1**
"Barely/not important"	**–**	**–**
No response	**–**	**–**
	100	*100*

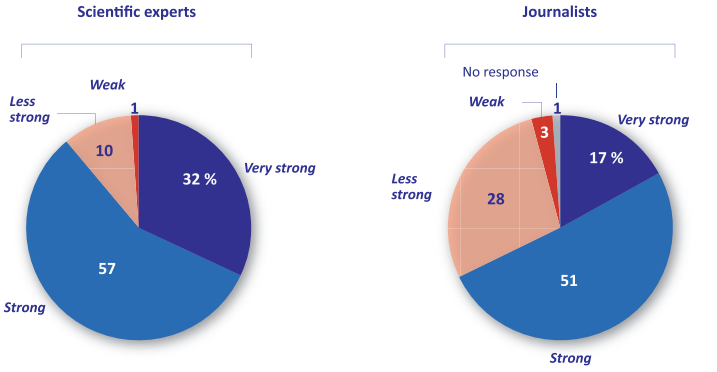
Basis: German Federal Republic, scientific experts and journalists
Source: Allensbach Archive, IfD Survey 6263

The overwhelming majority of researchers surveyed are also convinced that the public's attitudes – and also, in part, their concerns – affect political decisions on the framework conditions for scientif-

ic research. 89 percent of the researchers surveyed consider public opinion to have a strong or very strong influence on the framework conditions for research, an assessment that two-thirds of journalists share.

Tremendous Influence by the Public

Question: "In your estimation, to what extent do the attitudes and fears of the public influence political decision-making about framework conditions for scientific research? Is this influence...?"



Basis: German Federal Republic, scientific experts and journalists
Source: Allensbach Archive, IfD Survey 6263

It has, however, been emphasised that the influence of public opinion varies considerably from discipline to discipline and among the different research areas. The decisive questions here are whether or not the research area is of interest to a wider public, and whether or not controversial debates develop. This was (and still is) the case with both genetic engineering in agriculture and stem cell research. At the same time, the pre-survey in-depth interviews with scientific experts showed again and again that research institutions in Germany, like, for example, the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) or the Max-Planck-Gesellschaft (Max Planck Society), can act as a shield against certain obstacles to research in particular fields:

"The extent to which public discussion and opinion forming influence the scope for scientific research depends on the field. Obviously, things like stem cell research and similar subjects are in focus. These affect people very directly, and ethical considerations come into play. This, of course, affects people very directly. If the discussion on the kind of research we want to do or not do reaches the church, as it can in extreme cases, this naturally has a massive influence. We can see this specifically in the current German legislature, and its effects on genetically modified organisms and stem cell research. This research is also far from being standardised around the globe. In Germany, it's much more restricted than in other places."

"Public opinion plays a significant role, because research does not take place in a vacuum. If it is funded with public money, it requires political support. If that's not there, neither is the money. On the other hand, there is also a certain freedom, because science is primarily free, and the main funding institution, the DFG, is free from political influence. It is driven by scientific quality, not by political wave-making. This enables it to manage without a political tailwind once in a while. Let's take a couple of examples: stem cells, genetic engineering. When it comes to subjects like that, the political climate does matter. Otherwise there isn't enough public funding available."

"Society's opinion can have a considerable influence. You can't carry out genetic engineering in agriculture in Germany. Just forget it. If you're interested in carrying out that kind of research, you've got to emigrate. You can either welcome this or bemoan the fact. It is, however, certain that, as soon as their daily lives are impacted, the public will get heavily involved. In my field, I haven't yet come across anything where I've had the feeling that I'm crossing any potentially difficult boundaries. I'm not doing any research which is particularly welcomed by the public or which is particularly critical. I'm part of the ivory tower, like a lot of researchers. No-one really understands exactly what that is. You can explain it, but it's just a bit too far removed from the everyday and too abstract."

"That always depends on the research field. Genetic engineering in agriculture, for example, is a very large area of contention. In this field, ultimately, a lot of researchers in Europe, or at least in Germany, have given up hope, particularly those in industrial enterprises, because the debate has become ideologised. In that respect, public discussion can be a major problem for science."

"We can see its influence in the fact that now, for example, plant biotechnology has essentially left Germany. This has to do with the fact that large sections of the population have decided that they don't want anything to do with genetically modified food. In that respect, Germany is not a market for it. This means, of course, that parts of this field, which are far removed from genetically modified foods, are no longer being researched in Germany."

Despite these critical statements about the effects of public discussion on genetic engineering in agriculture and stem cell research, the re-

The Overwhelmingly Positive Influence of the Social Climate ...

Question: "How would you estimate the social climate in Germany as regards science and research? Would you say that, in Germany, attitudes towards science and research are ..."

	Scientific experts	Journalists
	%	%
"Very open"	**13**	**13**
"Largely open"	**59**	**71**
"Less open"	**25**	**12**
"More closed"	**2**	**2**
Undecided, no response	**1**	**2**
	100	*100*

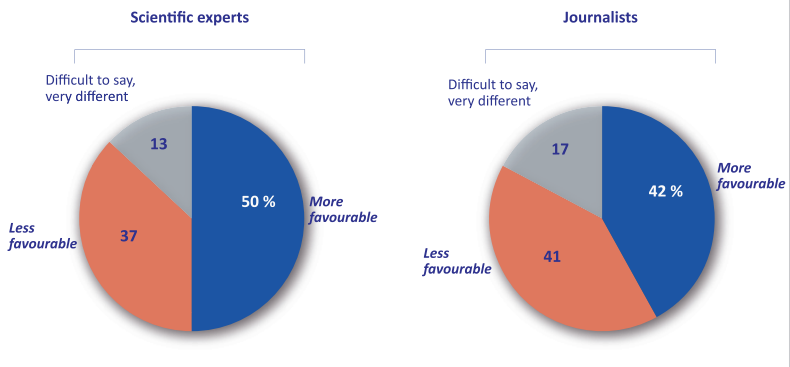
Basis: German Federal Republic, scientific experts and journalists
Source: Allensbach Archive, IfD Survey 6263

searchers surveyed did not overwhelmingly have the impression that they were battling a very difficult social environment, one fraught with rejection. Although a minority perceive the social climate towards science and research as being very open, the majority consider it open, on the whole. Just one in four researchers find it insufficiently open, while a vanishing minority view the social environment as rejection-filled and generally opposed to science and research. The journalists surveyed tend to draw more positive overall conclusions than the scientific experts, as shown in Graphic 3.

Even in comparison with other countries, one in two researchers surveyed consider the social environment in Germany more open to research; 37 percent find it less so. The journalists surveyed are, interestingly, more sceptical than the average scientific expert.

... Partly in Comparison to Other Countries

Question: "If you were to compare Germany with other countries, would you say that the social environment in Germany is more or less favourable towards science and research than that in other countries?"



Basis: German Federal Republic, scientific experts and journalists
Source: Allensbach Archive, IfD Survey 6263

Some of the participants, however, considered it impossible to make a generalised judgement. In the extensive in-depth interviews, it was noted that there were considerable differences both between countries and between fields:

"Oddly, Germany is divided. When it comes to technology and engineering, particularly things like mechanical or vehicle engineering, it's the Germans who embrace this knowledge and its application. We're the only country in the world, I think – or one of the few, anyway – which has no speed limit, and we're a premium market for certain vehicle brands. This is great, because it's also good for exports. In that field, therefore, there's a high level of acceptance of technology and innovation. Things are different in the life sciences. There, new technologies are traditionally met with scepticism, particularly when it comes to genetic engineering. In certain areas, this has been overcome, because using genetic engineering methods in medical applications has produced some successes. It would be interesting to discover where the whole thing comes from. I think it's a German thing, but when it comes to certain technologies, like genetic engineering in agriculture, that isn't tolerated anywhere in Europe. But Germany plays a significant role."

"National cultures exist, but they aren't as different from each other as they are sometimes portrayed. We hear, for example, the same thing over and over again: "Oh, those Germans with their fear of nuclear energy, the French all love it." And when you look at the Eurobarometer 2010, at the survey data, you'll see that France and Germany are always next to one another, always in the middle of the field compared to the rest of Europe. So some stereotypes aren't true. There are certainly cultural differences: for example, the Japanese are renowned for their love of play when it comes to robots and other things, and that leads naturally to the fact that they develop particular research fields more quickly and easily than we do. There are different regulatory systems. In Europe, the precautionary principle is relatively strong, while, in the USA, it's more of a free market. Until something happens, you can, as it were, do almost anything. Then again, everything there is regulated in terms of product liability. I think these types of regulatory systems are perhaps stronger than the cultural differences."

"It's always said, for example, that the conditions for stem cell research in England are much more favourable. In England, though,

the conditions are much more difficult when it comes to animal experimentation in research. I think every country has its own background and difficulties. You can't generalise. In Germany, we have healthy discussions of the risks and side effects of research. We also have good reason in our country to consider the ways in which research can be abused. I have respect for the fact that some discussions take longer here than they do elsewhere. The framework conditions are, all in all, extremely positive when compared to other countries. Is there a more positive prevailing mood in the Anglo-Saxon countries towards research and progress, towards feasibility and risk management capabilities? I believe this very much depends on the context. There are certain cultures in various countries which have been shaped by history and which have their roots in strong interest groups. It's easier to work in embryo stem cell research in England, but overall it's not easier to perform research there. The funding situation here is better; there's more money going into research. And work in some research areas is, positively speaking, better regulated here than it is in England."

"I have a great deal of contact with the USA, and the same intense discussions are being carried out there on embryo stem cells and nucleus transfer. In the USA, too, there's extremely strong opposition to embryo stem cell research, for example. In the USA, informing the populace is more usual than it is in Germany. At Harvard, for example, they have a facility, like a museum, for the public, which is part of their laboratory. I thought that was really great. Communication is, however, linked to the fact that, in the USA, funding must be attracted. That's why researchers approach the population; not just the alumni, but the population."

"In other countries, there are more favourable environments, of course there are. In the newly industrialised countries, particularly. There, science and technology have a different status, because those countries want to advance. They are, of course, at a different level, even in their infrastructure. When we compare them with other countries, like USA or Australia, for example, they place greater trust in scientific discovery and progress. I would disagree

with anyone who said that you can't get anything done here, though. Over the years, we've been able to do research here that we would never have thought possible. You can't say that you can't do that in Germany. I think that science is pretty well-placed here. We can use our hard-won freedoms to do a great deal."

Although half of all the researchers surveyed assessed the social environment as favourable compared to other countries, only 15 percent perceived greater freedom for research. Half of all researchers, however, are convinced that research in Germany, on average, is subject to more provisions and restrictions than it is in other countries. One in three researchers perceived no major difference between the framework conditions in Germany and those in other countries. The critical voices come from an above-average number of researchers who work in corporations – thus, more are employed in applied research and less in basic research. The majority of these researchers are convinced that researchers in Germany have fewer freedoms than those in other countries. Of the scientific experts from research institutions, only four out of ten share this assess-

Fewer Freedoms for Research?

Question: "What is your impression: Do researchers in Germany have more freedom in their research than researchers in other countries? I mean that they have relatively few restrictions or regulations, or do researchers in Germany tend to have fewer freedoms than researchers in other countries, or is there, in your opinion, no major difference?"

	All scientific experts	Scientific experts from –		All journalists
		corporations	research institutes	
	%	%	%	%
More freedoms	**15**	**8**	**22**	**18**
Fewer freedoms	**47**	**55**	**40**	**52**
No major difference	**33**	**33**	**33**	**20**
Undecided, no response	**5**	**4**	**5**	**10**
	100	*100*	*100*	*100*

Basis: German Federal Republic, scientific experts and journalists
Source: Allensbach Archive, IfD Survey 6263

ment. The majority of scientific experts from research institutions either perceive no major difference between the framework conditions for research in Germany and in other countries, or perceive even greater freedoms for researchers working in Germany. The majority of journalists are also sceptical of scientific experts from corporations.

The public, too, assumes that there are more restrictions on research in Germany than in other countries, and less freedom for scientists. This particularly applies to those portions of the population who have a pronounced interest in scientific topics. Half of these people are convinced that researchers in Germany have fewer freedoms than those in other countries; 38 percent of the overall population shares this opinion.

Public Feels that German Science Has Fewer Freedoms

Question: "If you go with what you know or suspect: Do researchers in Germany have more freedom in their research than researchers in other countries? I mean that they have relatively few restrictions or regulations, or do researchers in Germany tend to have fewer freedoms than researchers in other countries, or is there, in your opinion, no major difference?"

	Total population	Population interested in science and research
	%	%
More freedoms	**13**	**16**
Fewer freedoms	**38**	**50**
No major differences	**25**	**22**
Undecided, no response	**24**	**12**
	100	*100*

Basis: German Federal Republic, population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

Many of the researchers draw a distinction between legal framework conditions and regulations and opinion formation among the wider public. Although the correlation between this opinion-forming process and the development of legal framework conditions and regulations is emphasised, shaping public opinion among the general population or in particular population groups is considered just one of many influenc-

ing factors. The social environment and the shaping of public opinion among the wider population affects researchers very differently, depending on the field in which they work and whether they are engaged primarily in basic or applied research.

Most people, therefore, do not agree with the oft-cited blanket criticism that the German population is opposed to innovation. In the in-depth interviews, reactions ranged from the complete rejection of this idea to selective agreement right through to another, more positive, interpretation of scepticism towards progress:

"In my opinion, this is absolutely untrue. It's a myth from the 1980s or thereabouts. There have, meanwhile, also been historical investigations. This comes ultimately from an economic sector that was focused on location and competition. And this myth stubbornly persists, despite all empirical refutations. This is almost an interesting phenomenon in itself. Resistance to technology exists in certain areas: nuclear energy is one well-known example; genetic engineering in agriculture is another. But when you look at the broad spectrum of new technologies, there's nothing like that. Instead, I almost get the feeling that there's a resurgence of optimism surrounding technology, like the one we had in the 1960s."

"I can't understand that. In our research area, genetic engineering in medicine, which requires a great deal of innovation, we actually have a very positive general attitude towards science and research."

"Certain population groups believe that we don't need any more innovation or science. But in my experience, the largest – by far the largest – sector of the population recognises the need for it. There is a discrepancy between what the media publish and what a large proportion of the population thinks. If things are explained properly, people see them as positive. The difficulty is that public opinion often paints a completely different picture, and that causes a backlash. When we constantly hear and read how dangerous and harmful everything is, even people who have, until now, perceived things positively, become uncertain and alarmed. The media considers anything related to danger and disaster [to

be] much more appealing than anything which runs according to plan and which results in success."

"That's not really true. I wouldn't describe the climate in Germany as hostile to innovation. What there is in Germany, definitely, or what is somehow specific to Germany, is a very strong belief in the goodness of nature. Anything natural must somehow be good. Any manipulation of nature is initially criticised, because nature is intrinsically good, and anything that humans do to it can, initially, only be bad. Of course, as soon as we get a serious illness, this belief evaporates. Then we say that we have got to confront nature before it kills us."

"I wouldn't subscribe to the argument that there is a fundamentally hostile environment here. We do discuss things in more detail than other countries, and regulate them more. (....) There is, of course, a great deal of public opposition to a number of research fields – there's no question about that. Here, we often hear arguments against unfettered progress in biological and medical research, including the bioethical issues. Increasingly, the question arises as to whether or not animal experimentation can be justified. This goes so far that we see demonstrations by anti-vivisectionists. That affects us, of course, when a demonstration is announced and the police arrive and there are demonstrators waving banners in front of our building."

"We see innovation being very strongly blocked in certain areas. Genetic engineering in agriculture is the prime example. This is very strongly objected to in Germany, with people using both rational and irrational arguments. In other countries, it's simply accepted as a positive development. And research is carried out there. That means that the initiatives which oppose it in Germany are irrelevant globally, in a globalised society. That's how you have to look at it."

"I think there's a healthy scepticism. I see a healthy scepticism in the public. I see it as a healthy discussion. A healthy sceptical discussion.

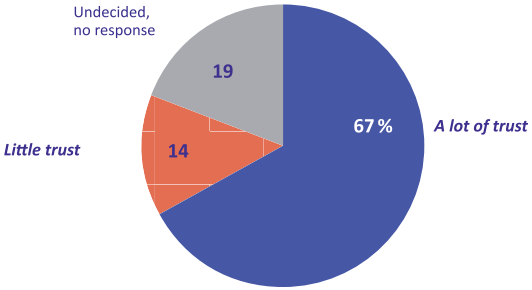
I see a healthy scepticism in the discussions, whenever we are as scientists getting into areas where there are some borderlines, when we are beginning to cross borders. Maybe you could argue that it is not to the scientist alone to decide but also the society as such."

No fundamental opposition to innovation

The opinion of most researchers that the social climate in Germany is shaped not by a general hostility towards innovation, but by very disparate reactions to different research fields, has been confirmed by multiple studies carried out over the past few years. The vast majority's fundamental attitude towards science and research is positive, and characterised by trust and goodwill. During a test of spontaneous reactions to keywords like "research", "science", "technology", "state-of-the-art technology" and "innovation", the overwhelming majority reacted positively: 88 percent reacted positively to the word "research"; 84 percent to the word "science"; and 68 percent to "innovation." Two-thirds of the population generally express a large degree of trust in researchers' expertise and sense of responsibility.

Great Trust in Science

Question: "What would you say: All things considered, how much trust do you have in researchers in Germany, in their competence and accountability?"



Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

In response to the question of which groups have advanced the Federal Republic of Germany over the past 60 years, the majority of the population names (in addition to the population itself) primarily entrepreneurs, scientists and engineers. 60 percent of the population are convinced that the country's future also depends heavily on the consistent funding of scientific progress. A strong relative majority believe that scientific progress generally simplifies and enriches the lives of the wider population. Just one in four see scientific progress as the primary cause of increasing problems and difficulties. Today's younger generation are particularly fascinated by technological advances and the potential uses of modern technology. The overwhelming majority of the younger generation also assume that their future careers depend on their ability to master modern technology, particularly communication technologies.

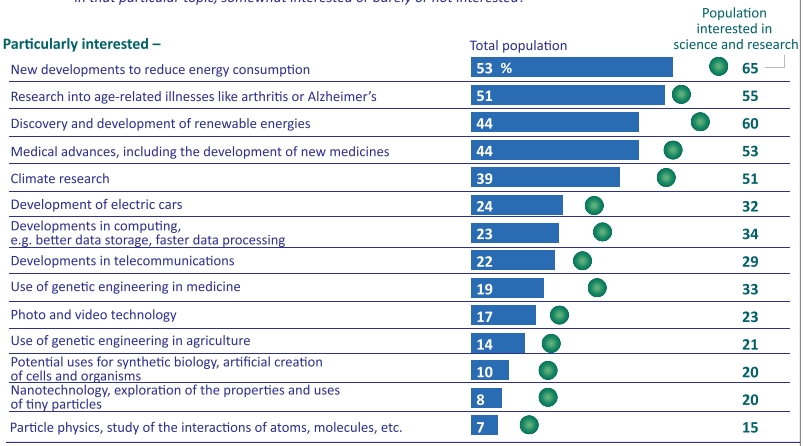
At the same time, today's scientific discoveries must be communicated to a society that exhibits the following characteristics: it is interested in scientific research only to a limited extent and highly selectively; it is ill-informed about many controversial fields, some of which have been discussed for years; in some cases, it is extremely risk-averse; and it regards certain fields of research with complete suspicion and resistance.

The sector of the population that is generally interested in scientific topics and research results comprises a good one-third of the population: 7 percent are extremely interested, while a further 28 percent are distinctly interested. This summarised self-assessment is, however, of limited value. The level of interest varies considerably depending on the field of research and according to an obvious pattern: the more specific and closer to people's daily lives a field is, the more people expect to benefit personally from scientific advances in that area – and thus, the greater their interest. The majority of this sector is very interested in innovations that will reduce energy consumption, or research into age-related diseases, such as arthritis and Alzheimer's. Medical research, too, is generally received with great interest, as is the further development of renewable energies and climate research. On the other hand, opportunities posed by synthetic biology, nanotechnology or particle physics are of considerable interest to just a small minority – partly because the vast majority of people cannot picture their specific benefits, or can do so only to a limited extent. These strongly differing levels of interest

can also be observed among those who are very interested in scientific topics and research results. While this group is more interested than average in all the topics surveyed, their spectrum of interests for the different research fields is wider than that of the overall population. Two-thirds of those, therefore, who are particularly interested in science and research are interested in innovations that will reduce energy consumption, while 60 percent are interested in advances in renewable energies. 55 percent are interested in research into age-related diseases, while just 20 percent are interested in the opportunities presented by synthetic biology or nanotechnology, and 15 percent are interested in particle physics.

Differentiated Interest

Question: "These cards contain several topics from the areas of science, research and technology. Please place the cards on this sheet according to whether you are very interested in that particular topic, somewhat interested or barely or not interested?"



Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013
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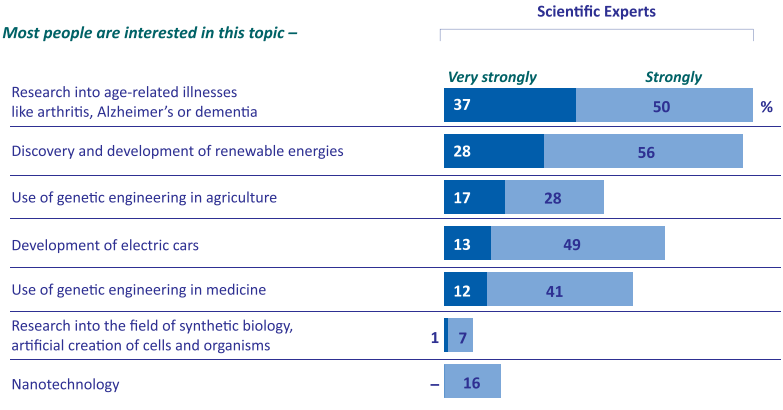
Both scientific experts and journalists are aware of this differentiation of interests. The overwhelming majority of experts are thus convinced that the results of research into age-related diseases or into the further development of renewable energies were received with great interest from the outset, whereas nanotechnology and synthetic biology are fields which fall outside of the public's interest and attention.

Assessment of the Public's Interest in Research Areas

Question: "Could you tell me how you perceive people's interest in each of these research areas?"



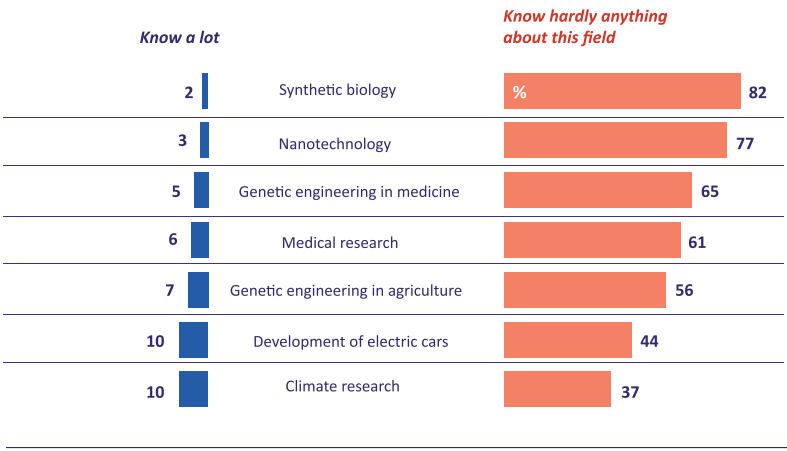
Basis: German Federal Republic, scientific experts
Source: Allensbach Archive, IfD Survey 6263

The population assesses its own level of knowledge regarding synthetic biology as low, particularly in areas that do not really interest them. 82 percent of the overall population conclude that they know nothing or next to nothing about synthetic biology. When it comes to nanotechnology, the figure is 77 percent; for genetic engineering in medicine, the figure is 65 percent; and for genetic engineering of crops, which has long been a controversial subject of debate in Germany, the figure is 56 percent.

In view of this balance between levels of personal interest and knowledge, the conclusion that could be reached is that research areas outside of the public's attention have little to fear from public opinion. As regrettable as we may find it, if highly promising fields raise little or limited interest among a wider lay audience, these may prove potential windows of opportunity for scientific freedom. The results of the population survey, however, make it clear that, even with low levels of knowledge and interest, opinions are certainly formed.

While the vast majority of respondents react positively to abstract keywords like "research", "science", "cutting-edge technology" and

Most Perceive Own Level of Knowledge Realistically As Low



Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013
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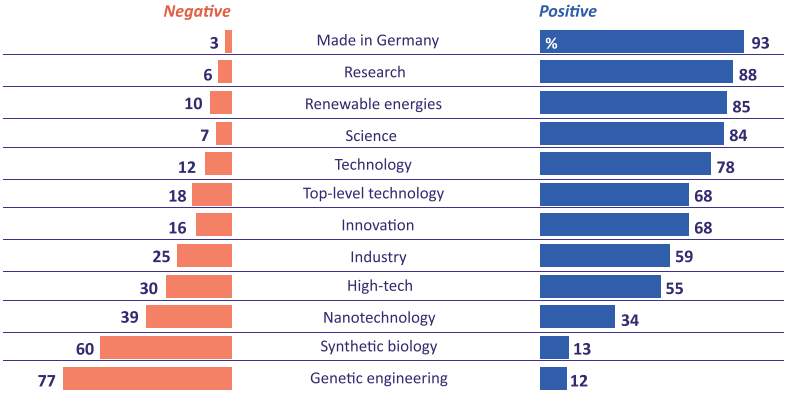
"innovation", the negative emotional reactions produced spontaneously by terms like "synthetic biology" or "genetic engineering" are just as strong. Although the majority freely admit to knowing little about genetic engineering, 77 percent react to the term with spontaneous antipathy. When it comes to synthetic biology, about which the overwhelming majority know next to nothing and are completely unfamiliar with the term, the vast majority still reacts with spontaneous antipathy: 60 percent dislike the term "synthetic biology", while just 13 percent react favourably. Such word association tests may appear playful, but they illustrate the fact that, when it comes to communicating with a lay audience, even the description of a research field can create barriers.

Words trigger associations – even without an appreciable level of basic knowledge. The overwhelming majority have specific associations with synthetic biology, despite the fact that two-thirds of those surveyed heard the term for the first time during their interview. The overwhelming associations were "interfering with nature" and "risk, danger", followed by "cutting-edge research", "multinational con-

Spontaneous Emotional Reactions to Key Terms

These terms are –

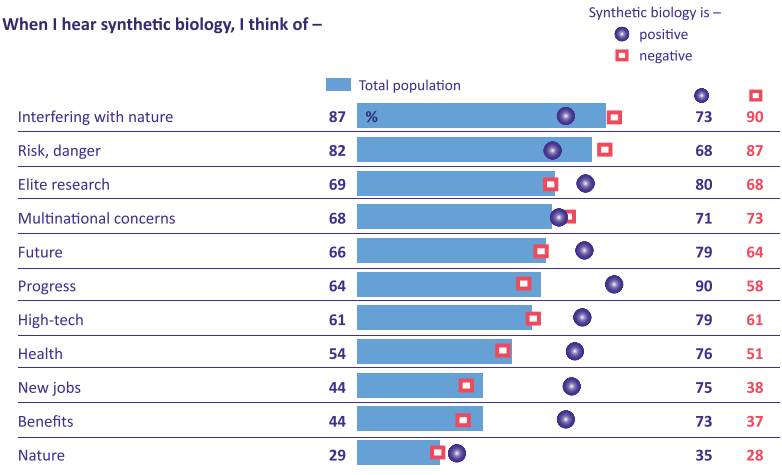


Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

cerns", "future", "progress", and "high tech". 87 percent associated the phrase "interfering with nature" with synthetic biology, 82 percent associated it with "risk", while two-thirds associated it with expressions like "future" and "progress". In contrast, just 29 percent associated synthetic biology with "nature". These associations illustrate the conclusion reached by one of the scientific experts: that Germany is very strongly characterised by a "strong belief in the goodness of nature", and that "any manipulation of nature is initially criticised".

The small minority which reacted favourably to the term "synthetic biology" still, in the vast majority, associated it with phrases like "interfering with nature", "risk" and "multinational concern". An above-average percentage, however, also associated it with terms like "progress", "health", "new jobs" and "benefit". This pattern parallels the results of studies of acceptance levels for genetic engineering or nuclear energy, which repeatedly showed that population groups which were either in favour of or opposed to the field in question differed more strongly in their assessment of its benefits than in the assessment of its risks.

Associations for “Synthetic Biology”



Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

Synthetic biology is associated with similar risks and dangers to genetic engineering. In contrast, the term “nanotechnology”, a field that is completely unfamiliar to the overwhelming majority, is linked in our minds primarily with terms like “future”, “progress”, “high tech” and “cutting-edge technology”. At the same time, nanotechnology is associated with having benefits by an above-average number of people – more than genetic engineering in medicine and considerably more than synthetic biology.

The question of the extent to which a research field is strongly associated with risks and only to a limited extent with advantages and benefits increases in significance when viewed against the backdrop of risk aversion. 42 percent of the population are in favour of blocking scientific research projects and fields if they are risky – even if the risks are small. The more unfamiliar a scientific topic appears, the stronger this fundamental risk aversion is.

Even among population groups with low levels of knowledge, research fields trigger associations and spontaneous likes and dislikes. These, however, are not firmly cemented during the early stages of opinion formation. As part of this study, we also examined the extent

Associations with Research Fields

Question: "A question on 'genetic engineering in agriculture' / 'genetic engineering in medicine' / 'nanotechnology' / 'synthetic biology'. "When you hear the term '.....' what do you think of? I'm going to read you some terms and I would like you to tell me whether or not these come into your head."

	Associations with –			
	Genetic engineering in agriculture %	*Genetic engineering in medicine* %	Nanotechnology %	Synthetic biology %
Interfering with nature	**87**	**79**	**47**	**87**
Risk, danger	**78**	**80**	**51**	**82**
Future	**52**	**74**	**77**	**66**
Progress	**47**	**69**	**76**	**64**
Elite research	**44**	**67**	**74**	**69**
Multinational concerns	**65**	**64**	**56**	**68**
High-tech	**42**	**59**	**76**	**61**
Health	**64**	**72**	**39**	**54**
Benefits	**41**	**51**	**66**	**44**
New jobs	**28**	**42**	**47**	**44**
Nature	**52**	**30**	**26**	**29**

Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

to which participants' interest in and evaluation of selected research fields changed when they were provided with information and usage examples. The results show that, in particular, providing information on a field's specific uses significantly changes both participants' interest level and assessment.

Risk Aversion

	Total population	Population interested in science and research –		
		Considerably	Limited	Scarcely/ not at all
	%	%	%	%
"In my opinion, we must be prepared to accept certain risks during the testing of scientific developments; risks can never be entirely ruled out."	**43**	**54**	**41**	**28**
"I see that differently. If there is even a slight risk to humanity, then we should do without scientific progress."	**42**	**33**	**44**	**52**
Undecided	**15**	**13**	**15**	**20**
	100	*100*	*100*	*100*

Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

2. Effects of Specifying Benefits of Research Fields

In view of the strong likes and dislikes expressed and the sharply defined associations with selected research fields, the question arises of the extent to which the interest and assessment levels change if research fields are presented less abstractly, using specific aims and usage examples. In order to verify this variation, the random population sampling was divided into two equally-sized, representative groups. In one group, the areas of research were discussed abstractly. In the other, the research areas were presented using specific aims and usage examples. Afterwards, the interest levels, emotional reactions and assessment of economic potential for each field were ascertained for each group. In all cases, receiving specific information about research fields resulted in major changes in both interest levels and assessment.

Effects that using specific examples have on interest in particular research fields

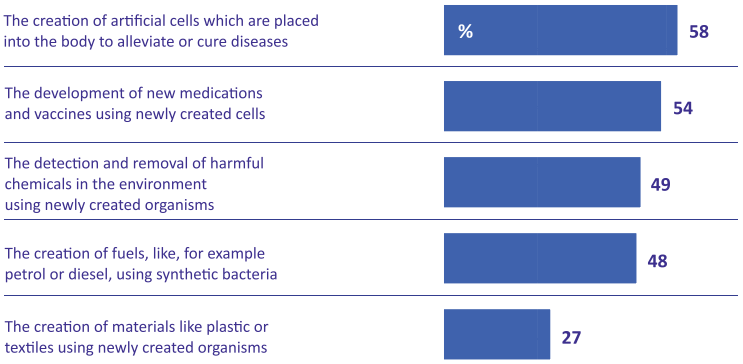
As has already been documented, the level of interest in different fields of research differs greatly. In particular, research fields whose benefits even a lay public can immediately grasp, or where a direct connection to their own interests is present, are received with great interest, whereas areas like synthetic biology, nanotechnology or particle physics are initially received by the majority with disinterest. In synthetic biology, for example, only 10 percent expressed considerable interest, 31 percent expressed limited interest, while 56 percent could not imagine being interested in this topic at all.

When various potential uses for synthetic biology were presented to them, however, their levels of interest changed significantly. This particularly applied to those examples linked to people's expectation of benefits. Thus, 58 percent found the production of artificial cells to fight illnesses interesting, while 54 percent were interested in the development of new medicines and vaccines using newly created cells. Just under half of the respondents were interested in the idea of us-

ing synthetic biology to detect and destroy harmful substances in the environment, or to create fuels. There is considerably less interest, on the other hand, in applications used to create materials like plastics or textiles.

Reactions to Specific Applications of Synthetic Biology

Question: "Various potential uses for synthetic biology are listed here. Which of these areas do you find interesting?"

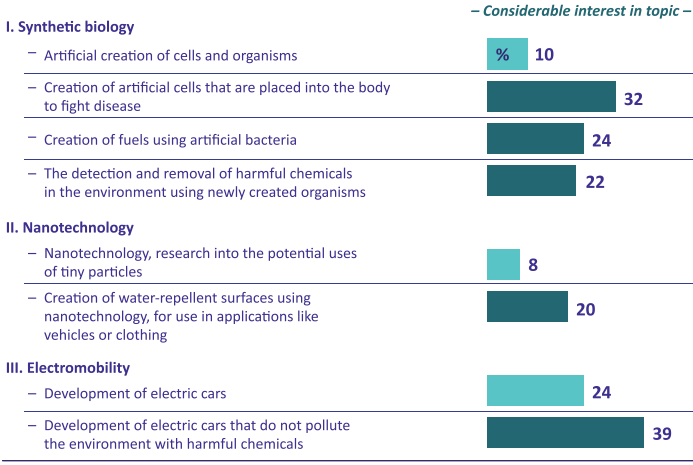


Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

These interest levels indicate a considerable amount of openness towards a field to which the majority reacted with antipathy and disinterest when it was abstractly presented as synthetic biology. These results should not, however, be interpreted as a lively interest on the part of the majority. The group showing considerable interest in the uses of synthetic biology is significantly smaller. Yet even if we focus our analysis of the effects of specifying usage on those showing considerable interest, we see a significant shift in interest levels. Without specific application examples, just 10 percent of the population showed a distinct interest in synthetic biology, but this interest doubled or tripled when examples of specific usage were presented: 32 percent expressed a distinct interest in synthetic biology being used to fight disease; 24 percent had a distinct interest in its use in creating fuels; and 22 percent were

interested in its use for detecting and destroying harmful substances in the environment. Even with other research fields, like, for example, nanotechnology or electric mobility, the level of interest changed significantly when specific examples of the uses of these fields were presented for discussion.

Considerably Greater Interest when Specifying Benefits

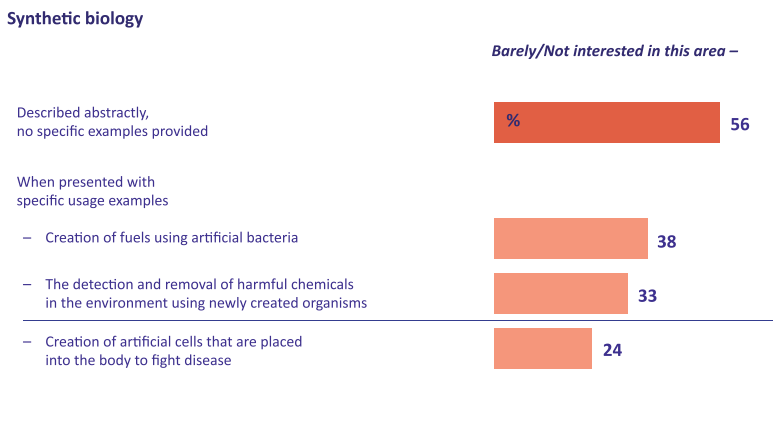


Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

The group which showed limited interest – and thus, at least indicated openness – became larger when participants were given specific usage examples, whereas the group of completely disinterested participants shrank to a minority. Initially, 56 percent of the population could not imagine that the opportunities afforded by synthetic biology would be an interesting field, but depending on the application example selected, only 38-24 percent expressed disinterest.

Like their interest levels, participants' fundamental attitudes towards research areas also change, some significantly, when the potential uses of these fields are specified using examples.

Lack of Interest in Synthetic Biology



Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013
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Altered attitudes after being presented with examples

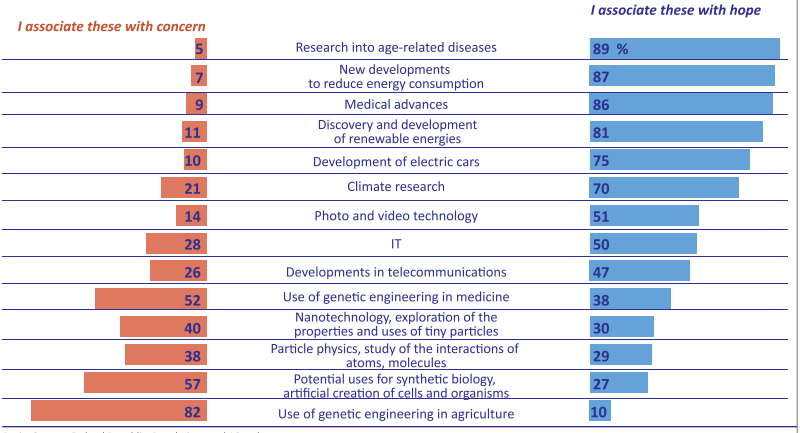
The word association test and the associations connected with selected research fields showed that a lay public will spontaneously react to a field of study either positively or negatively, even with little or no knowledge of the topic. The vast majority also easily divided the research fields presented for discussion into those research areas they associated with hope and those which tended to trigger concerns. Not surprisingly, the overwhelming majority associated medical research with hope. They also associated hope with research which promises greater energy efficiency and more efficient usage of renewable energies, electric mobility, and climate research. On the other hand, research fields like genetic engineering, nanotechnology, particle physics and synthetic biology overwhelmingly tended to cause concern. In answering this question, participants were expressly given the option of not commenting on a particular research area if they did not associate it clearly with either hope or concern. If we take into account the fact that almost 60 percent of those surveyed had heard the term “synthetic biology” for the first time during their interview, it is quite

remarkable that 84 percent still expressed an opinion on synthetic biology when asked this question.

Just 27 percent associated the opportunities provided by synthetic biology, the artificial creation of cells and organisms, spontaneously with hope, while 57 percent associated them with concern. Only genetic engineering in agriculture produced a more negatively biased result. When genetic engineering in medicine is described abstractly, it also attracts far more concern than optimism, rather than sharing the positive assessment of medical advances in general.

Hopes and Fears

Question: "We don't have the same associations with all research areas. Some areas are perceived more hopefully, while others evoke more scepticism or concern. Please take another look at the cards and arrange them on this sheet, according to whether you associate them more with hope or more with concern. Cards which evoke no particular reaction, please set aside."



Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

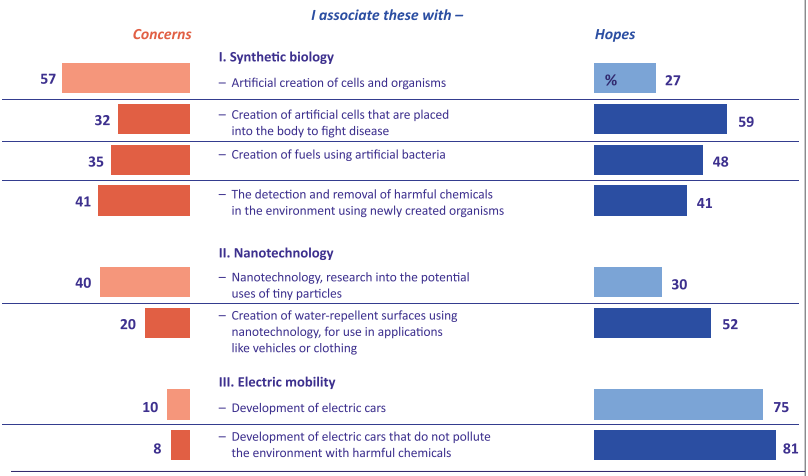
When respondents were exposed to specific usage examples, their categorisation of fields as either full of hope or fraught with risk altered fundamentally. In some cases, these results were completely reversed. For areas in which the population can, from the outset, envisage their uses – for example, medical research or research into electric mobility – the change tends to be limited. As these are fields that the public can specifically envisage, presenting respondents with usage examples or specifying benefits changes public opinion

only marginally. For example, 75 percent of respondents associated electric mobility with hope from the very outset. When explicitly advised of the reduction in environmental pollution, the percentage of respondents who viewed research into electric mobility as positive increased to 81 percent.

In contrast, the application examples had a sweeping effect on those research fields with which the vast majority were initially unfamiliar, like nanotechnology and synthetic biology. When it was described as research into the use of minute particles, 30 percent of those surveyed associated nanotechnology with hope, while 40 percent associated it with concern – and thus with risk. When its use in the creation of water-repellent surfaces for vehicles and clothing was cited, 52 percent of respondents associated nanotechnology with hope, whereas just 20 percent reacted negatively and with concern. The concerns which considerably outweigh the positives when synthetic biology is described abstractly shift to a positive evaluation which far outweighs the negative, at least for some of the potential uses described. When synthetic biology is abstractly described as the artificial creation of cells and organisms, 27 percent react with hope. If, more specifically, the creation of artificial cells to fight disease is mentioned, this figure increases to 59 percent. Adding the example of the creation of fuels using artificial bacteria changes this research area from one fraught with risk to one filled with hope in the minds of many. For the example of synthetic biology detecting harmful substances in the environment and using newly created organisms to dismantle them, the test subjects reacted with an equal mixture of hope and concern. The reaction to all application examples is universally more positive than to the purely abstract description of the research area. At the same time, the differing reactions show that a great deal also depends on which specific examples are presented. The extent to which the population can connect examples to their own hopes and interests is of considerable influence here.

In the same way, specific application examples increase support for research areas. The spontaneous positive or negative associations with a specific research field do not correspond to the support or rejection of related research. Whereas the emotional reactions to synthetic biology when no specific application examples are provided are predominantly negative, only a minority (24 percent) of those sur-

Specific Applications Change Basic Attitudes Considerably



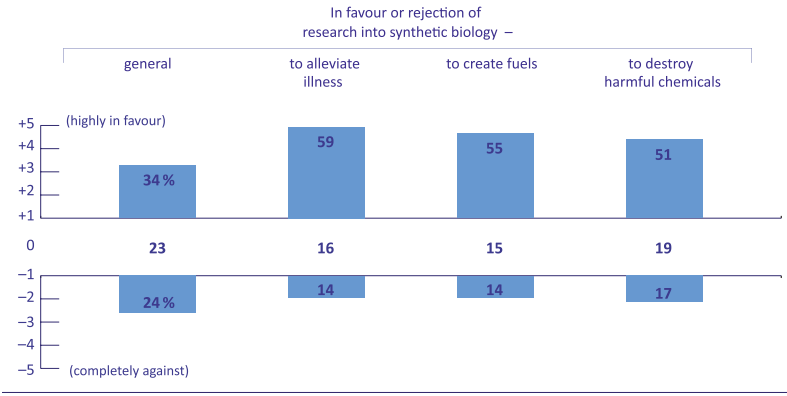
Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

veyed spoke out against research in this area. 34 percent are in favour of research in this field, even if that favourable attitude tends to be less pronounced. 23 percent are neither for nor against research in this area, and a further 19 percent withheld their votes. Here, the reaction seems considerably more reserved than with the stronger emotional indicators like word association or associating fields with hope or concern.

The pattern of specific application areas considerably changing people's opinions, however, also applies here, with people being in favour of or against research. Whereas only a minority of respondents was generally in favour of research into synthetic biology, the majority supported this research once it was explained using specific examples. This was particularly noticeable when the medical usages of synthetic biology were illustrated, but it was also entirely noticeable when examples such as using it to create fuels or destroy harmful substances were presented. Support for research in these areas ranges, on average, from 51 to 59 percent, whereas only 14 to 17 percent still state that they are opposed to research in these areas.

Reaction Test with Different Usage Examples for Synthetic Biology

Question: "How do you feel about research into synthetic biology? All things considered, are you for or against? Perhaps you can tell me according to this scale. +5 would mean that you are highly in favour of research into synthetic biology, while -5 means you're completely against it."



Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

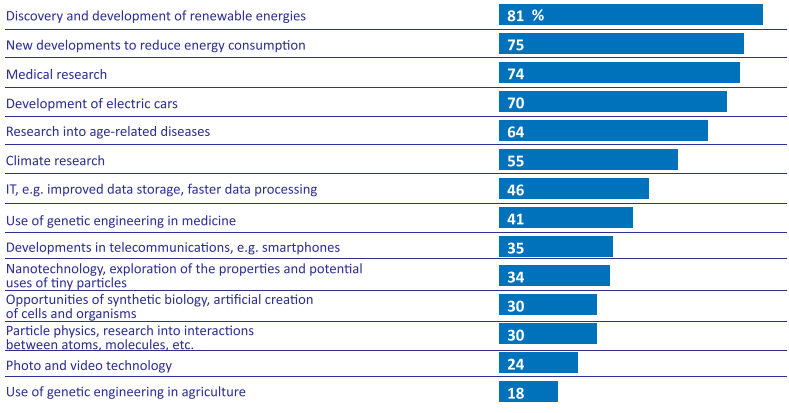
Changed Assessment of the Economic Significance of Research Fields

When it comes to assessing the economic potential of those research fields for which they can see the specific benefits, or for which they assume a considerable need, the population rates them particularly high. The overwhelming majority are convinced that the field of renewable energy, as well as research into greater energy efficiency, innovations in the field of electric mobility, and medical research all promise great economic opportunities for the country. 55 percent are convinced of the same in relation to climate research, while almost half see considerable economic potential in IT projects involving the development of technologies for better data storage or faster data processing. On the other hand, only a minority is convinced that nanotechnology, synthetic biology or genetic engineering in agriculture have significant economic potential.

The test group which was presented with specific uses for different research fields tended to estimate the fields' economic potential as higher, particularly in those areas which have, until now, tended to be

Economic Significance of Research Fields

Question: "What do you think: Which of these research areas offer major economic opportunities for Germany? Which would you say?"

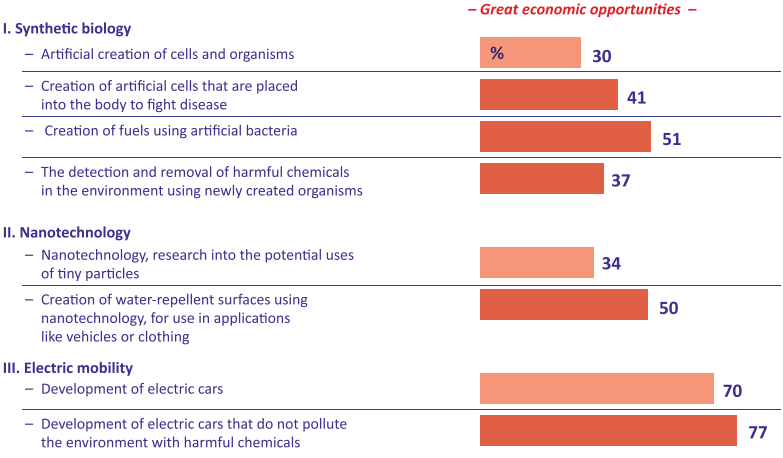


Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

less well-known. For example, 34 percent of the test group which evaluated nanotechnology abstractly considered that it offered major economic opportunities, compared to 50 percent of the test group which were advised of nanotechnology's potential in creating water-repellent surfaces. The assessment of synthetic biology's economic potential changed most when respondents were presented with the example of using it to create fuels. 51 percent were convinced that synthetic biology had great economic potential in this area, whereas only 30 percent ascribed economic potential to synthetic biology when no usage examples were presented.

The specific application examples brought the population's perception of the economic potential of various research fields closer to those of scientific experts and journalists. These groups, particularly, estimate the potential of nanotechnology and synthetic biology as considerably higher. Two-thirds of the scientific experts surveyed see great economic potential in nanotechnology, while almost two-thirds also see it in synthetic biology. The opinions of the scientific experts and the population are, interestingly, particularly wide apart. The journalists, too, are

Assessment of the Economic Significance of Research Fields

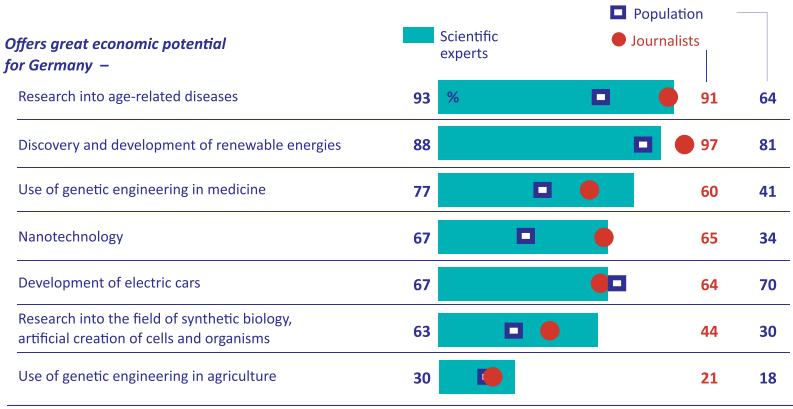


Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

clearly less convinced of the fields' economic potential than the researchers. This applies particularly to synthetic biology, as well as, to a limited extent, to genetic engineering in both medicine and agriculture. Three-quarters of the researchers surveyed see great economic potential for genetic engineering in medicine, whereas six out of ten journalists and 41 percent of the population do the same. When it comes to synthetic biology, almost two-thirds of researchers are convinced of its great scientific potential. In contrast, just 44 percent of journalists and 30 percent of the population are certain of the same when no application areas are mentioned for this field.

Economic Potential of Research Fields

Question: "How do you assess the economic potential of different developments and research fields for Germany? Could you please tell me whether the following fields offer great economic potential for Germany, or whether this is not the case?"



Basis: German Federal Republic, scientific experts and journalists
Source: Allensbach Archive, IfD Survey 6263

Overall, the results show that both the public's interest in and their assessment of areas of research are by no means set in stone. Instead, they change considerably when specific aims and usages are illustrated.

3. Opportunities for Improved Scientific Communication

The results of the representative population survey reveal considerable opportunities for consistent scientific communication that could result in the more effective presentation of aims and potential applications. The question is whether scientific communication is a challenge that is considered important and accepted by the scientific community itself.

Even in the pre-survey in-depth interviews, it became clear that researchers today considered it both important and practically a matter of course that the public be informed about significant scientific discoveries and research issues. There are multiple reasons for this: firstly, it illustrates the significance of science and research for the development of society; secondly, a large part of research is financed from state funds; and last but not least, public opinion is considered highly significant when it comes to providing freedom for research. These reasons are conveyed by the following quotes:

"I consider it eminently important that this information is out there, and not just the information, but also the discussion on science and research. On the one hand, it is true that, ultimately, our prosperity and society have been based on science and research. On the other hand, there are absolutely reservations about certain technologies. These are, from a scientific perspective, partly justified and partly unjustified, but it's important to talk about them, especially with the wider public. In the long run, after all, science and research will only continue to advance if society embraces it and if that is what is wanted."

"I consider it highly necessary, absolutely necessary, because we are living in a world in which there can be no further development without scientific advances. I know that many of the questions raised are ethical ones which are controversially discussed. I con-

sider it essential that science makes an effort to communicate its aims and results to the layperson. This is our duty."

"I consider it very important, given that we are paid by taxpayers at the Max Planck Institute, so I think we have an obligation to go out and inform people about what we are doing and why we are doing it. I also think it's important that we do this – in a society like Germany – to help create an understanding of the reasons for research."

"When it comes down to it, the taxpayer funds research, whether at a university or a research institution, and, in my opinion, they have a right to be informed about it. That is one aspect. The other aspect goes further: I think that in the past there was a lot that was not communicated, and the population is quite uneasy. This unease is something that we, as researchers, need to address."
"This is extraordinarily important. The example of genetic engineering in agriculture in Germany illustrates what can happen if insufficient public relations work is carried out."

In several discussions, it was spontaneously mentioned that the attitude of science towards scientific communication has changed considerably. Scientific communication today is seen much more as a challenge, as well as being more widely accepted, than was previously the case:

"In my subjective opinion, scientific reporting has hugely increased over the last 15 years. (....) As research is also in the public interest and carried out using public funds, I consider it necessary to keep the public informed about it and to allow them to have a say."

"I consider scientific communication very important. I think that much has improved over the last 20 years, since I've been observing science from a researcher's perspective."

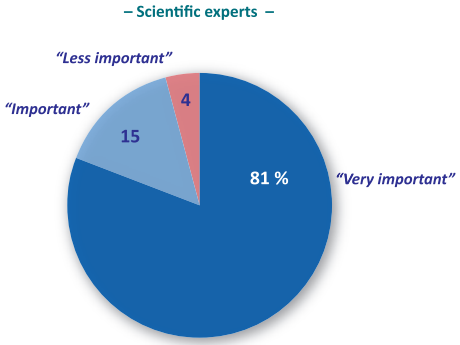
"We have to accept that we have a duty to the public, not least because of the public funding we receive. This is, however, I be-

lieve, generally accepted nowadays, with just a few exceptions. Scientists who think they can sit in their ivory towers are almost extinct, and the new generation is both open to debate and to fighting for their cause."

In the quantitative survey, there was an extremely broad consensus among scientific experts that informing the public about significant scientific discoveries is an important task: 81 percent classified it as very important; a further 15 percent considered it important, and just a small minority of 4 percent ascribed it only limited significance. The journalists who were surveyed at the same time were, without exception, in agreement that communicating scientific results to the public is an important task.

Consensus: Informing Public of Research Results is Important

Question: "How important do you consider it that the population is kept up to date about significant scientific discoveries? Do you consider it ..."



■ All the journalists surveyed consider providing information on scientific discoveries (very) important

Basis: German Federal Republic, scientific experts
Source: Allensbach Archive, IfD Survey 6263

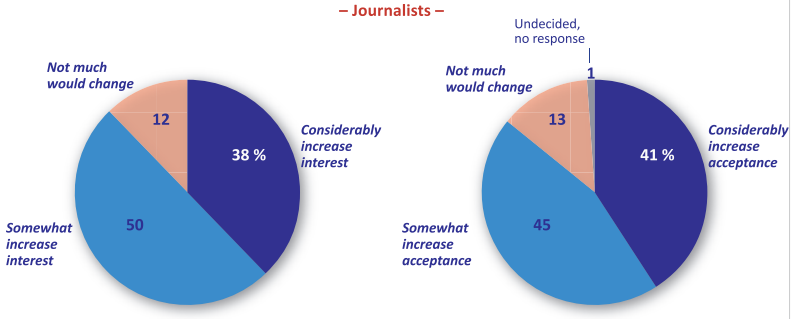
Like the journalists, the majority of the researchers surveyed understand that increasing scientific communication can increase both interest in and acceptance of research fields. Nine out of ten journalists are of the opinion that more intensive scientific communication would in-

crease the interest of the general public in scientific topics and research results. 38 percent even believe that it would considerably increase the public's interest. In the same way, the vast majority of journalists are convinced that it would also contribute to a better acceptance of research fields; here, too, four out of ten journalists agree that more intensive scientific communication would increase social acceptance – not just limitedly, but considerably.

Potential for More Intensive Scientific Communication

Question: "If science were to address itself more to the general public and attempt to explain their work and discoveries to a lay public, do you think that this would considerably increase the population's interest in scientific topics and research results, or would not much change?"

Question: "And do you believe that science could considerably or somewhat increase the public's acceptance of particular research results by doing this, or would not much change?"



Basis: German Federal Republic, journalists
Source: Allensbach Archive, IfD Survey 6263

Of the scientific experts, the majority declared themselves convinced that science has a number of opportunities to influence public interest in and acceptance of research. In the in-depth interviews, it was mentioned that a great deal depends on how the public is informed:

> *"Science can contribute here by doing good public relations work, by reporting advances without linking those advances to unrealistic hopes, and also by explaining important questions which are, as yet, unresolved, and which need further work."*

"Science can absolutely influence the level of interest and acceptance. I believe it's important for science to communicate what it is doing and appear as little as possible like a teacher who always knows better. I think the essential instruments that science can and does use nowadays are open house days, the Science Night events, where we actually let people into the lab to look around – that doesn't look very threatening. It's important for people to realise that science is not an alien world which is somehow closed off to them. Instead, they can be admitted to this world at any time."

"I believe that science can do something by openly discussing new techniques and new technologies. Openness, dialog opportunities: those are what's important. And then it's important that science is truthful; that it doesn't create false expectations or make pronouncements that don't come to fruition. There are, unfortunately, examples: I'm thinking of gene therapy. About 10 or 15 years ago, that was far too strongly heralded as the technology of the future, which would revolutionise the whole of medicine. There are individual successes, but it's not that powerful, not by a long chalk. Raising expectations and then not fulfilling them is bad in the long run."

"Openness as it relates to possible risks, in my opinion, at least in an open system like the one we have in Germany, contributes to building trust. Researchers who are afraid of mentioning potential risks are often afraid of losing acceptance by discussing the risks involved. It could be exactly the opposite."

Researchers who work in corporations are considerably more convinced of the opportunities provided by consistent scientific communication than researchers at universities and other research institutions. Of the scientific experts from corporations, almost three-quarters of them assumed that science has many opportunities to influence interest in and acceptance of research results; of the scientific experts from research institutions, just half of them shared this opinion.

Major Opportunities For Science to Influence the Public ...

Question: "In your opinion, to what extent can science itself influence the development of interest in and acceptance of research results? In your opinion, does science have many or few opportunities to do this?"

Basis: German Federal Republic, scientific experts
Source: Allensbach Archive, IfD Survey 6263

At the same time, scientific experts who work in corporations are more sceptical of the efforts made in this area than researchers from universities and other research institutions. Both groups agreed that research does not make particularly intensive use of its opportunities. Only one in nine researchers has the impression that science is, in general, taking great advantage of its opportunities to influence interest in and acceptance of research results. The vast majority sees limited usage of these opportunities, an impression that is particularly shared by scientific experts from universities and other research institutions. That science is hardly using its opportunities in this area is, among researchers from research institutions, the conclusion of a vanishing minority. On the other hand, a good one-third of researchers from corporations believe that science is barely (or not) making use of its opportunities.

In the pre-survey in-depth interviews, multiple reasons were cited for researchers' limited exploitation of communication opportunities. These included a lack of time, as researchers' own work keeps them very busy. Researchers also, however, mentioned an incentive system which keeps them focused on their inherent tasks rather than allowing

... Which Are, However, Used Only in a Limited Fashion

Question: "To what extent does science make use of its opportunities? In your opinion, to what extent does it influence the way interest in and acceptance of their research results develop? Would you say ..."

	All scientific experts	Scientific experts from –	
		corporations	research institutions
	%	%	%
"Very"	**11**	**8**	**14**
"Somewhat"	**68**	**57**	**78**
"Scarcely/not at all"	**20**	**35**	**6**
No response	**1**	**–**	**2**
	100	*100*	*100*

Basis: German Federal Republic, scientific experts
Source: Allensbach Archive, IfD Survey 6263

them to reach out to the general public. Furthermore, it was also emphasised that communicating with a lay public or making statements about social controversy in research is not part of a researcher's training, with scientists being insufficiently schooled in this subject. Finally, multiple respondents pointed out that taking on these communication tasks doesn't suit everyone:

"The problem is not so much the willingness to do something about it. But in today's everyday university world, it's simply too much effort."

"It's difficult to make a good impression. Colleagues who believe they can come up with something off the cuff can easily end up getting themselves into hot water. In a discussion with an engaged, orientated, and for all I care green politician, you can come off second-best, even though you may have the knowledge to present a better case. Researchers are just not sufficiently trained in presenting knowledge to a lay public."

"The incentives in the scientific system are simply different. Researchers are evaluated on their publications – and of course, on their research results – but not on their efforts to inform the wider public."

"That depends completely on the individual researcher's personality. We're not trained to do it at all."

"There's a whole spectrum of attitudes among researchers. There is, certainly, particularly among researchers doing basic research, the opinion that you shouldn't spend too much time on things like scientific communication, because that takes you away from your actual research. But I would say that this opinion is decreasing. Then we have the scenario in which many researchers understand the need to provide information about their subject, but they either can't do it well, because that's not something that just comes naturally, or they don't want to do it, because it takes time. But they see it positively, they see that there must be something, and they think that's something that can perhaps be delegated to the research organisations or the media office. I think that scenario's always been there and it's one that will continue. And then there's a smaller group who consider it their job, not the job of the institution or the scientific system. These people are often researchers working in fields where there is a good deal of public discussion."

"I believe that the majority of researchers would describe it as a necessary evil, simply because researchers aren't usually huge fans of publicity. That's just the researcher personality type. If you need to hang out with large numbers of people, you don't go into research."

"If I look around here, they see that more as a necessary evil. If they can avoid it, they do. It's not something that they see as an opportunity, generally speaking. I would like to see that as a wonderful opportunity. I also see some of the guests we've had here. I can see that we have some "catching up" to do in communicating with the public."

The conviction of the majority that the opportunities for consistent scientific communication are being used only to a limited extent is also reflected in the call for German universities and other research institutions to become increasingly involved in this issue. Eight out of ten journalists hold this opinion, as do just under two-thirds of the scientific experts surveyed. Here, too, an above-average number of scientists who work in corporations want increased commitment. Those who consider the current level of enthusiasm insufficient cite a variety of reasons, including a lack of time on the part of the researchers, focus on research and teaching, insufficient personnel and professionalization of public relations work by research institutions, as well as communication problems between experts and the lay public. Whereas scientific experts tend to see the first reasons as decisive factors, journalists have the impression that communication problems also play a large role:

Call for More Commitment by Universities and Research Institutions

Question: "Do you get the impression that universities and other research facilities in Germany and the researchers who work there do enough, all things considered, to communicate their research and scientific results to the public, or should more be done?"

	All scientific experts	Scientific experts from –		All journalists
		corporations	research institutions	
	%	%	%	%
Do enough	**36**	**26**	**45**	**16**
Should do more	**63**	**74**	**53**	**82**
No response	**1**	**–**	**2**	**2**
	100	*100*	*100*	*100*

■ **Researchers see the causes of the existing problems as primarily due to lack of time; the journalists surveyed see it as a communication problem**

Basis: German Federal Republic, scientific experts and journalists
Source: Allensbach Archive, IfD Survey 6263

In the pre-survey in-depth interviews, more commitment was called for, as well as more resources and a stronger proactive direction to scientific communication:

"Too little is done in this field. Whereby I must say that we, as researchers, also need to take ourselves in hand, because we don't keep it sufficiently on our radar. On the other hand, we don't have the appropriate professional support within the universities, faculties and institutes. Of course, doing all this professionally also costs money. I see that happening via international cooperation with major institutions in the USA, which have really professional media departments."

"I consider it incredibly important that the public is informed, so that people can form their own opinions. As a researcher, I have a duty to present information so that it's comprehensible. This is something that I actually do regularly, by trying to explain our latest discoveries to the different demographic groups at my institute. I believe that German universities need to do more in this area. I also think that the Max Planck Societies should do more. I thought it was a great step, when we were told that every institute could hire a media spokesperson, but that was for five years, and then it had to come out of our own budgets. So then the various institutes got rid of their media spokespeople. Having something like that in the long run would be an improvement."

"Professional scientific communication is, from my perspective, an essential job for the scientific academies, to prevent them [from] becoming merely clubs where old gentlemen present younger ladies with scientific awards for good work. Instead, they should have a fundamental responsibility to contribute to the society which, after all, to an extent funds them. That wasn't the case in Leibniz' day."

"Nowadays we place a great many press releases on new research results in the media every day. Only a very few of these press releases really resonate. Here, too, you need a feel for which topics are really relevant. Then you have a good chance of generating resonance in the public. Despite this, people still make the mistake of distributing detailed information which interests researchers, but which doesn't always interest the public."

"The DFG, the Max Planck Societies, Helmholtz – they do considerably more and are also better equipped for public relations work than the universities."

"Scientific communication is very reactive. We receive next to no training in media relations. There is almost no proactive approach to the media, except in press releases about publications. The DFG and the professional associations are more proactive in media relations, but you then have to hope that topics are picked up. The activity doesn't need necessarily to be performed by the researchers themselves; the impetus can come from a team member with PR experience. But even that assumes that the researchers are willing to do that. You get no credit for doing it in our merit system. We are evaluated based almost entirely on other criteria."

"In scientific communication, there is certainly still a lack of proactive action, but my impression is that proactive action, rather than reactive action, is increasingly coming to the fore. People now see that we're living in an environment that we need to help shape, and the better they can do that, the easier it is. In many cases, we have professionals sitting there who are not so easy to unseat."

"We have to do much more to ensure that we become more professional in representing our research topics, not just to a scientific lay audience, but also to a scientific expert audience. The DFG and other funding bodies require a summary of the project to be presented to the general public. But you can practically tell from the summaries how difficult it is for some researchers to produce even a short text."

"All major institutions and organisations have a department whose job it is to do that. So these activities could, of course, be increased. We can see that it's necessary. In this regard, I believe we're on the right path. For the past few years, for example, the DFG has been awarding a prize for scientific communication. There's quite a lot of money involved, even. There's always something new and interesting receiving an award. The German Fed-

eral Ministry of Education and Research does that too, at different levels, including in schools. You have to start early. You have to have the courage to stand up to all those doomsday prophesies and get the facts across."

Genetic engineering is one example of the consequences of delayed communication which was mentioned again and again in the pre-survey in-depth interviews with researchers. Now, looking back, the majority of scientific experts are convinced that society's rejection of genetic engineering in agriculture is due to insufficient information on scientific discoveries, which was communicated too late:

"When it comes to genetic engineering, it's very clear that communication in this area was too late and insufficient. The non-scientific opinion leaders were simply there earlier. They got there first and there was nothing left. And if you want to add something after the fact, well, forget it."

"The rejection of genetic engineering is certainly to do with the fact that it was communicated too late, and perhaps successes were heralded that have not yet materialised. Personally, I believe that genetic engineering will prevail. It practically has, overseas – just look at America – both north and south."

"Of course there are risks involved with genetic engineering in agriculture; there's no question about it. But there are also strategies for keeping the risks low. The strategies for minimising risks have not been properly communicated. The value, the reasons why we even need it, must also be better presented. A fundamental problem with genetic engineering in agriculture is that the public is under the impression that this is a playground for major concerns, which are using it to pursue a particular kind of profit maximisation. The ideas behind it, those of feeding the world and of hygiene, have not really been brought to the fore."

Overall, 58 percent of scientific experts draw the conclusion, in hindsight, that the rejection of genetic engineering in agriculture can be

traced back to insufficient communication by science itself. Of the journalists surveyed, however, only one in three shares this opinion. Most journalists consider the topic of genetic engineering in general one which is difficult to communicate to a wider audience.

Dissention between Scientific Experts and Journalists

Question: *"A question pertaining specifically to genetic engineering in agriculture: A fundamental rejection of genetic engineering in agriculture has taken hold in society in Germany. How do you see this: Is the rejection of genetic engineering in agriculture partly due to insufficient or delayed communication of scientific discoveries, or does it have less to do with that?"*

	Scientific experts	Journalists
	%	%
Due to communication	**58**	**36**
Has less to do with communication	**41**	**63**
No response	**1**	**1**
	100	*100*

Basis: German Federal Republic, scientific experts and journalists
Source: Allensbach Archive, IfD Survey 6263

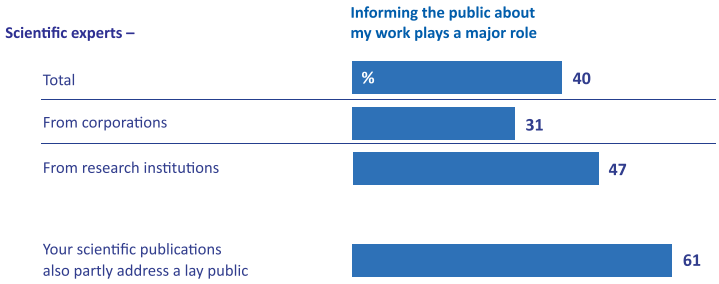
Overall, the journalists surveyed assessed both the researchers' communication tendencies and their ability to communicate with a lay public far more critically than the researchers themselves.

4. The Wider Public as the Target of Scientific Communication

Although there is complete consensus that informing the public about the results of scientific research is an important task, it plays no great role in the everyday activities of the researchers surveyed. Still, 40 percent of them engage in this task more often, with scientific experts from universities and other research institutions doing so more than researchers working in corporations. In addition, six out of ten researchers target their publications partly towards the scientific layperson.

Significance of Scientific Communication About Your Own Scientific Work

Question: "What role does scientific communication play for you personally? Do you address the broader public outside of your teaching activities in order to present your specialist area or your current results and discoveries?"



Basis: German Federal Republic, scientific experts
Source: Allensbach Archive, IfD Survey 6263

The fact that only a minority is involved more frequently in scientific communication is primarily due to the structure of researchers' activities, the time pressure and the incentive system, but has little to do with the belief that communication with a lay public is superfluous,

or that research results and science in general are too complicated to communicate easily. In the pre-survey in-depth interviews, most of the interviewees vehemently refuted the theory that science's complexity makes it difficult to communicate:

"Of course it's all very complicated, but as a researcher, you have to be able to describe the phenomena you're working on in simple terms. Of course, you can't explain every single detail or want to share detailed knowledge. That's not possible. But I believe that translating complex content to a certain general level is both important and absolutely possible."

"The impression that science is too complicated to communicate to a lay public is incorrect. What we're doing, genome research, is incredibly complex. But you can break it down so that everyone understands what it is and what it's used for. That takes effort, it takes work; but you've got to do it."

"It takes time. But I would never agree that it is too complicated. Quite the opposite! There are so many exciting things happening that explaining what we are doing can be exciting!"

"The impression that science is too complicated to be communicated to a lay public is complete nonsense. That's absolutely untrue."

"I don't consider it impossible to make someone understand the basic concepts. It's much more difficult, for example, to talk about ethics – whether or not we should perform stem cell research. Then you need to get into relatively detailed explanations and clarify what, out of what you've researched, is, on the one hand, technically possible and, on the other, actually useful."

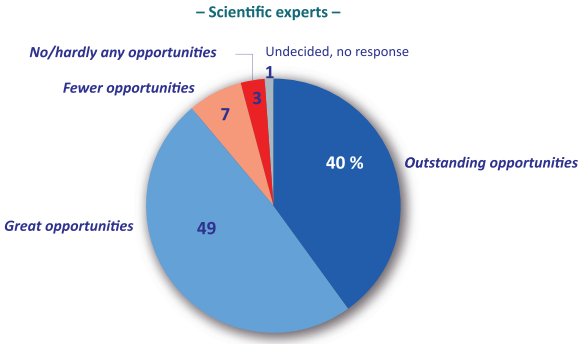
"That's true when we're talking about details. But that's not the kind of communication we're talking about. There comes a point when a physicist in a particular area can't explain something to a chemist, because their work is so specialised and advanced. But I

think that even scientific communication can't engage at that level. In such cases, it is often more the interpretation of science than the science itself that is interesting: What does that mean? What will that mean for us? And that is, of course, possible without any of the detail you would need in a lab in order to arrange an experiment. Sometimes researchers lack the ability to achieve this level of communication, because they're so caught up in the lab details."

When it comes to their own field, nine out of ten scientific experts see very great or great opportunities to inform the public, at least broadly speaking, in terms that anyone can understand. By the same token, many are convinced that it is generally possible to outline basic natural sciences research results in such a way that they are understood by people outside their subject area.

Optimism Relating to the Communicability of Your Own Specialist Area ...

Question: "When you consider your own specialist area and the particularly significant research results in this area: How do you assess your opportunities to address the public about them, at least broadly? Do you see outstanding opportunities, great opportunities, fewer opportunities or no/hardly any opportunities?"



■ **90 percent are also convinced that it is, as a rule, possible to outline basic natural science research results clearly and comprehensibly.**

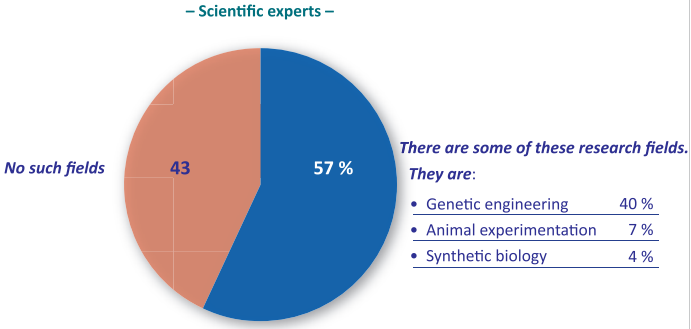
Basis: German Federal Republic, scientific experts
Source: Allensbach Archive, IfD Survey 6263

At the same time, the majority also concedes that the prerequisites for communication differ from field to field. The majority of researchers draw the conclusion that, in their areas, there are specific fields which,

although extremely significant, are difficult to communicate to the lay-person. Here, in particular, genetic engineering was mentioned again, as well as scientific projects which require animal experimentation and – cited by a small minority – synthetic biology.

... As Well As Topics That Are Difficult to Communicate

Question: "Are there, in your area of specialisation, research fields which are highly significant but which are difficult to communicate, or are there no such fields in your area?"



Basis: German Federal Republic, scientific experts
Source: Allensbach Archive, IfD Survey 6263
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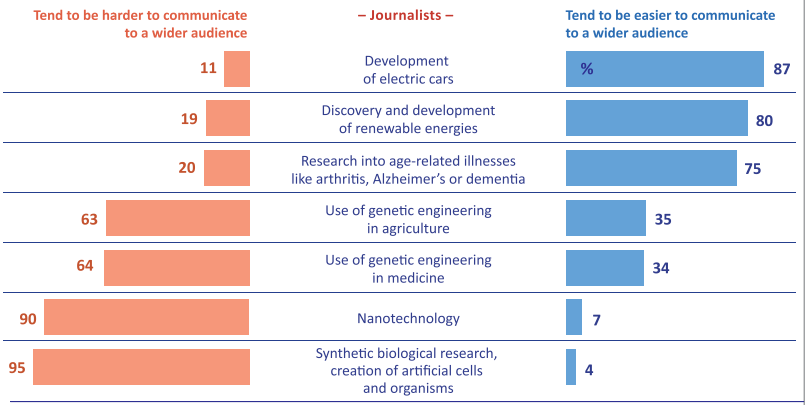
The journalists who were surveyed in parallel, the vast majority of whom are also convinced of the merits of scientific communication, also draw the conclusion that there are fields which are extremely difficult to communicate to a wider audience. They see few problems with all those fields which appear self-explanatory to the public from the outset, or in which the public perceives a direct benefit – for example, research into age-related diseases, the further development of renewable energies, or the field of electric mobility. Instead, the vast majority of journalists are convinced that it is difficult to communicate information on genetic engineering to a wider audience. Interestingly, the journalists perceive almost no difference between genetic engineering in medicine and genetic engineering in agriculture. The fields which, for the overwhelming majority of the population and certainly also for

some of the journalists, still appear largely abstract, like nanotechnology and research into synthetic biology, are considered even more difficult. Nine out of ten journalists are convinced that these areas can be communicated effectively to a wider public only with difficulty. The journalists' ranking here correlates strongly with the interests and value judgements of the wider public. The results consistently show that the prerequisites for scientific communication differ greatly between the various research fields, with some researchers facing particularly large challenges. This also means that communication strategies must be discussed specifically for each discipline.

Different Prerequisites for Different Areas of Specialisation

Question: "Could you tell me which of the following research fields and potential applications are in your opinion, difficult to communicate to a wider audience, and which are easy?"



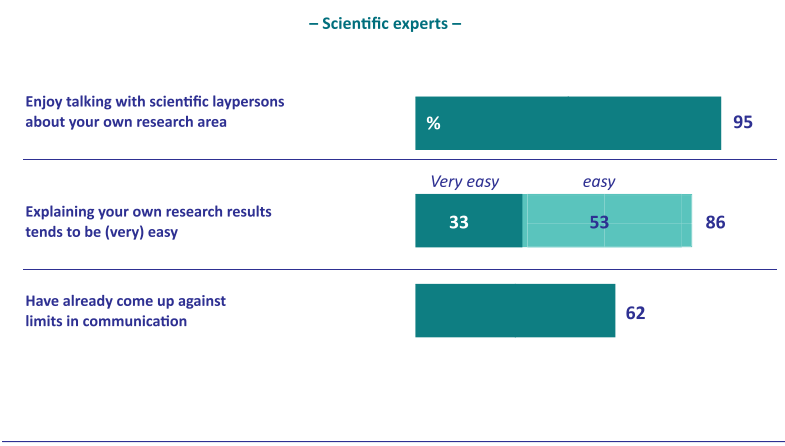
Basis: German Federal Republic, journalists
Source: Allensbach Archive, IfD Survey 6263

Overall, the vast majority of the researchers surveyed consider the opportunities for communicating findings from their own research area as good.

The overwhelming majority also enjoy talking about their own research area, even with scientific laypersons. Most of them have also received the impression that they can explain their own research and findings to laypersons without too much difficulty. Despite this, most

of them have, in their own opinion, reached limits in their communications. Two-thirds of researchers have had this experience.

Communication with Scientific Laypersons



Basis: German Federal Republic, scientific experts
Source: Allensbach Archive, IfD Survey 6263
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During the pre-survey in-depth interviews, respondents also mentioned that successful communication must be learned. It is particularly important to repeatedly verify one's assumptions:

> *"I think it's now become relatively simple. But it's been a long road to get here. For me, my key experience was teaching children's classes. I had to give a presentation to children. That was really an interesting learning process. That was one of the presentations which I spent a lot of time on. I did the presentation and then thought, that won't work, you've got to shorten it some more. I think I made five or six versions of that presentation, each one simpler than the last. It was very well received, and then at some point I gave the children's presentation to an adult audience. And they loved it. When it comes down to it you need to scale down the requirements more than you think would be necessary. Then you've got it right."*

"That's a very difficult task, one for which you really need to train and where you learn something new every time. When teaching students, I find it difficult to determine the level of knowledge you can assume for your audience. The scientific laypersons in the average population are much more heterogeneous in their backgrounds, which makes it more complicated to make oneself understood. You have to learn to speak in metaphors without getting too flowery in your descriptions, and you have to learn to use animated processes, like symbols, which are comprehensible and descriptive. And the exciting scientific questions, particularly, also have an ethical component to them; they bring up normative questions about the morally right thing to do. Reflecting on these connections is an important task for researchers."

"Again, that's an area where I can only speak for my fields, but I certainly enjoy it. I deal quite often with popular science and visit public places: adult education colleges, schools, sometimes even a secondary school will invite me, that's really good fun. Of course, it's hard, too. The need to be very cautious in your assumptions is hard to instil in others."

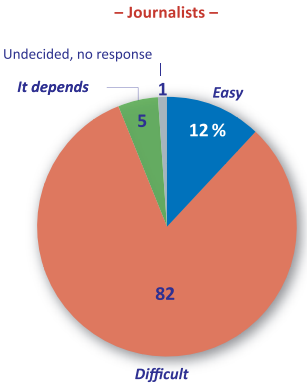
"I'm really in the fortunate situation that the essential things that fascinate and enthuse us can easily be communicated."

The journalists surveyed are much more sceptical than the researchers themselves. The overwhelming majority of journalists have the impression that researchers in general tend to find it difficult to communicate with a lay audience. Just 12 percent of the journalists surveyed shared the impression of the overwhelming majority of researchers, that is, that researchers find it easy to explain their research results.

Both researchers and journalists see objectivity, trustworthiness and transparency as important prerequisites for successful scientific communication. Although many of the scientists surveyed complained about the frequently predominant focus on risk in public discussions of scientific discoveries, most of them also emphasised that this can-

... Very Different Impressions from Journalists

Question: "How easy or difficult is it, in your experience, to explain your work and significant discoveries in your field to researchers and laypersons? Is it easier or more difficult to explain things to researchers?"



Basis: German Federal Republic, journalists
Source: Allensbach Archive, IfD Survey 6263

not be allowed to lead to one-sided scientific communication. This means that researchers must be able to hold their own in a public debate which is biased to one side or the other, but not to the extent that they end up favouring one side by emphasising the benefits and opportunities and obscuring the risks. Several respondents also emphasised that it is important to disclose one's own boundaries and uncertainties during scientific communication, as well as the different opinions which, at least during certain research phases, come up again and again:

> *"You must always communicate both the risks and opportunities. Of course, you mustn't forget that, even within science itself, there are, of course, different schools of thought, factions and controversies which reflect the state of science and which often do not result in a unified opinion on the state of science. If the researchers themselves cannot agree on the actual state of science, what are the opportunities, what are the risks? So then it takes about five to ten years to figure that out."*

"We need balanced communication of both opportunities and risks. Looking at the world through rose-coloured glasses is not realistic, and wouldn't bring science any lasting benefits. Science thrives not only on new discoveries, but also on questions. To achieve genuine acceptance, therefore, we need both positive and negative reporting on progress, as well as on any associated problems."

"You have to communicate the risks, too. Referring to synthetic biology: I believe that, because, when it comes down to it, we understand only a little of our normal biology. How much less would we understand, therefore, when we create systems based on chemicals that don't exist in nature? And I think that's something that we also need to say, very clearly. As a rule, we cannot estimate the dangers, and we have to consider whether we can minimise these risks, perhaps through regulation – no early application, etc. etc."

"If risks exist, they have to be communicated. We have to talk about these things, and perhaps suggest measures that can be taken to counteract these risks."

The majority of the researchers surveyed spontaneously mentioned neutrality and objectivity as fundamental prerequisites for successful communication, whereas just 6 percent of them consider emphasising primarily the positive aspects to be promising. Furthermore, the researchers interviewed considered it particularly important to translate their area of research into specific applications, to relate it to people's everyday lives, and to illustrate the purpose and benefits of research. Every fourth researcher considered this particularly important whenever the public is to be informed about new areas of research. The journalists surveyed mentioned this aspect far more frequently than the researchers. The results of the reaction test previously mentioned, where participants reacted to both abstract and example-based descriptions of research areas, shows how important this aspect is. It is still indubitably underestimated by sectors of the scientific community.

Furthermore, both researchers and journalists mentioned the need to simplify information to account for the requirements of a lay public and to select the right communication channels and media types to communicate the information. The journalists also mentioned the need to use as little specialist terminology as possible and advised not shying away from detailed explanations, provided that they are comprehensively formulated.

Perceptions of Prerequisites for Successful Scientific Communication

Question: "In your opinion, what is particularly important when you want to inform the public about a new research field for which there is, as yet, no fixed impression? What must be considered when doing this?"

	Scientific experts	Journalists
	%	%
Taking a neutral stance, objectivity, transparency	**53**	**53**
Using specific examples to explain its relevance to daily life, illustrating purpose and usage	**25**	**43**
Giving simple explanations	**17**	**17**
Selecting the correct communication channel, e.g. Internet, regional newspaper	**11**	**13**
Formulating explanations comprehensibly, using few specialised terms	**9**	**17**
Explaining comprehensively and in detail	**8**	**17**
Emphasising primarily the positive aspects	**6**	**–**
Taking laypersons seriously, taking fears into account	**3**	**6**
Other	**9**	**6**

Basis: German Federal Republic, scientific experts and journalists
Source: Allensbach Archive, IfD Survey 6263

Just as objectivity and balance are considered the most essential elements for effective scientific communication, using one-sided descriptions which overemphasise the opportunities and benefits and conceal the disadvantages is considered a particularly serious error, one to be avoided at all costs. Furthermore, scientific communication must, according to both researchers and journalists, guard against asking too much of the public, using too much detail, arguing too abstractedly, and using too much specialist jargon. This last aspect was spontaneously mentioned almost twice as frequently by the journalists interviewed than by the scientists.

Errors in Scientific Communication

Question: "In your opinion, what are the biggest mistakes a person can make when reporting on scientific results?"

	Scientific experts	Journalists
	%	%
Taking a one-sided position. Overemphasising opportunities, concealing risks, being too optimistic	**37**	**46**
Requiring too much knowledge, explanations too complicated, overwhelming, too much detail	**27**	**22**
Not taking people seriously, arrogance, pretentious presentation	**20**	**19**
Using too much specialist jargon	**14**	**27**
Being too abstract, not relating topic to everyday life	**10**	**18**
Providing false information or unsubstantiated discoveries	**4**	**–**
Factual or content errors, describing things incorrectly	**–**	**7**
Unthinking regurgitation of information, not developing and conveying own opinion	**–**	**8**

Basis: German Federal Republic, scientific experts and journalists
Source: Allensbach Archive, IfD Survey 6263

In the pre-survey interviews, in which the 'language barriers' between experts and the lay public were explicitly addressed, it became clear that the challenges which arise from translating scientific language are very well-known:

"When it comes down to it, this is the main obstacle. If someone uses two or three terms in a presentation that the general public doesn't understand – or can misunderstand, because the terms are somehow interpreted differently in general usage – he or she has lost their audience. I consider it very important to maximise one's effort in this area. It's impossible to avoid specialist terms entirely, but if you're going to use them, you have to explain them."

"Every researcher speaks jargon, because they socialise so much within their own specialist circles. Leaving the jargon behind and not sounding stilted isn't that easy. You really have to develop a lively, jargon-free way of speaking in order to communicate your

subject matter. It comes back to the same thing: people have got to be trained."

"You can sort of translate it, but you need to think carefully to do that, because you're considering which knowledge you can assume, the level you think your lay audience is at, the level at which you need to communicate."

"You have to translate the specific scientific language. For example, chemists have their own specialist language, the language of formulae, and this formula language... You can't expect the general population to learn formulae so that you can explain things to them more clearly. The same applies to mathematics, to physics. You need to be able to translate it, and that's a specific skill. Some people can do that, they can do it very well, and they explain things using examples or analogies that illustrate similar content – and then there are people who just can't do it."

"The chances are 100 percent; it works; you just have to do it. And there's a lot of work involved."

In several interviews, it was also mentioned that scientific communication is not solely the preserve of researchers, even though researchers enjoy a particular level of trust. Scientific communication is viewed as a specialised task in which researchers play a central role, but which should, as far as possible, be supported by professional communicators in the specialist departments and media. Mediators and translators between the scientific world and the wider public were described as an important prerequisite for successful communication:

"It always sounds more authentic if researchers themselves can communicate. Not everyone can be expected to do this effectively. This is not a new problem. The best researchers are not always strong communicators. We encourage this with Communicator awards, and other medical faculties give similar prizes. Here, too, we need everything: we need researchers who can present arguments effectively to the public, and we also need professional sci-

ence journalists. I believe that they will, however, have a relatively small market."

"We need communicators! I believe there are enough people who train to doctorate level in the natural sciences, in IT, in mathematics, and who then decide not to pursue a scientific career after all. Perhaps they wouldn't be happy working as engineers in major engineering firms, but they're good communicators; they could do it, they want to do it... and they would do it if there were career options for it."

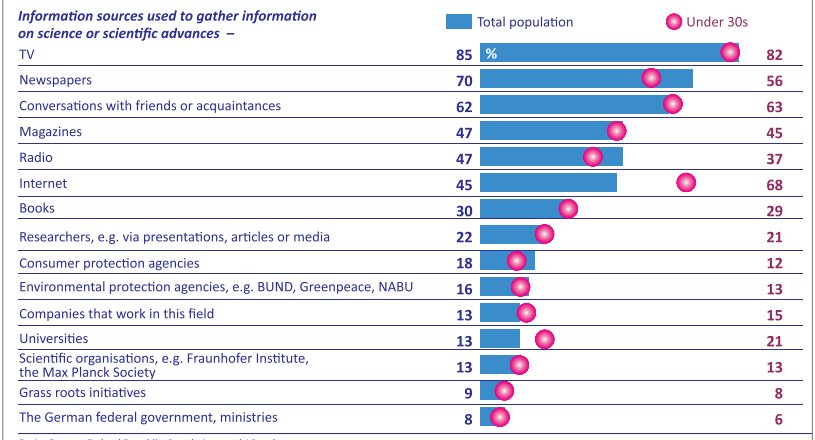
"I agree that it's important to create a link between researchers and the public, because the researchers simply don't have the time. I believe that there are extremely talented researchers who can do that. There are, after all, prizes for the best scientific television program and things like that. But those are few and far between. And because science has a huge influence on society in many areas, from microelectronics to automation processes right through to biotechnology, medicine and so on, I believe that it wouldn't be a bad thing for major organisations to promote science and to create more communication centres or organisations."

5. Major Significance of the Media

In the vast majority of cases, scientific communication with the public is not direct. Instead, it occurs via the media. Nowadays, there are so many ways to communicate directly with the wider public, whether it's through presentations, open days, popular science publications or the Internet. The mass media – and particularly TV and print media – are by far the public's most significant sources of information on scientific topics. 85 percent of the total population aged 16 and over state that TV is one of their sources for learning about scientific topics and innovations. 70 percent stated that they get information from newspapers, while 47 percent get information from magazines and radio. Talking to friends and acquaintances always plays a large part. The Internet has, until now, occupied a position in the middle of the field, but it is con-

Sources of Information on Research Topics

Question: "There are many different ways in which people can inform themselves or learn about science or scientific advances. What about you: which sources have you used to learn something or gain information?"



Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

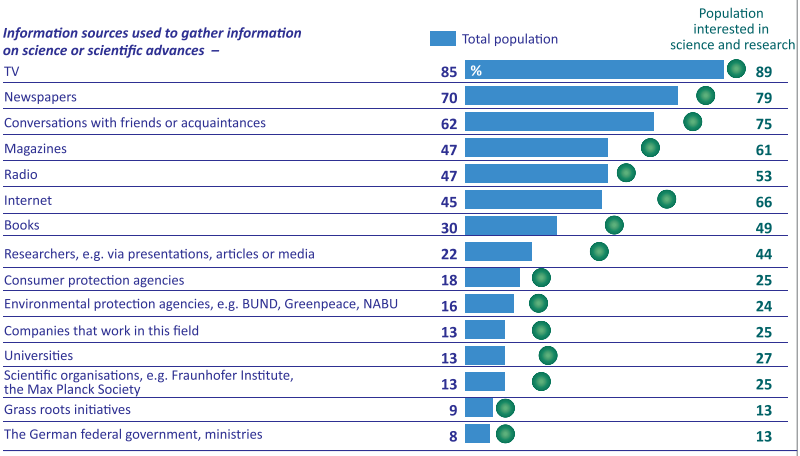
tinually increasing in significance. Among the younger generation, the Internet is mentioned (after TV) as one of the most significant sources of information on science and innovation.

In contrast, just a minority gets their information directly from researchers and scientific organisations, whether this is from presentations and articles by researchers, university events or through publications and events by scientific organisations like the Max-Planck-Gesellschaft (MPG, Max Planck Society) or the Fraunhofer Institutes. The percentage of the population reached directly by science, is however, by no means marginal: 29 percent of the total population have received information directly from researchers, universities or scientific organisations about research results. As the percentage of students and graduates in the younger generation is currently considerably higher than it was 20 years ago, this sector is also informed of the state of research directly by science at an above-average level.

Those population groups who are interested in science and research get their information more directly from researchers, whether this is through presentations, articles or statements, university events

Sources of Information on Research Topics

Question: "There are many different ways in which people can inform themselves or learn about science or scientific advances. What about you: which sources have you used to learn something or gain information?"

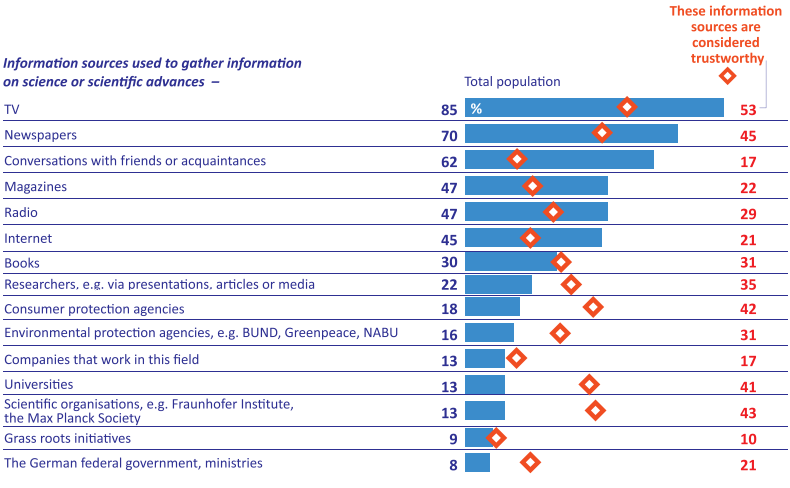


Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

or publications distributed by scientific organisations. 53 percent of those interested in science and research overall mentioned obtaining such information from the following methods: 44 percent from presentations, articles and statements by researchers, and 25 percent (also) from events and publications distributed by scientific organisations.

The use of sources to gain information about scientific topics is shaped by the population's general information-gathering habits, but says little about how well-founded and trustworthy these various sources of information are when it comes to scientific topics. The level of trust people place in the mass media to provide well-founded information on scientific topics is great, but it is far lower than the usage levels for these information sources. 85 percent of the population gets their information on scientific topics – and particularly research results – from TV, though just 53 percent consider TV to be a reliable source for this information. Newspapers are used by 70 percent of the population as a source of information, with 45 percent considering this information to be generally reliable. There is an even greater difference between the levels of usage of and trust in information gained through personal conversations with

Usage of and Trust in Information Sources



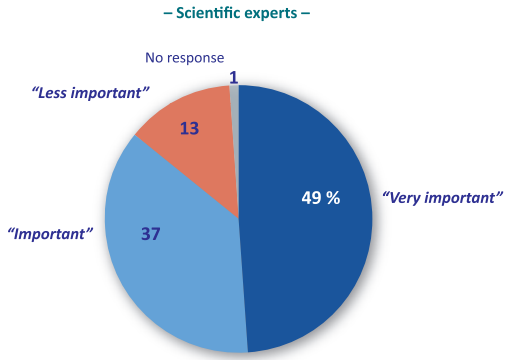
Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

friends and acquaintances. The Internet currently has more credibility problems to overcome than other types of media. Whereas with both TV and newspapers, the majority of those who use these sources of information to inform themselves about scientific topics consider them reliable, less than half of those who use the Internet for information consider it to be a reliable source. 45 percent mention the Internet as a source of information about scientific topics, but just 21 percent of those consider it a generally reliable source of such information.

This is different when it comes to the providers of information, whether it comes directly from science or from other organisations. The population group which considers information from researchers, universities and scientific organisations, consumer protection organisations, environmental protection organisations, and ministries to be reliable is significantly larger than the group which has, until now, accessed these sources. This particularly applies to universities and scientific organisations. Just 13 percent of the population can remember having received information directly from scientific organisations; 43 percent are, however, convinced that information from these sources is generally reliable.

Contact with Journalists is important

Question: "When it comes to making your scientific research results known to a wider audience: how important, in your opinion, are close contacts to journalists? Would you say that close contact with journalists are ..."



Basis: German Federal Republic, scientific experts
Source: Allensbach Archive, IfD Survey 6263

The results show the significance of the mass media for communicating information from science, as well as the extent to which both the media and science could benefit from intensive cooperation in scientific communication. The vast majority of scientists surveyed were also in agreement that close contact with journalists is important when it comes to communicating scientific research results effectively to a wider audience. Half of the scientific experts categorised this contact as very important, 37 percent considered it important, while just one in 8 considered it not particularly important.

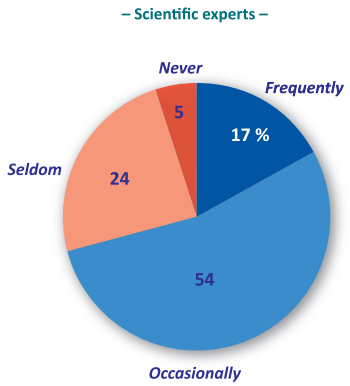
The respondents' experiences with media reporting of scientific topics, and particularly their own research areas are, however, very different.

6. Relationships between Science and Journalism

The vast majority of natural scientists surveyed work in fields which, in their experience, sometimes attract interest among the media and the wider public. Around three-quarters of the researchers surveyed assessed the interest of the media and the public in their subject as major. Of these, most also have contact to journalists. Overall, 17 percent of the researchers surveyed reported frequent contact, with a further 54 percent reporting occasional contact. Only one in four researchers seldom or never contact journalists. Scientific experts from universities and other research institutions have, on average, more contact with journalists than scientific experts who work in corporations.

Frequency of Contact with Journalists

Question: "How often do you personally have contact with or meet with journalists?"



Basis: German Federal Republic, scientific experts
Source: Allensbach Archive, IfD Survey 6263

The expertise of journalists who report on scientific topics is evaluated very differently by the various researchers. One in three researchers is under the impression that most journalists who work with such topics have a good basic understanding of them, whereas 30 percent draw the conclusion that many journalists lack the requisite basic knowledge and understanding of the complexities of science. Researchers who often address a lay public assess journalists' expertise more positively than their colleagues who overwhelmingly or exclusively address specialist audiences. In both groups, however, a good one-third draw a different conclusion, a tendency that already became apparent during the in-depth interviews. Multiple interviewees indicated that journalists who regularly and intensively deal with scientific topics often have a good understanding of science, with some having considerable upfront knowledge. Comprehension problems, however, often arise when journalists from political or economic reporting departments, or the arts sections, tackle scientific topics.

"Journalists who are involved in science often have a very good level of basic knowledge they can draw on. I'm thinking here of those specialist journalists who write for the national press."

"There is scientific journalism, there are very good scientific journalists who have a basic understanding of the topics, and they are relatively easy to deal with. You don't need to explain to them what a cell is. I believe that a lot depends on that. There are a lot of scientific journalists who can communicate these things relatively well. It would be asking too much to ask a regular journalist, who usually deals with subjects like foreign policy, to tackle something like that."

"There are many journalists who have a very good level of basic knowledge, there's no question. These are usually academically trained people who can understand and implement logical structures."

"There are journalists who are very well educated; they've usually dropped out of studying natural sciences, for example, and have

then become journalists. These are also people you can talk to. But the average journalist is only out to get some sort of scandal to further his or her career. If you're having some sort of rambunctious roundtable discussion, the kind people want to listen to, it doesn't matter what the level of discussion is; if the viewing rates are high, the moderator will soon be given a more significant program. In my opinion, this system doesn't help improve scientific reporting."

"Scientific journalists tend to have a good level of knowledge. The problem tends to lie with those journalists who don't work at the science desk, but who report on politics or economics."

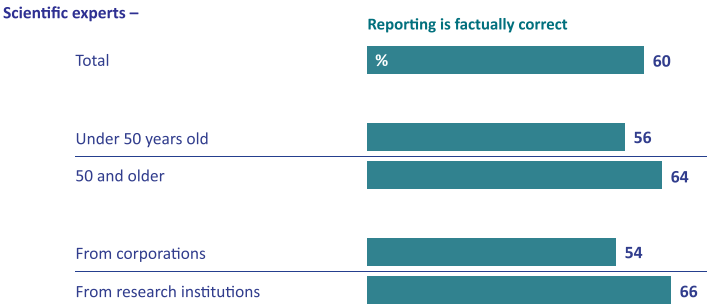
"Most journalists have no natural science training. I'm talking now about my area, where my experience is. There's absolutely no point in wanting to work with a journalist who has no training whatsoever in the natural sciences. That just won't work – when it comes down to it, we simply don't speak the same language. If I'm talking to someone about DNA and genes, but they have no understanding of modern biology, the conversation is of relatively little value. I end up trying to translate the material directly for the layperson, which I don't think helps the journalist. I don't think I'm very good at it, so it doesn't help. What we really need are more qualified scientific journalists."

"I find that there's a relatively large discrepancy between TV and newspaper reports on science. The speed with which they are created is also noticeable. TV reports are usually very good, science is not misrepresented. Sometimes, when it comes to newspaper articles, you know that someone's written something, so there's a text there, but he or she had no idea what they were writing. The sentences are constructed correctly, but the writer simply didn't understand the subject. I believe that this is due to the lack of time that people are given to write a press release or an article for the daily newspaper on a specific research area – it's just not enough for someone who's not immersed in the material."

Overall, the majority draw the conclusion that media reports on their research area correctly convey the scientific relationships, developments and the significance of the research area or results. 60 percent of researchers draw this conclusion, whereas a good one-third perceive the facts as insufficiently represented. Younger researchers are more critical than older ones. Researchers who work in corporations are considerably more critical than researchers from universities and other research institutions. Of the researchers from corporations, a good half of them state that coverage of their own specialist area is usually factually correct, while two-thirds of researchers from universities and other research institutions think the same.

Conclusions on Reporting on Your Own Research Field

Question: "When journalists report on your area of specialisation: Do the articles or pieces usually correctly describe scientific relationships and discoveries and their significance, or are these often incorrectly reported?"



Basis: German Federal Republic, scientific experts whose specialist fields attract at least a limited level of public interest
Source: Allensbach Archive, IfD Survey 6263

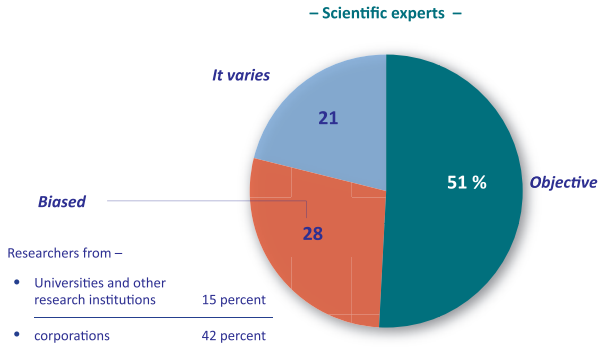
In general, half of all researchers are satisfied with the tenor of reporting. 51 percent of researchers consider the reports to be generally objective, 28 percent consider them biased, while one in five has had varying experiences in the past.

The scientific experts who report having had varying experiences were recruited primarily from universities and other research institu-

tions. Those who complained about biased reporting came primarily from corporations.

Bias of Reporting in Your Own Research Field

Question: "Are the articles on your research field objective or biased?"



Basis: German Federal Republic, scientific experts whose specialist fields attract at least a limited level of public interest
Source: Allensbach Archive, IfD Survey 6263

Above and beyond their own research area, researchers evaluated scientific reporting in the mass media varyingly. A good one-third of the researchers surveyed frequently perceive reporting as entirely negative, while a further 30 percent have this impression at least occasionally. Just one-third do not have this impression. In the pre-survey in-depth interviews, some respondents mentioned that reporting in the various media differs according to topic:

> *"Reporting is often very pithy, very simplistic, and geared towards doomsday scenarios. It often contains relatively few facts and little objectivity. There are differences; there are newspapers like the Frankfurter Allgemeine Zeitung or Die Welt, which produce first-class scientific reporting. But there are also numerous publications which do the opposite."*

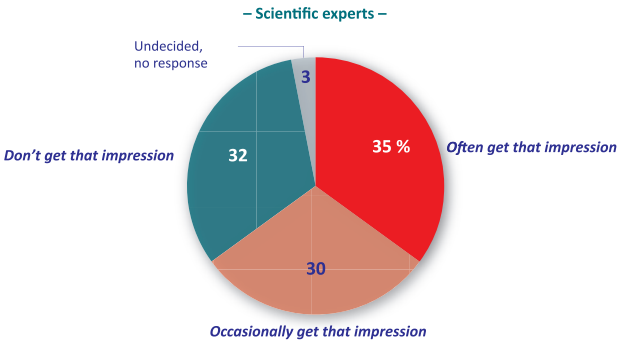
"Genetic engineering in agriculture is certainly a good example of a topic which is not often portrayed very factually. Instead, the arguments tend to reflect people's aims, particularly those of its opponents, as well as its supporters. Neither is probably quite as neutral as one would like. I do get the feeling, particularly with controversial topics, that too much opinion is written and too little that is either objective or based on hard facts."

"For the most part, science journalists are relatively good. If you have bad luck, of course, and talk to a program like Monitor or Panorama about cloning, things will go pretty badly. You've got no chance with that topic, no matter how well prepared you are. They set these things up to ensure that you can't catch a break."

The researchers surveyed set tremendous store by the tenor and quality of media reporting. The overwhelming majority believe that the media has an extraordinarily strong influence on public opinion of research results and their potential uses.

One-Sided Reporting?

Question: "When you consider how the media, i.e. television, newspapers, magazines, etc, report on scientific research results, do you often or occasionally get the impression that this reporting is biased towards the negative, or do you not get that impression?"



- **Three-quarters of the scientific experts perceive the influence of the media on the public's assessment of research results and potential applications as "very large"**

Basis: German Federal Republic, scientific experts
Source: Allensbach Archive, IfD Survey 6263

The broader media audience, that is, the population, draw a completely different conclusion about the tenor of scientific reporting. Only a vanishing minority of the population are under the impression that the tenor is more negative. Almost half of the total population feel that the reporting is balanced, while a good one-third find it predominantly positive. This conclusion is, interestingly, hardly dependent on whether a more sceptical or optimistic fundamental attitude towards scientific progress prevails. Both the population group which believes that scientific advances will bring them more advantages and security and that group which tends to associate scientific progress primarily with increased risk feel that the tenor of media reporting is hardly negative.

Assessment of Media Tenor

Question: "When you consider how the media, i.e. television, newspapers, magazines, etc, report on scientific research results, what is your impression? In general, is the reporting very positive, somewhat positive, balanced, somewhat negative or very negative?"

	Total population	Scientific advances bring more –	
		Security	Risk
	%	%	%
Very positive	**4**	**6**	**3**
Somewhat positive	**30**	**37**	**29**
Balanced	**46**	**43**	**47**
Somewhat negative	**5**	**5**	**5**
Very negative	**x**	**x**	**1**
Undecided, no response	**15**	**9**	**15**
	100	*100*	*100*

x = less than 0.5 percent

Basis: German Federal Republic, Population aged 16 and over
Source: Allensbach Archive, IfD Survey 11013

When evaluating these results, it should be taken into account that a lay public is only partly qualified to estimate the neutrality of media reports. The media audience cannot, as a rule, judge whether an expert quoted in the media is a recognised scientist or someone representing more of an outsider position. Researchers and even more journalists consider the exploitation of experts to be a widespread phenomenon. 75 percent of

journalists agree that it is, frequently, not the most recognised researchers in their fields who are quoted. Instead, it is those who hold a specific position. Two-thirds of scientific experts are convinced that opinion tends to be a more frequent selection criterion than scientific excellence.

Exploitation of Experts

Question: "The criticism is often raised that experts are exploited during socially controversial topics. Instead of interviewing researchers who are recognised in their fields, the media choose people who hold a particular position. How do you see that? Is the exploitation of scientific experts a widespread phenomenon, or does it happen only rarely?"

	Scientific experts	Journalists
	%	%
Widespread phenomenon	**63**	**75**
Happens rarely	**28**	**18**
Undecided, no response	**9**	**7**
	100	*100*

Basis: German Federal Republic, scientific experts and journalists
Source: Allensbach Archive, IfD Survey 6263

In the intensive interviews, however, some interviewees pointed out that the exploitation of researchers is now practised more by politicians than by the media, and that science is naturally now attempting to exploit the media in its turn.

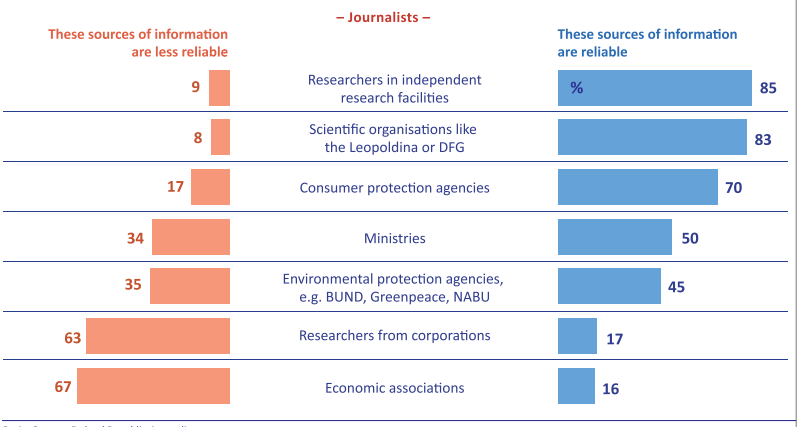
> *"Consulting researchers, or those who consider themselves researchers or who advertise themselves as such, is quite common. It's done by the media, but it's also a particularly popular practice among politicians. If they want to achieve a particular aim, some shady character who doesn't know a thing about the scientific world crawls out of the woodwork to provide a few quotes which are then used against science – but that's politics. I can't say the same about the media – I know it more from politics."*

"We're all exploiting each other. Science is trying to exploit the media; politics is trying to exploit science. This is completely fine, in moderation. It stops being fine if, for example, the wrong impression is given. After Fukushima, there was a lot of criticism of the media reporting. There were all sorts of experts appearing on TV, for example. And if you look at who they were, it was all one-sided. Yes, they were people that hardly anyone from the scientific community knew. Something like that is not OK."

The opinion that not only media and politics are exploiting science, but that science is, in turn, exploiting the media, is part of the journalists' everyday experience. One in five of the journalists surveyed has frequently heard that reporting of scientific topics should be slanted a certain way, while a further 57 percent have heard this occasionally. This type of attempt to influence reporting occurs frequently where economic interests are involved. In their interviews, journalists who frequently, or at least occasionally, report on scientific topics differentiated strongly between those information sources from universities and

Assessment of Reliability of Information Sources

Question: "What are your experiences with different sources of information when it comes to research topics?"



Basis: German Federal Republic, journalists
Quelle: Allensbacher Archiv, IfD-Umfrage 6263

scientific organisations and those from corporations. The overwhelming majority of the journalists surveyed consider researchers from independent research institutions and scientific organisations like the Leopoldina or the DFG to be reliable sources of information. In contrast, researchers from corporations and industry associations are considered by the majority of journalists to be second-rate, less reliable sources of information. 85 percent drew the conclusion that researchers from independent research institutions are, in general, reliable sources of information. Just 17 percent came to this conclusion in relation to researchers from corporations, while almost two-thirds, on the other hand, considered researchers from corporations to be less reliable information sources.

In the pre-survey in-depth interviews with researchers, it became clear that even science itself draws a dividing line between commercial and independent research – not in the sense of a negative delineation, but due to their differing roles and interests:

"I don't believe that science and business should cooperate more in scientific communication, as they have different interests. Science would not be well advised to allow itself to be guided by business interests in how it presents scientific results. I consider it a very good thing that the two worlds are relatively separate here and that academic success is not primarily aligned with economic success. Otherwise there would be a ready stock of arguments for discrediting science."

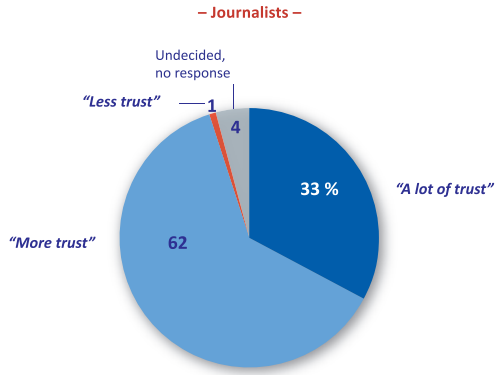
"This is a very difficult subject. In some areas, science and the economy are very closely connected; take, for example, the whole pharmaceutical research field, or organic chemistry. I think it's a good thing, and it will definitely do science good if the economy has a high level of interest in it. There are, after all, also businesses that carry out research – very good research. More than a friendly partnership would, in my opinion, not be useful, however. Science and business simply take different approaches. Science wants research for its own sake, while business is interested in making money from it. I don't think that the two approaches can be so easily reconciled."

"Business and science cooperate, of course, whereby business is less interested in the fundamental aspects of research and more in its application. But in Germany, two-thirds of research spending comes from business, so cooperation between business and science is essential for research's survival. This must not be allowed to affect the independent nature of science. Basic research, in particular, must be free of business interests, from material interests; but basic research also leads to innovation, to application, and of course we can only achieve that in collaboration with business."

Despite the differences journalists draw between researchers at research institutions and researchers in corporations, the vast majority of the journalists surveyed expressed trust in science. An explicit lack of trust was a view expressed only by a few outliers.

Trust in Science

Question: "All things considered, how much trust do you have in researchers in Germany, in their competence and accountability? Would you say that you have ..."



"No trust" = 0 percent

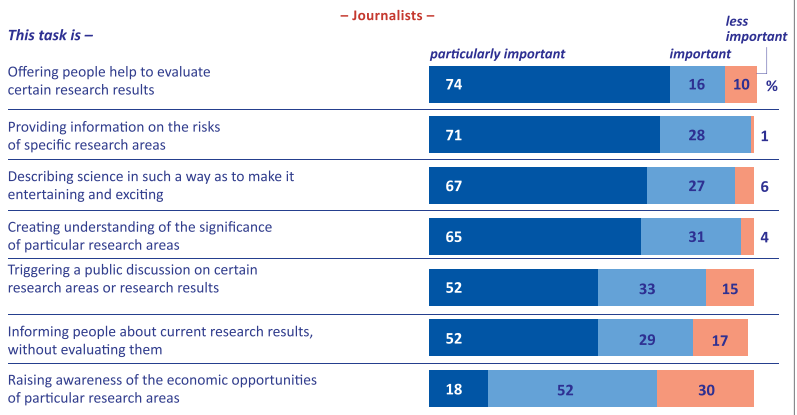
Basis: German Federal Republic, journalists
Source: Allensbach Archive, IfD Survey 6263

The vast majority of the journalists surveyed see themselves as mediators between science and the public. On the one hand, they want to offer people help in evaluating particular research results, while on the

other hand, they want to create an understanding of the significance of research areas. Reporters want to package science in such a way that it becomes interesting and exciting to a lay audience. Communicating risks also plays a very large part in journalists' perception of their work. 71 percent consider it particularly important to inform their audience about the risks of certain areas of research; this aspect plays an even more important part in their perception of their role than helping the public comprehend the significance of certain research areas. The economic potential of research areas and individual projects is, in contrast, considered much less significant by journalists. Whereas seven out of ten journalists consider it particularly important to identify the risks of certain areas of research, and two-thirds want to communicate the significance of research areas, just under one-fifth consider raising awareness of the economic potential of certain areas of research to be particularly important.

Understanding of Journalists' Role

Question: "As a journalist, what do you consider your main task when reporting on a scientific topic? What do you want to communicate most?"



Basis: German Federal Republic, journalists
Source: Allensbach Archive, IfD Survey 6263

7. Internet Improves Opportunities for Scientific Communication

According to both researchers and journalists, the prerequisites for scientific communication have changed considerably since the advent of the Internet. Particularly for journalists, the new ways of accessing knowledge via the Internet mean a serious expansion of their opportunities to inform themselves about scientific topics. 86 percent of the journalists surveyed see this as a major improvement in their information options, with 13 percent considering it a limited improvement. At the same time, two-thirds of the journalists are convinced that the Internet considerably improves the public's options for informing themselves about these topics.

Improving Access to Knowledge

Question: "How much, in your opinion, does the Internet improve opportunities for journalists / the public to inform themselves about scientific topics? Would you say ...?"

– Journalists –

	Assessment of the effects of the Internet on the –	
	Own information opportunities	Public's information opportunities
	%	%
"Very"	**86**	**67**
"Somewhat"	**13**	**25**
"Hardly / not at all"	**1**	**7**
Undecided, no response	**–**	**1**
	100	*100*

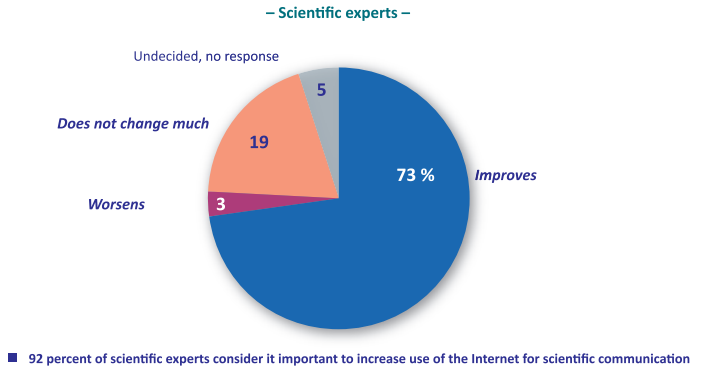
Basis: German Federal Republic, journalists
Source: Allensbach Archive, IfD Survey 6263

Of the researchers surveyed, the overwhelming majority appeared convinced that the Internet improves the prerequisites for dialogue with

the public on science and scientific discoveries. Almost three-quarters of the scientific experts surveyed held this position, whereas one in five expected no appreciable effects. 3 percent of the experts were convinced that the Internet's effects were more negative and impaired the chances for fruitful dialogue. For the overwhelming majority, there is no question that the Internet must be used more for scientific communication.

Positive Effects of the Internet

Question: "Does the Internet improve the prerequisites for dialogue with the public on science and scientific discoveries by making them better, worse, or does it not change much?"



■ 92 percent of scientific experts consider it important to increase use of the Internet for scientific communication

Basis: German Federal Republic, scientific experts
Source: Allensbach Archive, IfD Survey 6263
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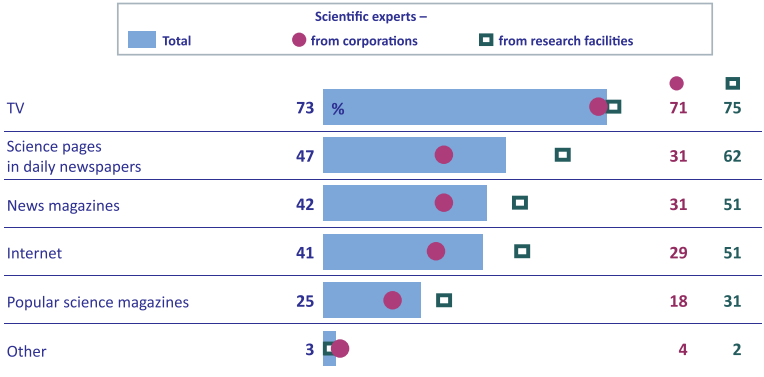
The question as to which media genre is the most suitable for sharing information about scientific topics and research results is, however, answered very differently. By far the greatest significance and communication potential here is, as before, attributed to television, followed by daily newspapers, news magazines, and the Internet. 73 percent of scientific experts consider television a particularly suitable medium for providing a wide audience with information on scientific discoveries. Almost half of those surveyed consider the scientific pages of the daily newspapers the best medium, while 41 percent consider the Internet to be the best. When assessing the significance of television, experts from both corporations and research institutions were, to a large extent, in

agreement. In contrast, the scientific experts who work at universities and other research institutions also consider daily newspapers, magazines, Internet and popular scientific magazines promising platforms to a much greater extent than scientific experts from corporations.

Suitability of Different Media Types for Scientific Communication

Question: "In your opinion, which medium is the most suitable for communicating scientific discoveries to a wider audience: the science pages of daily newspapers, popular science magazines like, for example, PM, news magazines like Spiegel or Focus, television, the Internet, or something else?"



Basis: German Federal Republic, scientific experts
Source: Allensbach Archive, IfD Survey 6263

In the in-depth interviews, it was also revealed that the evaluation of various communication channels and platforms depends on both their target audiences and the topics and communication goals:

"I'd say that that depends greatly on the audience. For a lay audience, I think television is still the best medium. For a specialist audience – like journalists, for example – I would consider personal presentations better, as they allow questions to be asked and any unclear points to be explained."

"The medium that most appeals to a given audience is always the best one. Books are the best medium for people who enjoy reading; for someone who enjoys films, television is the best; apps can

be created for people who enjoy being active. You just have to meet people on their level. If you do that, I think that science can be communicated effectively at any level."

"If we are just talking about impact and range, television is clearly the best. Visual images are the best; no-one wants to read long, complicated formulas and things like that. Print media, by which I mean popular science magazines and similar things, also, I think, have a relatively decent range. These are, therefore, the best option for people who want more detail."

"Anything that allows visual representation is suitable. If you go online, you'll find outstanding illustrations, especially in the very complicated field of molecular biology. You can listen to presentations; these are very accessible, and available for every level. There is a level which deliberately addresses a very wide audience, and there are also specialised presentations in this range. All that could, of course, happen on television. The illustrations that you look at online for particular presentations could, of course, just as easily be shown on television. If you always show science programming between 1 and 2 am, you'll never reach a large section of the population."

"It could be print media, electronic media – it depends a little on the audience's age. It could be social media if we're talking about the younger generation. There, especially, scientific discoveries are heavily used and applied through this digital revolution we're currently in. In that respect, there's definitely a certain opportunity."

"Well-written newspaper articles, of which there are still some, contain a lot of information. They force consumers, or readers, to address these issues while reading. Maybe I'm just too old or too conservative when it comes to these things: reading printed texts is a different form of perception from quickly skimming over something while you're surfing the Internet."

Some of the differentiations that are made here are incredibly important in developing communication strategies. For the past few years, for example, there has been a clearly defined generational split when it comes to information and communication patterns. Even if these differences are being influenced by the digital revolution and are not, therefore, expected to continue at this intensity level for long, for at least the next ten years, scientific communication must take into account that different generations can be reached to very different extents by the various platforms. Even the communication performance of the various media genres differs considerably, depending on other usage patterns. The speed of the Internet contributes to the general public's usage behaviour, which is characterised by fundamentally shorter time intervals and a wider selection than that offered by print media. In particular, young Internet-savvy users describe their Internet usage habits as being completely different from their print usage habits. It is also noticeable that print information is held in considerably higher esteem than digital information, with people believing that they retain more and understand more complex concepts after reading them. Primarily, however, the Internet is the medium which allows targeted information searches, and it can therefore satisfy activated and structured information requirements better than any other medium. This makes the Internet the superior channel for sharing information that interests both targeted groups and wider audiences. If, on the other hand, interest is to be sparked in a particular area, or information is to be communicated to the public without being initially and actively sought, other media platforms or strategies are generally more suitable.

The "talent" of the different media genres in communicating scientific topics was merely a peripheral theme in this study. In developing communication strategies, however, it is hugely important that the various generation-specific and background-specific information and communication cultures, as well as the usage patterns and specific communication abilities of the various media genres, are taken into account.

8. Study Data

- 6,263 – Survey of scientific experts and science journalists
- 11,013 – Representative population survey

Study Data					
Study population	A) Journalists from all types of media (print, radio, television, Internet), who write at least occasionally on scientific topics. B) Research institutions at universities and universities of applied sciences, as well as at non-university research institutions, who are engaged in biotechnological research. C) Corporations dedicated to and involved in biotechnology.				
Selection method	**Random sampling** A) The journalists were selected by random sampling by media type from the online journalists' directory published by „news aktuell GmbH". Only journalists who, according to the directory, work either exclusively or as part of their remit in science, were considered. B/C) The research institutions and corporations were selected by systematic random sampling from the biotechnology databases initiated by the German Federal Ministry of Education and Research. As a rule, the heads of the facilities or corporations were surveyed.				
Type of Interviews	Telephone surveys prearranged by email (A) or letter (B+C)				
Sample response rate/ Number of respondents		**Total**	A	B	C
	Gross sampling (=addresses contacted)	**562**	251	130	181
	Neutral rejections (incorrect addresses/not part of the total)	**49**	35	0	14
	Net sampling (= gross sampling – neutral rejections)	**513**	216	130	167
	Target contact not reached during fieldwork period	**161**	60	43	58
	Rejections (no time/no interest)	**143**	53	32	58
	Completed interviews	**209**	103	55	51
	Response rate (as a percentage of the net sampling)	**41**	48	42	31
Interviewers	7 trained phone interviewers				
Survey period	5 – 26 November 2013				
Allensbach Institute (IfD) archive number of survey	6,263				

Study Data	
Population group surveyed:	Resident population aged 16 and over in the Federal Republic of Germany.
Number of respondents	The total sampling comprises two representative partial samples (half-groups A and B). Furthermore, the selection was disproportionate for the old and new German federal states: In both half-groups and, therefore, also in the total sample, the east was more strongly represented at around one-quarter of the group, which is more than its population percentage of 19 percent. In describing the summarised results, this disproportionality was removed by using weighting.

Half group	West	East	Total	
A	863	286	1,149	persons
B	902	305	1,207	persons
Total	1,765	591	2,356	persons

Selection method	**Representative quota selection** The interviewers were given quotas which told them how many people to survey and the selection criteria to use. The surveys or quotas were, in accordance with official statistical documents, divided by German federal states and administrative regions, and within these regional units into large, medium and small towns, as well as into rural communities. The quotas were further divided into men and women, by age group, between the economically active and inactive, and by profession.
Weighting	To even out the disproportionality between the old and new German states and to align the information with structural data from official statistics, the results were weighted using factors.
Representation	As comparison with official statistical data shows, the weighted sampling corresponds to the total population over 16 in the Federal Republic of Germany. This correlation within statistical accuracy limits is essential for generalising the results.
Type of interviews	The survey was carried out face-to-face using a standardised questionnaire. The interviewers were instructed to read the questions word-for-word, without changing their order.
Number of interviewers	A total of 649 interviewers were selected according to strict test methods to participate in the survey.
Survey date	The interviews were carried out from 2-19 September 2013.
Allensbach Institute (IfD) archive number of survey	11,013

Statistics of the respondents in the 11,013 survey (German resident population aged 16 and over) compared to official statistics

	Representative population survey September 2013			Official statistics (*)
	Total	Half group		
	%	A %	B %	%
Regional Distribution				
Western states including West Berlin	81	81	81	81
Eastern states including East Berlin	19	19	19	19
	100	**100**	**100**	**100**
Northern Germany (Schleswig-Holstein, Hamburg, Lower Saxony, Bremen)	16	16	16	16
North Rhine-Westphalia	21	21	21	21
South-west Germany (Hesse, Rhineland-Palatinate, Saarland)	13	13	13	13
Baden-Württemberg	13	13	13	13
Bavaria	15	15	15	15
Berlin	4	4	4	4
Northeast Germany (Brandenburg, Mecklenburg-Vorpommern, Sachsen-Anhalt)	9	9	9	9
Saxony and Thuringia	9	9	9	9
	100	**100**	**100**	**100**
Town size				
Below 5,000 inhabitants	15	15	15	15
5,000 to 20,000 inhabitants	27	27	27	27
20,000 to 100,000 inhabitants	28	28	28	28
100,000 inhabitants and above	30	30	30	30
	100	**100**	**100**	**100**
Gender				
Men	49	49	49	49
Women	51	51	51	51
	100	**100**	**100**	**100**
Age				
16-29	18	18	18	18
30-44	22	22	22	22
45-59	27	27	27	27
60 and older	33	33	33	33
	100	**100**	**100**	**100**

(*) Original and estimated values (for German resident population aged 16 and over) according to official statistics. Source: Microcensus 2012

Statistics of the respondents in the 11,013 survey (German resident population aged 16 and over) compared to official statistics

	Representative population survey September 2013			Official statistics (*)
	Total	Half group		
	%	A %	B %	%
Profession				
Employed persons (working people and unemployed)	60	61	60	61
Economically inactive persons	40	39	40	39
	100	**100**	**100**	**100**
Professional sector (**)				
Worker	14	14	14	15
Employee	36	37	36	36
Official	3	3	3	3
Self-employed or freelance	7	7	7	7
Economically inactive persons	40	39	40	39
	100	**100**	**100**	**100**
Marital status				
Married	53	52	53	53
Men	27	26	27	27
Women	26	26	26	26
Single	31	31	31	31
Widowed or divorced	16	17	16	16
	100	**100**	**100**	**100**
Household size				
German resident population aged 16 years and over living in households with				
1 person	23	24	23	23
2 persons	40	40	40	40
3 persons	17	17	18	18
4 persons	14	14	13	14
5 or more persons	6	5	6	5
	100	**100**	**100**	**100**

(*) Original and estimated values (for German resident population aged 16 and over) according to official statistics. Source: Microcensus 2012

(**) for working people and unemployed (unemployed categorised by last employment)

Appendix: Project Development and Realisation

As part of the third Innovationsdialog (Innovation Dialogue) between the German Federal Government and the economic and science spheres on 27 February 2012, which covered technology fields and service-related innovations with a high potential for creating value and employment in Germany[38], synthetic biology was discussed in connection with the key technology "bioeconomy and biotechnology". In the course of the discussion, it became clear that there was very little empirical data available on shaping public opinion with regard to synthetic biology. This means that no reliable statements could be made about the public's attitude to this new research and technology field.

Inspired by this, the Institut für Demoskopie Allensbach (IfD, Allensbach Institute) and the Nationale Akademie der Wissenschaften Leopoldina (German National Academy of Sciences Leopoldina) undertook a joint study on the level of information on and acceptance of scientific innovation using the example of synthetic biology. The project was funded by the German Federal Ministry of Education and Research (BMBF) and ran from 28.01.2013 to 31.10.2014, under project number 16I1635.

The study was carried out in six steps:

1. First, the Leopoldina approached outstanding researchers from the following fields in the spring of 2013: synthetic biology, genetic engineering, microbiology, stem cell research, chemistry, IT, philosophy, ethics and law.
2. The Allensbach Institute carried out a total of 23 in-depth interviews with these researchers in summer 2013.
3. A quantitative survey carried out among 106 scientific experts and 103 journalists who often cover scientific topics was then carried out by the Allensbach Institute in autumn 2013.

38 For further information on this event, see http://innovationsdialog.acatech.de/themen/technologiefelder-und-dienstleistungsinnovationen-mit-wertschoepfungspotenzial.html (last accessed on 05.08.2014).

4. After reconciling the questionnaires, the Allensbach Institute performed a survey based on around 2,350 interviews with a representative cross-section of the public aged over 16 (autumn 2013).
5. The Allensbach Institute produced a detailed report on the survey results (winter 2013/14 – see Part II of this paper).
6. Based on this report by the Allensbach Institute, various experts from the Leopoldina provided considerations on the communication of synthetic biology (spring/summer 2014 – see Part I of this paper).

The Leopoldina and the Allensbach Institute would like to thank all the project contributors for their assistance, particularly the researchers who made themselves available for the in-depth interviews.

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Imprint

Publishers
Jörg Hacker and Renate Köcher

Graphic design and typesetting
unicom Werbeagentur GmbH, Berlin

Editing
Henning Steinicke and Stefan Artmann

Printers
mediabogen
Fiedler-Nöschel GbR
Marienburger Straße 16
10405 Berlin

Print run
1,500

ISBN 978-3-8047-3324-4

Bibliographic information published by the Deutsche Nationalbibliothek (German National Library)
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie (German National Bibliography); detailed bibliographic data are available on the Internet at http://dnb.d-nb.de.

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