European Journal of Clinical Nutrition (2014) **68,** 411–415

www.nature.com/ejcn

EDITORIAL

Fraud in science: a plea for a new culture in research

European Journal of Clinical Nutrition (2014) **68,** 411–415; doi:10.1038/ejcn.2014.17

German philosopher Karl Jaspers described science as methodical insight that is mandatorily certain and universal.[1] It is the ethos of modern science to want to reliably know on the basis of unbiased research and critique.[1] This claim is not always fulfilled by scientists.

Currently, there are numerous and partly publicly discussed cases of research misconduct and fraud. These cases span various sciences, but are particularly common in biomedical research. Misconduct and fraud in science do not only offend against its inherent norms and rules summed up in the 'scientific ethos' but also make a mockery of its goals—namely gaining knowledge as profound as possible, which again motivates further research and can be practically applied. Scientists depend on cooperation with each other as well as on productive, constructive and trusting relationships with possible investors, users of scientific results—especially patients—and the general public. Trust and honesty is vital for any kind of successful research. Violations of good scientific practice do not only affect those directly concerned but also science and society in general, and, if permitted, we run the risk of undermining the public's trust in scientific practice as a whole.

Despite numerous cases of research misconduct being made public, this issue is still a taboo topic among the scientific community. The following may be considered as isolated cases: Complete frauds, sometimes staged as a sensation by the media, like those of the South Korean clone scientist Hwang Woo-suk,[2] cases of manipulated data of researchers, for which there was furthermore no sufficient ethic vote—as in the case of the anaesthesia scientist Joachim Boldt,[3] plagiarism in theses of politicians and studies with obvious deficiencies like those of the French molecular biologist Gilles-Eric Séralini.[4]

It would be too narrow-minded to question only the individual integrity of the scientist. Very often, if we look into these seemingly isolated cases of research misconduct further, structures can be identified in scientific practice, which benefit such misconduct if not promote it.

HOW FREQUENT IS RESEARCH MISCONDUCT?

Cases of research misconduct frequently become public, sometimes even in quick succession. Exact numbers concerning research misconduct are not available; however, according to the report of the German ombudsman for science (formerly the ombudsman of the DFG, German Research Foundation), in 2011 a total of 20 new proceedings were initiated, while 24 proceedings from previous years were continued.[5] More than half of these proceedings came from the biomedical field. At present, there are not even somewhat plausible estimations of the dark figure of (so far) unknown cases of violation and fraud.

A study recently published in the *Proceedings of the National Academy of Sciences* (*PNAS*)[6] proves that retractions of already published articles have become more frequent in the past 30 years. Between 1977 and 2011, 2047 articles were retracted in the fields of biomedicine and life sciences, with research misconduct being the most frequent reason for retraction. Twenty-one percent of the cases claimed unintentional errors as a reason for retraction, whereas 43% of the articles were retracted owing to 'fraud' or 'suspected fraud', which has increased 10-fold since 1975. 'Plagiarism' and 'duplication' (the so-called 'self-plagiarism') make up the remains of the retracted articles in almost equal quantities.

When comparing the origin of the authors concerned, three-quarters of the cases of 'fraud' or 'suspected fraud' came from the United States, Germany and Japan. Concerning 'plagiarism' and 'duplication', no unambiguous allocation could be made; however, authors from the United States and China were most commonly involved.

Journals with a higher impact factor (IF) are more frequently affected by 'fraud' or 'suspected fraud' and 'errors' than lesser-ranked journals, whereas 'plagiarism' and 'duplication' are more commonly found in journals with a lower IF. The list of journals with the greatest number of retracted articles is headed by *Science* (IF: 32.45), *PNAS* (IF: 10.47) and *The Journal of Biological Chemistry* (IF: 5.12). Regarding retractions due to 'fraud', *The Journal of Biological Chemistry* tops the list, followed by *Anesthesia & Analgesia* (IF: 3.07) and *Science*. Concerning proven 'errors', *Science* leads, followed by *PNAS* and *Nature* (IF: 36.24). 'Plagiarism' and 'duplication' were similarly frequent in all journals. What is striking is that numerous prestigious journals are also affected by such cases (e.g. *The New England Journal of Medicine*, IF: 50.08).

The average period between publication and retraction of articles was 33 months in all cases; it was highest in cases of 'fraud', reaching 47 months. Regarding 'plagiarism' and 'duplication', it took an average of 26 months for an article to be retracted. Before retraction, many articles are frequently cited. Concerning articles published in highly prestigious journals (such as the *Lancet*, *Nature Medicine*, *Cell*, *Nature*, *New England Journal of Medicine*) and later retracted, between 234 and 758 quotations were counted for the period between 2002 and 2010. Thus, it can be assumed that the misconduct of the respective researchers has caused considerable harm to the scientific community.

WHAT IS RESEARCH MISCONDUCT?

Possible mistakes have to be differentiated from misconduct with intent and fraud. Characteristics of fraud range from plagiarism to the violation or assumption of the intellectual property of other authors and data forgery. What is considered as fraud is data misuse, the manipulation of results and their presentation, the independent invention of data, the concealment of undesired results, the disposal of original data, submission of false data, disturbance of the research of other scientists and deception. Fraud also encompasses active participation in misconduct of other researchers, joint knowledge of the forgeries of other authors, coauthorship of forged publications and the gross neglect of responsibility.

GOOD SCIENTIFIC PRACTICE

In 1998 the DFG published a memorandum on safeguarding good scientific practice.[7] Good scientific practice implies to work '*lege artis*', to always entertain doubt and self-criticism, to mutually check and examine results, to be accurate when securing quality, to be honest and to document and store primary data to ensure reproducibility.[7] In research institutes and research groups, transparency of the organisational structure, unambiguous

responsibilities, information, on-going training and supervision of staff and colleagues are part and prerequisite of good scientific practice. This also includes regulations for storing data, for the allocation of authorship, accountability and responsibility for observing the guidelines and regulations of dealing with possible misconduct.

These fundamental rules have to be applied when using DFG funds. Guidelines for good scientific practice were also published by the Leibniz-Gemeinschaft and the Max Planck-Gesellschaft.[8,9] All university and non-university research institutions in Germany have implemented respective guidelines. In light of recent events (a reaction to the case of 'von und zu Guttenberg' in media, politics and science), in 2011 the DFG held a symposium of the alliance of research associations (i.e. the Alexander von Humboldt-Stiftung, the Deutsche Akademische Austauschdienst, the Deutsche Akademie der Naturforscher Leopoldina, the Deutsche Forschungsgemeinschaft, the Fraunhofer-Gesellschaft, the Helmholtz-Gemeinschaft, the Hochschulrektorenkonferenz, the Leibniz-Gemeinschaft, the Max-Planck-Gesellschaft and the Research Council.) with the title 'Good scientific practice', and thus remains active in dealing with the issue.[10]

CONTROL

Good scientific practice is first of all subject to the self-control of scientists within their community. Self-control seems to be reasonable, especially because, respectively, qualified scientists can themselves judge best, which results are plausible and which appear rather suspicious. However, the principle of self-control presumes that a scientific community is able and willing to control itself sufficiently. Especially in highly interconnected research—nationally and internationally—concerning complex questions and problems, trust is a crucial but fragile principle. In general, between cooperating scientists, research misconduct is considered impossible, and mistrust, a poor partner. Yet, the recently disclosed cases of research misconduct make it very obvious that self-control, if taken seriously, is a high demand placed on authors, which is very often limited by personal factors or by pressures linked to their university, institution and/or funding body. In how far alternative or complementary concepts of external control are necessary and what format they may take has not yet been extensively discussed.

CONSEQUENCES

The possible consequences of a violation against good scientific practice comprise labour law-related sanctions (e.g. warning, dismissal), academic sanctions (e.g. the revocation of an academic degree), sanctions according to civil law (e.g. compensation) and criminal sanctions (e.g. due to forgery). A revocation must be made and the subject matter must be set right. Violations against good scientific practice must be communicated to all cooperating partners, research communities, professional associations and to the public. Here, the rights of those affected must not be curtailed.

Each research institute has an ombudsman for science, who is elected from the circle of scientists; scientists in an executive position are not electable.[7,11] The nominated ombudsman for science is challenged with the prevention of research misconduct, informing his or her colleagues about ethical principles of research, examining possible allegations of misconduct and following the appropriate course to solve such matters.

The ombudsman analyses the meaning and the motives of such violations; here, confidentiality has to be ensured and those affected have to be saved from rash harm. It is also part of the duties of the ombudsman to inform the administration, the Dean and project sponsors. He or she should be independent and free of conflict of interest.[cf. 11]

REASONS FOR RESEARCH MISCONDUCT

Considering the principles of science and the many cases of fraud recognised over recent years, the question of reasons for research misconduct is becoming increasingly topical. Misconduct does not simply result from poor character or the misjudgement of individual scientists. Although personal factors are certainly not irrelevant, the manner in which research institutions are organised must also be taken into consideration. No scientist can be *a priori* certain that he or she does not commit errors one way or another—even though unintentionally—or that he or she is not affected by the misconduct of others; however, prevention of research misconduct is becoming ever critical. The following arguments are addressed to explain possible reasons for research misconduct.

'Publish or perish'

Success and an academic career are the result of numerous publications. In Germany there are many universities, academies and research institutes, which employ ca. 40 000 professors and numerous assistants.

Science not only serves to further the knowledge and interests of an individual but also to build their own academic profile. Both the 'success' and the 'failure' of individual researchers and research groups immediately result in effects on the reputation of their respective institutions and associations.

When wishing to make a personal career as a scientist and to increase the 'success' of one's institution, one has to publish regularly, quickly and in high-ranking journals. Hence, scientific research is subject to high pressure, which is increased by financial incentives. If there is little success (i.e. only few publications or numerous publications but in lesser-ranked journals), it is unlikely that the career of the scientist will continue long term. One's own research has to be successful in the sense of 'publish or perish' to guarantee a job and income in the future.

Uncertain research structures

Younger scientists, especially, are often dependent on subsidies limited in time. Social uncertainty is a very adverse condition for research. In recent decades, it was possible to support excellent and large-scale research projects by financial means offered by the state and the EU, and ambitious research projects were realised. Nowadays, the volume of funding available has decreased and research institutes, universities and their employees are competing for funds that ultimately determine the feasibility and scale of projects undertaken.

The existence of such projects, as well as jobs in research, is also limited by the respective period of funding leading to a high degree of instability. High competition for limited funds is generating more pressure on scientists to be the 'best', judged by the number of publications and the journals in which they are published.

The dimensions of research

The dimensions of research supersede the scientist's daily life. At the moment biomedical research has a high reputation within our society and thus enjoys a certain kind of advantage of trust, which is not least fuelled by the patients' hope for (more) effective therapies and further medical concepts. Research not only fulfils one's own ambitions as a scientist but also exterior demands for solving important questions for the future of our society. It also establishes and stabilises the so-called 'research sites'.

The insights of science do not only have value within the field but also in a further reaching way for society and the economy. This is generally held true for countries like Germany, which is rather poor in natural resources but whose know-how is their most important resource in the globalised world.

Regarding methodical and technological progresses, today scientists are under the impression that they live in times of great discoveries and essential biomedical progress, leading to biomedical research being characterised by a spirit of optimism. Modern biomedicine has taken up an immense rise, creating an almost 'revolutionary' enthusiasm in medicine and also arousing the public's interest. Discoveries and sensations from science have become part of our everyday life.

We want to believe that complex medical problems can be solved within a relatively short period of time, and diseases that have previously been deemed fatal, can be prevented or successfully treated. To achieve that, great joint efforts are necessary as well as more and more financial means for ever bigger 'mega'-projects. There is a vision that the time until the next breakthrough can be shortened by bigger investments. The position and ambition of a scientist thus succeeds his or her daily life and genuine workspace, his or her responsibility reaches far into far future and society, whether the individual scientist, the work group or the institute may or may not want this.

The 'hype', which is nowadays regularly created for medical applications that are only envisaged or that seem to be almost visionary, is fuelled by researchers and the public in a complex interaction with each other, no matter if they like it or not. The impetus for researching may go beyond interest in scientific knowledge; research also serves as a means of self-fulfilment, self-representation and not least the vanity of the agents. For the scientist, this development involves the danger of failing oneself and one's own aspirations, since despite any highly specialised knowledge: Scientists are no better people.

Dysfunctional communication

Presently, we feel that communication between scientists is 'disturbed'; self-control does not really work. High research activity and great dependency on external funding influence the culture of communication. This has had an effect on scientific journals over recent years, with an exponential increase in the number of publications, and also in the creation of new peer-reviewed journals.

Publication of articles is subject to the self-control of scientists. An article submitted for publication is usually assessed in the form of an anonymous review, normally by two independent scientists. If the reviews are contradictory, the Editor may seek the opinion of further experts in the field. This form of self-control is, however, stretched to its limits. The number of experts who are qualified for reviewing is limited, their time is limited, and in addition, regarding the present national and international research networks, their independence can no longer be guaranteed.

Despite there being a number of strategies and programmes for detecting plagiarism,[cf. 12] their usage often exceeds the effort reasonable for those reviewing in an honorary capacity, which may result in a degree of unintentional incompleteness when reviewing. Publishers of professional journals and their editors strive for effective strategies against research fraud; however; there are obviously limits to self-control and at present successful alternative or complementary forms of external control have not yet been established.

The loss of a critical discussion culture

A loss of a critical discussion culture harms the quality of research. Adverse factors conditioning misconduct can be observed at conferences and congresses. Here we are overwhelmed with data and almost exclusively see 'successful' presentations; projects seem stringent, and results are very often 'perfect'. One can do nothing else but congratulate. Hardly ever are negative results or one's own mistakes addressed. Our 'togetherness' finds itself in a rather care-free and positive atmosphere; arguments on a matter can seldom be found. What is thus not promoted is dealing critically with research results.

Networks increase 'productivity' and create dependencies

Networks of research institutions and scientists serve the purpose of science, but they also have a 'multiplier effect'. A broad and partly global cooperation of scientists requires common values and responsibility. Results of 'successful' networking include, for example, multiple authorship of publications, multiple evaluations of the same data and redundancies or overlapping of scientific publications.

The responsibilities are not always set clearly within networks and among the authors of publications (in spite of the regulations of academic journals[cf. 11]), and in practice are not really transparent. It is possible that many coauthors are not conscious of their responsibility. If numerous authors bore common responsibility for a publication, this could serve the function of self-control.

The appreciation of authors whose effective part in the respective article is limited or minor becomes a disadvantage if they become unaware accomplices, even in individual cases of research misconduct. Being accepted in the context of many experts promotes one's reputation and career; however, this way of thinking might be damageable for the integrity of science. Networks can also obstruct the clarification of research misconduct: If one 'falls', many others will 'fall' too. Who would really want that?

Hierarchies create disquieting pressure

Research institutions and great associations, such as clusters of excellence and collaborative research centres, not only have democratic but also partly hierarchical governance structures. They may promote one's success or affect it negatively. In the worst case, they promote inequality in research and use relationships of subordination and dependency and hamper critical discussions.

Running research associations and deciding on applications and external funds implies power on the one hand, but on the other hand, it also entails responsibility. The maintenance of power is an obvious strategy (and taken for itself not objectionable) of those who want to achieve this power and keep it. The balance of power and responsibility decides on how 'successes', which are necessary for establishing or continuing a group or project, are achieved. If power is favoured over responsibility, inequality and dependencies can affect the quality of the academic work by putting the individual scientist under pressure to produce results in a certain way. Researching and publishing under pressure increases the danger of mistakes and therefore research misconduct.

Too much is published

The very successful scientists of today (sometimes called 'heroes of science' or 'giants in medicine') generally have such a high number of publications that outsiders may feel 'dizzy': Top researchers seldom publish more than 20 articles a year, and usually in the so-called 'top journals' (i.e. journals with a high IF). If a certain number of publications within a certain period of time is exceeded (with due respect), doubts concerning the responsibility and integrity of the respective scientist may arise. Publishing more and more and better each time increases the danger of losing control over the content and of not fulfilling a researcher's responsibility.

Money may 'spoil' researchers

Considering the high number of calls for attractive research projects, submitters as well as reviewers and counsellors are overburdened and also partly overcharged. Taking part in many activities eventually makes us reach the limits of our possibilities. The genuine interests of a scientist must not be dominated by 'always wanting' and 'always participating'.

Thus, it is not honest to 'devote oneself' to a research project, unless the project is an exact fit with one's own interests and qualifications, just to get the money. A researcher's capacity and productivity is limited and cannot be stretched infinitely by external funds. If the expectations are not fulfilled and the necessary honesty is missing, money can become a disadvantage for research. Who would admit that he or she is not really interested in a certain project for which he or she has received money and that he or she has possibly spent part of the money elsewhere?

'Libertarian' research mentality and 'research factories' impede thinking against the tide

A 'libertarian' research mentality and 'research factories' impede thinking against the tide and force 'success'. The placing of external funds takes place is influenced by research structure; those who already have a lot are persuasive and are therefore more likely to receive future funding and perhaps higher volumes. The result of this is thematically and methodically concentrated, and nowadays highly upgraded centres, or 'research factories', which show high productivity and growth rates and secure futures. These centres suppress smaller work groups that struggle to compete.

The concentration of research in the name of 'success' creates power structures and endangers the breadth and quality of research. Thinking against the tide has become hard and rather seldom considering the thematic conformity in research centres. Today libertarian principles (known from economics) determine the success and the future of biomedical research; high profit (i.e. high scientific output) means everything.

Consequently, a publication in a prestigious journal demands a further publication in an also prestigious journal and so on: Scientific growth is seemingly continued to infinity. The 'real' gain of scientific knowledge does not necessarily grow with the number of publications; the 'surplus value' of research (i.e. in the sense of creating knowledge) has yet to be proven.

However, this view contradicts the calls and the expectations of those funding the projects and the promises of those receiving the funds. Failure is not provided for: Those who receive high funds are doomed to be successful (i.e. there has to be a result); however, this is obviously a case of positivism misunderstood. Research funding is beneficial, but at the present height, it also means a risk to research, because 'more' money does not automatically mean 'more' knowledge. This (at least felt, if not always admitted) discrepancy may affect scientists behaviour in a negative way.

POSSIBLE WAYS OUT

Considering the rather disillusioning diagnosis concerning the complex network of individual, social, economic and structural factors conditioning forgery, fraud, plagiarism and other forms of research misconduct, the question of what format effective prevention and constructive processes dealing with discovered misconduct could take arises.

Openness

Discussing problems, our mistakes and causes in an open and self-critical way should serve to raise awareness and warn researchers of the potential dangers and consequences of misconduct. In cases of fraud or plagiarism, the agents are not just 'black sheep'. Individual responsibility shall not be denied and must not be downplayed. However, we have to be aware that generally all researchers bear the risk of research misconduct, violations of good scientific practice are possible for each of us and each scientist is liable to the pressures that fuel such behaviour or, indeed, help disguise it.

Transparency

Academic work requires transparency. Researchers should be subject to internal and external assessment that verifies their research and relates it to respective control mechanisms. It has to be discussed—not only within the research system, but in a wider context. On the one hand, freedom of research must be ensured, but on the other hand, research responsibility must be realised. Without doing away with self-control, it however becomes apparent that self-control alone is not sufficient and that concepts of external control must be developed and evaluated.

Culture

Self-control has to be credible, but under the given circumstances of scientific work, this is not always possible; multiple charges, diverse networking and the diverse interests of researchers, reviewers and counsellors subvert the principle of self-control and our credibility. High research activity demands for a discourse on how much 'self-control' a 'booming' science can afford. This discussion cannot only be led by those with 'power' (who are themselves part of the problem because of their high amount of external funds). It is essential to think against the tide.

Restrictions

Voluntary restrictions on researchers (e.g. in the number of doctoral candidates, in the amount of attracted funds, in the number of publications each year) and the establishment of a responsible relationship between supervisors and assistants are prerequisites for good scientific practice. Scientific work also demands modesty; overestimating oneself and one's own thematic coverage will backfire. This is especially true in times of 'data- and tool-driven' research, which demands responsibility and discipline when dealing with results.[13]

Basic understanding

Even though external control may be effective, scientists should still be obliged to self-control. Acting as a researcher does not only serve the purpose of furthering knowledge and progressing personally, but relationships with others must also be considered. Rules of good scientific practice have to be accepted by all of us and embedded into attitudes and personalities.[14] Academic training (e.g. in research training groups or in 'young research groups') should account for that.

Less pressure

The pressure to succeed imposed by highly financed research institutions and groups has to be reduced. The fundamental values of science must self-evidently and always have priority; they are honesty, decency, objectivity, credibility, doubt, responsibility and openness.

What increases the risk of research misconduct is working only for profit (i.e. the number of publications and the height of the IFs) and growth (i.e. more and more publications). Thus, research that is libertarian and at the same time only oriented towards the market contradicts the idea of science. Research institutes should overcome the temptation of only seeing themselves as players of the market.

Quality offensive

The volume of research fraud that has become known begins to demand a quality offensive to be produced. It could imply proactive controls and random samples, the vocation of quality assurance commissioners, the central filing of data and documents, the obligation to take part in regular self-trainings or even workshops on 'error learning culture'.

Critical distance

Researchers of today are voluntarily or involuntarily part of a media-marketed academic life. It is not only about the secrets of nature, discoveries and problems that have to be solved effectively; science 'charms'. Results affect researchers (who gain an impetus for their work out of this) and academic journals (which 'sell' well if the stories are 'good'), and also the 'world' (which wants to be helped and entertained by scientific knowledge). The scientist should know the inherent risk of this 'charm'; the limitations of science itself and, of course, also the personal limits of the scientist are always present.

PROSPECT

The problem of research misconduct has to be offensively addressed in all its diverse shades within universities, research institutions, institutes and work groups. Guidelines of good scientific practice are already part of the daily work at many places, but they are just a first step towards a transparent and diverse research culture. Interaction of research, public and politics[15] is in specific need of more attention to keep up the still high credit of trust in science and to encourage and support scientists to meet this trust by an appropriate scientific ethos. In September and October of 2012, the Global Network of Science Academies (IAP), together with the InterAcademy Council and the European Research Council (ERC), formulated strategies and parameters of actions against research misconduct.[16,17] They again stress the personal responsibility of scientists and institutions, as well as the principle of self-control in science. Here, academic journals, academies and associations are assigned a special role. However, these arguments and recommendations are conform to the discussion so far; they remain within the realm of science itself, do not go further and do not reach any new quality—at least until now.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ACKNOWLEDGEMENTS

This contribution was made in the context of the BMBF Kompetenznetz Adipositas (Junges Netzwerk, FKZ 01GI1123 and EPI Germany, FKZ 01GI1121A).

MJ Müller[1], B Landsberg[1] and J Ried[2]
[1]*Institute for Human Nutrition and Food Science, Christian-Albrechts-Universität, Kiel, Germany and*
[2]*Fachbereich Theologie, Lehrstuhl Systematische Theologie (Ethik), Friedrich-Alexander-Universität, Erlangen-Nürnberg, Germany*
E-mail: mmueller@nutrfoodsc.uni-kiel.de

REFERENCES

1 Jaspers K. Grundzüge der modernen Wissenschaft. Jaspers K. *Was ist der Mensch?* Piper: München, Germany, 2000, pp 93–95.
2 Zeit Die. http://pdf.zeit.de/online/2006/01/hwang_total.pdf. Accessed on 29 December 2005.
3 Zeitung Ärzte. www.aerztezeitung.de/praxis_wirtschaft/recht/article/819197/studiengefaelscht-bericht-belastet-anaesthesisten.html. Accessed on 08 August 2012.
4 Der Spiegel. http://www.spiegel.de/wissenschaft/natur/genmais-efsa-legt-abschlussbewertung-zu-seralini-studie-vor-a-869844.html. Accessed on 28 November 2012.
5 Ombudsmann für die Wissenschaft, Jahresbericht 2011. www.ombudsman-fuer-die-wissenschaft.de/fileadmin/Ombudsman/Dokumente/Downloads/Berichte/Jahresbericht_2011_Ombudsman.pdf. Accessed on 21 March 2012.
6 Fang FC, Steen RG, Casadevall A. Misconduct accounts for the majority of retracted scientific publications. *Proc Natl Acad Sci USA* 2012; **109**: 17028–17033.
7 DFG—Deutsch Forschungsgemeinschaft. Gute wissenschaftliche Praxis. http://www.dfg.de/foerderung/rechtliche_rahmenbedingungen/gwp/index.html; http://www.dfg.de/download/pdf/dfg_im_profil/reden_stellungnahmen/download/empfehlung_ wiss_praxis_0198.pdf. Accessed on 10 January 2010.
8 Leibniz-Gemeinschaft. www.leibniz-gemeinschaft.de/. Accessed on 24 February 2014.
9 Max-Planck-Gesellschaft. http://www.mpg.de/pdf/procedures/regelnWissPraxis.pdf. Accessed on 24 February 2014.
10 'Gute wissenschaftliche Praxis'—Symposium der Allianz der Wissenschafts organisationen. Berlin http://www.dfg.de/foerderung/rechtliche_rahmenbedingungen/gwp/111129_symposium/index.jsp. Accessed on 29 November 2011.
11 DIW—Deutsches Institut für Wirtschaftsforschung. Forschungsethische Prinzipien am DIW Berlin und Verfahren im Umgang mit wissenschaftlichem Fehlverhalten. http://www.diw.de/documents/dokumentenarchiv/17/diw_01.c.407627.de/forschungsethischeprinzipien_20121025.pdf. Accessed on 4 November 2012.
12 COPE, Committee of Publication Ethics. Promoting integrity in research publication. http://publicationethics.org. Accessed on 30 September 2012.
13 Dyson FJ. Is science mostly driven by ideas or by tools? *Science* 2012; **338**: 1426–1427.
14 Dörner, K. 'Ich darf nicht denken'. Das medizinische Selbstverständnis der Angeklagten . Ebbinghaus, A, Dörner, K, Hrsg. Vernichten, Heilen. Aufbau: Berlin, Germany, 2001. *Der Nürnberger Ärzteprozeß und seine Folgen?*
15 *Wissenschaft und Demokratie.* Frankfurt a.M., Germany: Suhrkamp, 2012.
16 IAP—The Global Network of Science Academies and InterAcademy Council. Responsible Conduct in the Global Research Enterprise. A Policy Report. http://www.interacademycouncil.net/File.aspx?id = 28253. Accessed on 2 February 2014.
17 ERC—European Research Council. ERC Scientific Misconduct Strategy. http://erc.europa.eu/sites/default/files/document/file/ERC_Scientific_misconduct_strategy.pdf. Accessed on 11 October 2012.