PERFORM toolkit for researchers to develop reflexivity, understanding of RRI values and creative approaches to public engagement

PERFORM brought early career researchers (ECRs) together with performers, teachers and secondary school students to develop performance-based activities that explored Responsible Research and Innovation (RRI) and the human dimension of science. During 2016-2018, PERFORM delivered two rounds of bespoke training courses in Bristol, Paris and Barcelona to enable ECRs to develop the relevant cross disciplinary skills to support this activity. These included: communication and engagement skills, team working and a more holistic and interdisciplinary understanding of research including RRI values.
This user-friendly toolkit presents key topics covered in the training courses in the form of written guides and short films. It is freely accessible online as a resource for higher education institutions responsible for training ECRs, or for ECRs to use independently as a framework for informal professional development training.

PERFORM training for early career researchers

This toolkit shares key learning from the two rounds of bespoke training for early career researchers (ECRs) that took place in Spain, France and the UK as part of the Horizon 2020 PERFORM project between 2016 and 2018.

The training was led by the University of Bristol in the UK, Atelier des Jours à Venir in France, and Universitat Autònoma de Barcelona and Universitat Oberta de Catalunya in Spain. In total, 84 early career researchers took part in this training.

Researchers at a science busking training in the UK

Researchers at a training session in Spain

The overall aim of the training was to provide appropriate tools to early career researchers that would allow them to develop cross disciplinary skills such as communication and engagement skills, team working, a more holistic and interdisciplinary understanding of research including Responsible Research and Innovation (RRI) values and social inclusion. Responsible Research and Innovation is an approach that anticipates and assesses potential implications and societal expectations with regard to research and innovation, with the aim to foster the design of inclusive and sustainable research and innovation[1].

To help develop an improved understanding of RRI, the training aimed to enable ECRs to address these key questions:

- How is my research embedded in social practices, norms and values of the scientific community?
- What are my responsibilities towards society?
- How does my reflexivity on the issues above translate in the way I communicate about science?

The courses across the three countries all included aspects of training on: social aspects of science and reflexivity on research practice, performance skills, communication skills, working with teenagers, working with schools, gender equality issues, and ethics.

1. EC Horizon 2020: Responsible Research and Innovation

Aim of the toolkit

The aim of this resource is to support ECRs in their reflective thinking around RRI values and processes and introduce them to some creative performance methods for public engagement, inspired by the PERFORM project. This toolkit has been designed as a user-friendly starting point for professional development on these topics.

There are many other excellent and extensive resources for supporting RRI training, for example those on RRI tools: https://www.rri-tools.eu/. This toolkit does not intend to replicate these resources.

Who is the toolkit is for?

This resource is designed for higher education institutions responsible for training ECRs, or for ECRs to use independently as a framework for informal professional development training.

The PERFORM project brought together interdisciplinary groups of ECRs - and a variety of perspectives - which enabled rich discussion. This toolkit is relevant to ECRs from all scientific disciplines and is designed to be able to be used by an interdisciplinary cohort.

Toolkit contents

Written sections

The written sections are designed so that they can be used in a standalone session, to inform a short discussion or to implement a standalone training session. Users can also select a number of sections to form a training course, with each section forming one session.

There are seven sections:

- Research Ethics and Integrity
- Reliability of Scientific Knowledge
- Wellbeing at Work
- Values in Science
- Reflexivity in Research
- Responsible Research and Innovation
- Performance Approaches for Exploring Responsible Research and Innovation

Films

Integrated into some of the written sections are links to corresponding short films. Four films focus on key topics: Research Reproducibility, Reflexivity in Research, Responsible Research and Innovation, and Creative Approaches to Public Engagement. The films feature speakers who contributed to the PERFORM ECR training in Spain, France and the UK. The films end with reflective questions, which serve as a starting point for discussion. They can be used alongside the written guides, or as a standalone resource.

How to use

Each toolkit section features at least one discussion-based activity, which is designed to support ECRs to collectively reflect on the content presented in the readings and/or films.

You may want to consider organising the discussion in different ways, for example:

- Presentation and general discussion of the references
- Small group discussions, followed by general discussion about the topics
- Individual reflection and writing of answers on post-its, which are then displayed on a board, so that answers remain anonymous.

Some of these discussions may raise sensitive or controversial issues. The Seeds for Change collective provides useful general guidance on how to effectively facilitate discussions of this kind. You can find their tools here: https://www.seedsforchange.org.uk/tools

This toolkit was produced by PERFORM partners the University of Bristol (Martha Crean & Ellie Hart) and Atelier des Jours à Venir (Livio Riboli-Sasco & Claire Ribrault).

The design and content was informed by written evaluations of each round of ECR training and reflection sessions with ECR participants. The following PERFORM partners contributed to the development of ECR training or toolkit: Universitat Autònoma de Barcelona, Universitat Oberta de Catalunya, University of Warwick, the Big Van Theory, TRACES, and Science Made Simple.

Guidance and consultation during the development of the toolkit was also provided by an external group of experts in the areas covered by the toolkit. We would like to thank the following people for contributing to the development of this toolkit:

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Research Ethics and Integrity

This section outlines fundamental responsibilities of the research community. It presents some existing frameworks for Research Ethics and Research Integrity, designed to provide researchers with a common basis for defining and implementing tangible and enforceable guidelines. In some countries, integrity is part of an ethical practice of research, whereas in other countries this is inverted and ethics is considered as one aspect of integrity.

What is Research Ethics?

Ethical research conduct implies the application of fundamental ethical principles and legislation to scientific research in all possible domains of research – for example biomedical research, nature sciences, social sciences and humanities.

The most common ethical issues include:

- the involvement of children, patients, vulnerable populations,
- the use of human embryonic stem cells,
- privacy and data protection issues,
- research on animals and non-human primates.

It also includes the avoidance of any breach of research integrity [as explained below].

European Commission Horizon 2020: Ethics

What is Research Integrity?

Good research practices are based on fundamental principles of research integrity. They guide researchers in their work as well as in their engagement with the practical, ethical and intellectual challenges inherent in research. These principles are:

- Reliability in ensuring the quality of research, reflected in the design, the methodology, the analysis and the use of resources.
- Honesty in developing, undertaking, reviewing, reporting and communicating research in a transparent, fair, full and unbiased way.
- Respect for colleagues, research participants, society, ecosystems, cultural heritage and the environment.
- Accountability for the research from idea to publication, for its management and organisation, for training, supervision and mentoring, and for its wider impacts.

All European Academies. (2017). The European code of conduct for research integrity. (ISBN 978-3-00-055767-5) Berlin: Germany.

Assessing integrity in research

The frequency with which scientists fabricate and falsify data, or commit other forms of scientific misconduct is a matter of controversy. Many surveys have asked scientists directly whether they have committed or know of a colleague who committed research misconduct, but their results appeared difficult to compare and synthesize. Fanelli (2009) carried out a meta-analysis of surveys, finding that:

A pooled weighted average of 1.97% ... of scientists admitted to have fabricated, falsified or modified data or results at least once –a serious form of misconduct by any standard– and up to 33.7% admitted other questionable research practices. In surveys asking about the behaviour of colleagues, admission rates were 14.12% ... for falsification, and up to 72% for other questionable research practices. Meta-regression showed that self reports surveys, surveys using the words "falsification" or "fabrication", and mailed surveys yielded lower percentages of misconduct. When these factors were controlled for, misconduct was reported more frequently by medical/ pharmacological researchers than others.

Considering that these surveys ask sensitive questions and have other limitations, it appears likely that this is a conservative estimate of the true prevalence of scientific misconduct.

Fanelli D (2009) How Many Scientists Fabricate and Falsify Research? A Systematic Review and Meta-Analysis of Survey Data. *PLoS ONE* 4(5): e5738.

The consequences of a lack of integrity in research include:

- Undermining public trust in research, through conflicting claims and misleading information.
- Misdirecting funding and unfairly crediting researchers or laboratories on the basis of substandard research, leading to resources being wasted.
- Damaging reputations, both of institutions which have been implicated in high profile cases and that of the UK within the international community.
- Risking public health, for example by asserting evidence that may cause people to decide to either undergo or refuse trials or treatment or to use products that have not been shown to be safe or effective.

Houses of Parliament, Parliamentary Office of Science & Technology. (2017). Integrity in Research. Postnote, 544

Contrasting discourses on scientific integrity

Even though integrity is widely considered to be an essential aspect of research... there is an ongoing debate on what actually constitutes research integrity. The understanding of integrity ranges from the minimal, which only considers falsification, fabrication and plagiarism (FFP), to the maximum, which blends integrity into science ethics. However, underlying this obvious range, there are more subtle differences that are not as immediately evident. There are diverging notions of integrity as an individual or as an institutional responsibility, or of integrity as adherence to a clear set of norms versus an aspiration to an unobtainable ideal.

Horbach, S. P. J. M., & Halffman, W. (2017). Promoting Virtue or Punishing Fraud: Mapping Contrasts in the Language of "Scientific Integrity." *Science and Engineering Ethics, 23*(6), 1461–1485.

PERFORM researcher reflection

> “I struggle at times with ethical controversies in my research. Can it be used to exploit species? Is it ethical to oversell the impact of my planned research to obtain funding? How can I stay upright, when adhering to my principles might jeopardize my academic career?”

Activities

Group discussion

1. In advance of the session, invite participants to read different guidelines to integrity (national ones, European ones, those specific to their institutions). You may also encourage participants to read about different ethical procedures in research. Allow everyone a week or two to read a range of guidelines.
2. A few days prior to the session, invite each participant to write answers to the following questions:
   - How does research integrity apply to your discipline or research project?
   - What research integrity issues are there in your discipline?
   - Is there a person in charge of research integrity in your institution?
   - Is training in research integrity offered to researchers? How do your mentors and colleagues view such training? Do they see it as valuable or as a waste of time?
   - Are there local procedures for dealing with misconduct in your institution? At what level do procedures exist?
   - If there is no formal procedure or named person in charge of research integrity, who can you talk to if you are concerned about misconduct or questionable research practices?
   - How difficult it is to have high standards of integrity and ethics in research?
   - What would success look like in your discipline? Is success compatible with unreliable research production?
   - How can we incentivise high standards of integrity and ethics in research?
3. At the meeting or training session, share your responses and discuss key issues that emerge.

Integrity Dilemmas

Use the Science Integrity Dilemma Game developed by the Erasumus University Rotterdam to discuss common integrity dilemmas: https://goo.gl/cC6nx5

References and additional resources

Research ethics:

- European Commission (2013) *Ethics for researchers Facilitating Research Excellence in FP7* Luxembourg: Publications Office of the European Union. https://goo.gl/EUjRH8
- *European Commission Horizon 2020: Ethics.* https://goo.gl/qa2Gc6
- Farrimond, H. (2012). *Doing ethical research*. Houndmills, Basingstoke, Hampshire: Palgrave Macmillan.
- Hughes, J., Hunter, D., Sheehan, M., Wilkinson, S., & Wrigley, A. (2010). *European Textbook on Ethics in Research*. Luxembourg: Publications Office of the European Union. DOI: 10.2777/17442

Research integrity:

- All European Academies. (2017). *The European code of conduct for research integrity*. (ISBN 978-3-00-055767-5) Berlin: Germany. https://goo.gl/8tF2eV
- Horbach, S. P. J. M., & Halffman, W. (2017). Promoting Virtue or Punishing Fraud: Mapping Contrasts in the Language of "Scientific Integrity." *Science and Engineering Ethics, 23*(6), 1461–1485. https://goo.gl/HA1Qa5
- Houses of Parliament, Parliamentary Office of Science & Technology. (2017). Integrity in Research. Postnote, 544

Malpractice:

- Fanelli D (2009) How Many Scientists Fabricate and Falsify Research? A Systematic Review and Meta-Analysis of Survey Data. *PLoS ONE* 4(5): e5738. https://goo.gl/hy9SYW
- Martinson, B. C., Anderson, M. S. and De Vries, R. (2005). Scientists behaving badly. *Nature*, 435(7043): 737–738 https://goo.gl/1zYuhU

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Reliability of Scientific Knowledge

This section examines the importance of reliability of scientific knowledge, for the scientific community and for society. Reproducibility is one criterion for reliability of scientific knowledge, but reproducibility and reliability are often conflated. In some research fields, reliability does not, and cannot, rely solely on reproducibility. In addition, reproducibility has different meanings that need to be clearly identified. There are three main causes of a lack of reproducibility: the inherent variability of the object being studied, experimental variability, and poorly defined methods.

Research Reproducibility

Marcus Munafò
Professor of Biological Psychology, University of Bristol

Watch this short presentation
to support your work on this topic >>

Reproducibility

Reproducibility—the extent to which consistent results are observed when scientific studies are repeated—is one of science's defining features, and has even been described as the "demarcation criterion between science and nonscience". In principle, the entire body of scientific evidence could be reproduced independently by researchers following the original methods and drawing from insights gleaned by prior investigators. In this sense, belief in scientific evidence is not contingent on trust in its originators. Other types of belief depend on the authority and motivations of the source; beliefs in science do not.

Considering its central importance, one might expect replication to be a prominent part of scientific practice. It is not. An important reason for this is that scientists have strong incentives to introduce new ideas but weak incentives to confirm the validity of old ideas. Innovative findings produce rewards of publication, employment, and tenure; replicated findings produce a shrug.

Open Science Collaboration (2012). An Open, Large-Scale, Collaborative Effort to Estimate the Reproducibility of Psychological Science. *Perspectives on Psychological Science*, 7(6), 657 – 60.

Re-thinking reproducibility

I take issue with the widespread reference to reproducibility as an overarching epistemic value for science and a good proxy measure for the quality and reliability of research results. Reproducibility comes in a variety of forms geared to different methods and goals in science … variation is linked to the degree of control that researchers are able and willing to exercise on their materials and on the environment in which their investigations take place, as well as to the extent to which they rely on statistical methods in assessing the validity of the evidence being produced. In studies where control over environmental variants is only partially achieved, for instance, reproduction resulting in different outcomes is perceived as highly valuable, since it can signal hitherto unknown sources of variation or define the scope of the hypothesis being tested.

By contrast, in studies that are carried out in highly idiosyncratic environmental conditions and/or on perishable and rare samples which do not lend themselves to statistical analysis, it is the very uniqueness and irreproducibility of research conditions that makes the resulting data valuable as sources of evidence. In such cases, a focus on enhancing reproducibility turns out not to be the best way to foster high-quality, robust research outcomes. Rather, it is the well-informed analysis of how reliable and meaningful data are obtained through irreproducible research practices that increases the sophistication of research methods and of the ways in which they are documented and disseminated.

Leonelli, S. (2018). Re-Thinking Reproducibility as a Criterion for Research Quality. Forthcoming in *Research in the History of Economic Thought and Methodology, Special Issue "Curiosity, Imagination and Surprise"*.

PERFORM researcher reflection

> "I found it interesting to consider the increasing issue of reproducibility in science. It highlights the issues within the academic system, where what is good for science is not necessarily good for scientists. As a scientist I feel that awareness of the issue is key, so that changes and planning can be put in place to try and increase reproducibility as much as possible. Reproducibility in my field of work can and has been an issue..."

Activities

Before starting discussion, ask everyone to pick one of the research projects they are working on and summarise it in 2-3 sentences. You may choose to focus on one of the discussion topics below, or you may want to address each of them in turn.

Understanding reliability

1. Write on post-it notes: In your research project, according to which criteria do you consider whether the research knowledge that you produce is reliable? (e.g. reproducibility of the results, cross-checking of the methodology by peers, consistency of the results with other studies, clear understanding of the possible biases, etc.). Write one criterion per post-it. Spread the post-its on a board.
2. Have a collective discussion on the following questions:
   - Is there a diversity of reliability criteria within your research group, for instance depending on the methods that are used?
   - What are the reliability criteria that are specific to your research field? Is there a person in charge of research integrity in your institute?
   - When do you doubt the reliability of your own results, or of the results presented by colleagues?

Understanding reproducibility

1. Read in advance or collectively read 'Re-Thinking Reproducibility as a Criterion for Research Quality' quoted above.
2. Invite everyone to write their definition of reproducibility on a piece of paper (e.g. ability to obtain the same results, ability to replicate the experiment, ability to replicate the analysis, etc.). Share everyone's definitions. The facilitator can introduce the publication 'What does research reproducibility mean?' referenced below, at this point.
3. Have a collective discussion on the following questions:
   - Is reproducibility a relevant criterion for the reliability of your research? Does your answer change depending on different interpretations of 'reproducibility'?
   - In which scientific disciplines do you consider reproducibility an important criterion for reliability? Does your answer change depending on different interpretations of 'reproducibility'?
   - (If appropriate:) In your field, what are the possible explanations if, when replicating an experiment or a study, you don't obtain the same results?

Reliability: why does it matter and for whom?

1. Carry out a quick survey on the following question and invite participants to provide precise examples to support their answer: Do you consider that the research published in your field is very/ reasonably/ moderately/ poorly reliable?
2. Discuss the following questions, asking participants to present examples to illustrate their opinion:
   - Why does it matter for the scientific community that results are reliable?
   - Why does it matter for society that scientific results are reliable?
   - How should scientists communicate with people about the reliability of scientific results?
   - What are the risks with scientists overplaying the reliability of their results?

References and additional resources

- Baker, M. (2016). *Is there a reproducibility crisis? Nature, 533(7604), 452-454*. DOI: 10.1038/533452a
- Goodman, S. N., Fanelli, D., & Ioannidis, J.P.A. (2016). What does research reproducibility mean? *Science Translational Medicine, 8(341), 341ps12*. DOI: 10.1126/scitranslmed.aaf5027
- Leonelli, S. (2018). Re-Thinking Reproducibility as a Criterion for Research Quality. Forthcoming in *Research in the History of Economic Thought and Methodology, Special Issue "Curiosity, Imagination and Surprise"* https://goo.gl/omtT8r
- Makri, A. (2017). Give the public the tools to trust scientists. *Nature, 541(7637)*, 261. DOI:10.1038/541261a
- Open Science Collaboration (2012). *An Open, Large-Scale, Collaborative Effort to Estimate the Reproducibility of Psychological Science. Perspectives on Psychological Science, 7(6),* 657 – 60. DOI:10.1177/1745691612462588

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Wellbeing at Work

There is growing evidence that researchers experience mental health issues. This is mainly due to work conditions, such as pressure to publish or the struggle for career advancement. It has been acknowledged that these kinds of pressures correspond to instances of misconduct and poor research practices. This section provides data from studies, examples of how researchers can build healthy work environments, and tips to ensure wellbeing.

Data about depression and anxiety in academics

A survey of 2,279 individuals (90% PhD students and 10% Master's students), from 26 countries and 234 institutions found that:

- graduate students are more than six times as likely to experience depression and anxiety as compared to the general population.
- 41% of graduate students scored as having moderate to severe anxiety ... vs 6% of the general population.
- 39% of graduate students scored in the moderate to severe depression range ... vs 6% of the general population.

Evans et al. (2018). Evidence for a mental health crisis in graduate education. *Nature Biotechnology 36, 282–284.*

The results of a questionnaire given to 437 professors found that:

- 54% judge that publication pressure 'has become excessive',
- 39% believe that publication pressure 'affects the credibility of medical research'
- 26% judge that publication pressure has a 'sickening effect on medical science'
- 24% have signs of 'burn out'

Tijdink, J., Vergouwen, A., Smulders, Y. (2013). Publication Pressure and Burn Out among Dutch Medical Professors: A Nationwide Survey. *PLoS One*

Personal testimony on finding balance

I feel that one of the culprits is our reluctance to openly acknowledge how we find balance. Or openly confront how we create a system that admires and rewards extreme imbalance... So with some humor to balance my fear, here's goes my confession: ... I created a "feelgood" email folder. I work fixed hours and in fixed amounts. I try to be the best "whole" person I can. I found real friends. I have fun "now".

Nagpal, R. (2013). The awesomest 7-year postdoc or: how I learned to stop worrying and love the tenure-track faculty life. *Scientific American.*

Identifying and aligning expectations in a mentoring relationship

Scholars expressed multiple reasons why it is important to align their expectations with those of their mentor early in the course of the relationship. Specifically, scholars noted that [the process of aligning expectations between mentor & mentee] helps to ensure that scholars receive what they need to be successful and provides them with clear guidance in their work... Several scholars commented that [this process] had additional, positive effects on the interpersonal aspects of their relationship (e.g. facilitated mutual trust, professionalism, respect).

Huskins et al. (2011). Identifying and Aligning Expectations in a Mentoring Relationship, *Clin Transl Sci, 4(6), 439-47*

PERFORM researcher reflections

> The academic work place is high-stress and consists of a never-ending series of rejections. Be it your manuscript, talk suggestions, application, or funding bid. Some years into my postdoc life, I developed depression and rejections often trigger a new bout. How do I try to keep the abyss away? Rigorous selfcare! No over-hours, no googling of peers, regular breaks and exercises! I insist that humanity - rather than competition - shall lead my actions.

> It's important to remember that we as academics do have some power to decide what this environment looks like, how it is structured, how we support each other. But first we need to make sure we value and care about each other - value building healthy, resilient communities – and we must value this over academic outputs, grants and publications.

Activities

Preparation for activities

This topic is sensitive and may raise personal feelings and emotional responses. It should be carried out within an emotionally supportive environment. If you plan to talk about these issues in a collective setting, as proposed for the first two discussion activities outlines below, here is some advice.

Before the collective discussion:

- Announce the topic at least one week in advance
- Identify someone whom you can turn to if serious psychological issues come out during the meeting. This should be either a professional psychologist, if there is one in the HR service for instance, or a person whom you trust for their skills in counselling or psychology.
- Do not expect easy solutions to issues that might be raised or create the expectation that they will be dealt with in any great depth during the session.

During the collective discussion:

- Make people comfortable: preparing the environment and providing refreshments can help.
- Make it clear that this a judgement-free zone! Announce this as a rule at the beginning of the conversation.
- Make sure everyone gets a chance to speak. There are various effective ways to ensure this happens, for example, you may consider inviting the most experienced people to talk last, to avoid influencing or deterring less experienced participants.

Reflect on your environment & your experience

Use the following questions to guide a collective discussion:

1. How much suffering and wellbeing is there in your work environment?
   - What do you know about wellbeing and suffering in your institution? What have you observed about wellbeing and suffering in your institution?
   - What questions do you have about the support for wellbeing in your institution and/ or the extent of the problem in your institution? How is this different to other places where you may have worked?
   - What kinds of pressures do you feel at work? Which of them are real or perceived? Consider the following quote from Wright et al. (2008): "the trainees seem to have been internalizing the expectations for productivity in the lab or in their institutions"
   - Is the pressure you experience related to any particular aspect of your work (such as recruitment, career advancement, or funding)?
2. How can you improve the situation?
   You may rely on *'The awesomest 7-year postdoc'* above, and also explore the 'Perspectives/ Opinions' resources below.
   - What can you do if you feel bad at work? What can you do when you see someone else feeling bad at work?
   - Invite everyone to make a list of what makes them feel good and then share your lists.

continued >>

Activities continued

Tell the story behind your CV

Adapt the activity 'Growing Up in Science' described in Ma (2017) below, by inviting participants to tell the story behind their CV. While your CV may show a linear progression in your studies and career, the reality might be quite different. For example, you may have had started studying other disciplines, you may have interrupted your studies, or you may have faced difficult personal issues that affected your career.

Express your expectations: one-to-one

Annual meetings as 'checkpoints' with your mentor/mentee can be a good opportunity to align your respective expectations. To support this process, you could refer to Huskins et al. (2011), quoted above (while acknowledging that this process of aligning expectations needs to be adapted according to cultures, personalities and situations).

1. Present the excerpt to your colleague / mentor / mentee and explain why you would like to share your expectations with them. Then, propose the following process.
2. Before the meeting, each of you writes down 5 expectations relating to your own needs (related to mentoring, scientific project, career and so on) and then 5 expectations you perceive/imagine to relate to your colleague's/mentor's/mentee's.
3. Meet, and read your expectations to each other. Discuss:
    - Do you understand your respective expectations?
    - Are there any expectations that surprised you or that you had previously misunderstood?
    - Are any expectations contradictory?
    - Are some expectations more of a priority than others?

References and additional resources

Surveys, Studies:

- Evans et al. (2018). Evidence for a mental health crisis in graduate education. *Nature Biotechnology 36, 282–284*. DOI: 10.1038/nbt.4089
- Leveque et al. (2017). Work organization and mental health problems in PhD students. *Research Policy, 46, 868 – 879*. https://goo.gl/C5oXYn
- Tijdink, J., Vergouwen, A., Smulders, Y. (2013). Publication Pressure and Burn Out among Dutch Medical Professors: A Nationwide Survey. *PLoS One*. https://goo.gl/1qs3Bj
- Wright, D.E., Titus, S.L., Cornelison, J.B. (2008). Mentoring and Research Misconduct: An Analysis of Research Mentoring in Closed ORI Cases. *Science and Engineering Ethics, 14(3), 323-36.* DOI: 10.1007/s11948-008-9074-5

Perspectives/Opinions:

- Alon, U. (2013). We have to change the culture of science to do better research. *TEDxLausanne*. https://goo.gl/DHLj9G
- Halffman, W. & Radder, H. (2015). The academic manifesto: From an occupied to a public university. *Minerva, 53(2), 165-187*. DOI: 10.1007/s11024-015-9270-9
- Ma, W. J. (2017). The stories behind a CV. *Science, 357(6354), 942*. DOI: 10.1126/science.357.6354.942
- Nagpal, R. (2013). The Awesomest 7-year Postdoc. *Scientific American*. https://goo.gl/W7ZuRc
- Ryan-Flood, R., & Gill, R. (2010). Breaking the silence: The hidden injuries of neo-liberal academia. In R. Ryan-Flood, & R. Gill (Eds.), *Secrecy and silence in the research process: feminist reflections* (pp. 228-244). Abingdon, Oxon; New York, NY: Routledge.

Review:

- Huskins et al. (2011). Identifying and Aligning Expectations in a Mentoring Relationship, *Clin Transl Sci, 4(6), 439-47*. DOI: 10.1111/j.1752-8062.2011.00356.x

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Values in Science

This section explores the ways in which values intersect with science. It introduces the core values of the scientific community and invites participants to make their own manifesto based on the ideal values of their academic community.

Reflexivity in Research

Dr Livio Riboli - Sasco
Member of Atelier des Jours à Venir

Watch this short presentation
to support your work on this topic >>

Values in science

Values intersect with science in three primary ways. First, there are values, particularly epistemic values, which guide scientific research itself. Second, the scientific enterprise is always embedded in some particular culture and values enter science through its individual practitioners, whether consciously or not. Finally, values emerge from science, both as a product and process, and may be redistributed more broadly in the culture or society. Also, scientific discoveries may pose new social challenges about values, though the values themselves may be conventional.

Allchin, D. (2012). Values in science: an introduction.

Re-thinking reproducibility

The sociologist Robert K. Merton was the first to propose (in 1942) that the scientific community relies on normative values. These norms have been identified in the form of "prescriptions, proscriptions, preferences and permissions" and "legitimized in terms of institutional values". Below are the four key values that Merton identified as binding the research community.

Communism	All scientists should have common ownership of scientific goods (intellectual property), to promote collective collaboration; secrecy is the opposite of this norm
Universalism	Scientific validity is independent of the sociopolitical status/ personal attributes of its participants
Disinterested-ness	Scientific institutions act for the benefit of a common scientific enterprise, rather than for the personal gain of individuals within them
Organized skepticism	Scientific claims should be exposed to critical scrutiny before being accepted: both in methodology and institutional codes of conduct

Merton, R. K. (1973) [1942]. The Normative Structure of Science. In Merton, Robert K. *The Sociology of Science: Theoretical and Empirical Investigations*. Chicago: University of Chicago Press.

However, the research community is diverse and research practices are many, so there can be gaps between these values and actual research practices. These values are still discussed, both with respect to the current research community and its practices and with further work in sociology of science & epistemology (see the Reflexivity in Research section of this toolkit).

PERFORM researcher reflection

> **"Science itself is not neutral, it depends dramatically on the political and economic context. As scientists and as part of society, we should have a critical approach towards the choices that are made in terms of research policies, and remember that this impacts not only the scientific community but the whole of society."**

Activity

Build a manifesto

Build your own manifesto with your colleagues for the academic community you belong to.

1. Read out loud a manifesto (choose either the Slow Science or Critical Engineer Manifesto).
2. Invite each participant to answer the following questions individually. Encourage participants to share in detail their personal points of view on the global and political issues at stake within academia:
   - According to you, what is the goal of scientific research in general?
   - Do the institutions that manage research (from universities to publishers) contribute to these goals? How do they state these goals on their webpage (check the institutions you belong to)?
   - What impact does the increasing presence of private and industrial interests in scientific research have on these goals?
   - Why should anyone choose research as a job? Would you recommend the job? In what way does your institution describe these jobs in recruitment advertisements? Is there any discrepancy between these advertisements and the actual jobs?
   - Who should be doing research? For example, should only paid workers do research or should anyone else? If so, who and on what areas of research?
   - Is research a job for which workers' rights should be better respected or is it just a passion that should be freed of any constraints?
   - According to you what is a good impact of scientific research on society?
3. Form groups of two to three, and find a consensus statement based on your different answers to the previous questions. Iterate: do a second round with groups of four to give and then eight to nine if needed.
4. Build a unique manifesto out of this process of convergence. Acknowledge the key disagreements on a separate statement.
5. Consider printing and posting your manifesto on the walls of your lab!

References and additional resources

Example of manifestos and oaths:
- British Student/Young Pugwash Group. The Student Pugwash Oath. https://goo.gl/qb5J3R
- Munafò, M. et al. (2017). A manifesto for reproducible science. *Nature Human Behaviour*, 1. https://goo.gl/H7WY34
- Slow Science Academy (2010). Slow Science Manifesto. https://goo.gl/GZ1itm
- The Critical Engineering Working Group. (2017). Critical Engineer. https://goo.gl/B2JUdQ

Two key readings on values:
- Allchin, D. (2012). Values in science: an introduction. https://goo.gl/AavgWR
- Merton, R. K. (1973) [1942]. The Normative Structure of Science. In Merton, Robert K. *The Sociology of Science: Theoretical and Empirical Investigations*. Chicago: University of Chicago Press.

On values at the crossroad between policies, science & society:
- Butler, D. et al. (2015). Science oasis under pressure. *Nature, 518(7537)*. https://goo.gl/9hUFpb
- Ottinger, G. (2015). Is it good science? Activism, values, and communicating politically relevant science. *Journal of Science Communication, 14(02), CO2*. https://goo.gl/ucVsxD
- Radder, H., 2010, Mertonian values, scientific norms, and the commodification of academic research. In H. Radder (ed) *The Commodification of Academic Research. Science and the Modern University* (pp.231-258). Pittsburgh: University of Pittsburg Press.
- UNESCO. (2017). Recommendation on Science & Scientific Researchers. https://goo.gl/jixTxU

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Reflexivity in Research:
situating knowledge productions, building stronger objectivity

This section invites researchers to reflect on how their cultural background and personal identity can influence their research activity. It introduces feminist epistemologies that propose a framework of 'situated knowledge' and 'strong objectivity', through which the reflexivity of researchers on their specific position can enable an increased objectivity.

Reflexivity in Research

Dr Livio Riboli - Sasco
Member of Atelier des Jours à Venir

Watch this short presentation
to support your work on this topic >>

How researchers' identities can affect research

As defined by Bero & Grundy (2016), "Reflexivity is a tool ... borrowed from the social sciences ... that makes transparent accounts for researchers' professional and personal identities." To guide the reflexivity process, they proposed the following series of 'Key questionsfor reflexivity':

- Who is the researcher?
  - What are their professional identities? What is their discipline, educational background, or training? Where are they employed? What is their career stage, and are they in position of power or influence? What is their area of research or theoretical perspective? What are their advocacy positions?
  - What are their relevant personal identities, including age, race/ethnicity, gender, religious or political affiliations, and life experience?
- How could who they are affect the design, conduct or reporting of research?
- Who or what is the focus of research? For whom does this have consequences? What are these consequences?
- Who or what is placed at risk / advantaged by this research? How?
- What are the ethical, social, political or economical implications of this research?

Bero, L. & Grundy, Q., 2016, *Why Having a (Nonfinancial) Interest Is Not a Conflict of Interest*, PloS Biol, 14(12).

The concept of "strong objectivity"

Sandra Harding (1993) has proposed the concept of 'strong objectivity' to describe how acknowledging one's own perspective does not undermine - but rather enhances - the objectivity of a scientific enterprise. The central concept of feminist epistemology is that of a situated knower, and hence of situated knowledge: knowledge that reflects the particular perspectives of the subject.

'Strong objectivity' requires what we can think of as 'strong reflexivity'. This is because culture wide... beliefs function as evidence at every stage in scientific inquiry: in the selection of problems, the formation of hypotheses, the design of research (including the organization of research communities), the collection of data, the interpretation and sorting of data, decisions about when to stop research, the way results of research are reported, and so on. The subject of knowledge – the individual and the historically located social community whose unexamined beliefs its members are likely to hold 'unknowingly' so to speak – must be considered as part of the object of knowledge from the perspective of scientific method.

Harding, S. (1993). Rethinking Standpoint Epistemology: What Is "Strong Objectivity?" In L. Alcoff & E. Potter (eds.), *Feminist Epistemologies* (pp.49 – 82) New York: Routledge

How culture shapes science: metaphors in research

E. Martin examined how culture may shape scientific knowledge, based on the analysis of metaphors used to describe the process of fertilization.

As an anthropologist, I am intrigued by the possibility that culture shapes how biological scientists describe what they discover about the natural world... Part of my goal in writing this article is to shine a bright light on the gender stereotypes hidden within the scientific language of biology...

Gerald Schatten and Helen Schatten set out to show that... the "egg is not merely a large, yolk-filled sphere into which the sperm burrows to endow new life"... This sounds like a departure from the stereotypical textbook view, but further reading reveals Schatten and Schatten's conformity to the aggressive-sperm metaphor. They describe how "the sperm and egg first touch when, from the tip of the sperm's triangular head, a long, thin filament shoots out and harpoons the egg." Then we learn that "remarkably, the harpoon is not so much fired as assembled at great speed, molecule by molecule, from a pool of protein stored in a specialized region called the acrosome. The filament may grow as much as twenty times longer than the sperm head itself before its tip reaches the egg and sticks. "Why not call this "making a bridge" or "throwing out a line" rather than firing a harpoon? Harpoons pierce prey and injure or kill them, while this filament only sticks. And why not focus, as the Hopkins lab did, on the stickiness of the egg, rather than the stickiness of the sperm?

Martin, E. (1991). The egg and the sperm: how science has constructed a romance based on stereotypical male-female roles. *Signs: Journal of Women in Culture and Society, 16(31), 485-501.*

PERFORM researcher reflection

> “Being introduced to standpoint theory made me aware of my standpoint and the fact I can actively change it. Science can be done differently, by thinking outside the box, and interacting with people other than scientists. Doing so could increase the benefit of science to society, and in my opinion, that is worth pursuing!”

Activities

Who are you as a researcher?

1. Discuss the ‘key questions for reflexivity’ in the ‘How researchers’ identities can affect research’ section above.
2. Ask everyone to write a reflection on their identity and how it influences their research (topic, practice, expectations, choices etc.). You could refer to the categories described in Haraway (1998), (section 1, Situated Knowers).
3. Invite everyone to share their written reflections.
4. Ask everyone to reflect on the following questions and then discuss:
   - Who is affected by, related to and concerned with your research topic?
   - Do you expect them to have different perspectives and opinions on your research topic?
   - Would you like to discuss it with them?
   - How could you initiate discussion with them?

Language, metaphors, hidden meanings and values

The aim of this exercise is to analyse the metaphors used in your research activity, and to reflect on the particular cultural perspectives and values that they bring to your research activity.

1. Before the discussion, ask everyone to bring an abstract from one of their recent papers, posters or grants.
2. Discuss the excerpt by E. Martin, above.
3. Ask everyone to underline, in their abstracts, all the words that could be considered to be metaphors, or have strong alternative meanings. For example ‘affinity’ can be used in a chemical sense, but could also relate to human relationships and connections, ‘mother cell’ can refer to a specific type of yeast cell, yet carries strong human associations, ‘invasion’ refers to cell motion, but can also refer to conflict.
4. Ask everyone to share what they underlined.
5. Discuss the following questions:
   - Do some words carry unexpected meanings, values, or representations?
   - Can you notice any trends in the metaphors used by different members of your group?
   - Could you have used a different word or metaphor?
   - Are you aware of how these metaphors may shape your research?
   - Are you aware of how your (cultural, personal) standpoint affects the metaphors you use in your research?

References and additional resources

- Anderson, E. (2016). Feminist Epistemology and Philosophy of Science. *The Stanford Encyclopedia of Philosophy*, Edward N. Zalta (ed.). https://goo.gl/vmFzu5
- Bero, L. & Grundy, Q. (2016). Why Having a (Nonfinancial) Interest Is Not a Conflict of Interest. *PloS Biol, 14(12).* https://goo.gl/46i1Zn
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- Harding, S. (1993). Rethinking Standpoint Epistemology: What Is "Strong Objectivity?" In L. Alcoff & E. Potter (eds.), *Feminist Epistemologies* (pp.49 – 82) New York: Routledge
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This project has received funding from the European Union´s Horizon 2020 research and innovation programme under grant agreement No 665826.

Responsible Research and Innovation

This section introduces Responsible Research and Innovation (RRI) as defined by the European Commission and explores two key aspects of RRI – public engagement and anticipation of possible applications of research.

Responsible Research and Innovation

Claire Grierson
Professor of Biological Sciences, University of Bristol

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to support your work on this topic >>

Introduction to RRI

Responsible research and innovation is an approach that anticipates and assesses potential implications and societal expectations with regard to research and innovation, with the aim to foster the design of inclusive and sustainable research and innovation.

Responsible Research and Innovation (RRI) implies that societal actors (researchers, citizens, policy makers, business, third sector organisations, etc.) work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of society.

In practice, RRI is implemented as a package that includes multi-actor and public engagement in research and innovation, enabling easier access to scientific results, the take up of gender and ethics in the research and innovation content and process, and formal and informal science education.

EC Horizon 2020: Responsible Research and Innovation

What is public engagement?

Public engagement describes the myriad of ways in which the activity and benefits of higher education and research can be shared with the public. Engagement is by definition a two-way process, involving interaction and listening, with the goal of generating mutual benefit.

National Coordinating Centre for Public Engagement. What is public engagement?

The need for scientists to engage publics about possible futures

Scientists must communicate with publics to inform them of future possibilities inherent in that research. And the communication must be two way. Publics must communicate with scientists how they feel about these future possibilities. This type of dialogic interaction is intended to shape research trajectories, i.e., various parties, researchers, investors, publics, other stakeholders are 'mutually responsive' to one another's concerns such that overall research systems adjust... There are of course many difficulties in facilitating this type of 'mutually responsive' science communication. One of the difficulties is that none of the parties precisely know the future and so they must negotiate between various images of the future that different parties have.

Reinsborough, M. (2017) Science fiction and science futures: Considering the role of fictions in public engagement and science communication work. *Journal of Science Communication, 16 (4).*

PERFORM researcher reflection

> "When we look back in 2067 at research carried out in 2017, what will we think about the choices we made as scientists? How will our research have been applied? Our research is fed into an imperfect political system... what responsibility do we have as the individuals in the lab to be controlling the research we do, and managing its application?"

Activity

Future thinking

This activity is designed to help researchers consider possible applications of their research and think about who may be affected by those applications. It demonstrates how the applications of science, and unintended consequences, can impact every part of society and all of our lives as citizens. It opens up discussion around the responsibility of science to engage with stakeholders and wider publics about these issues.

This activity is best done in groups of four or more.

1. Ask everyone to reflect on the following question and then share their responses: What is your purpose and motivation for carrying out your research?
2. Ask everyone to consider where their research might take us in the future and list all the possible applications that they can think of. Share these responses.
3. Invite everyone to reflect on and share their responses to the following questions:
    - Who could use these applications?
    - Could anyone be empowered to use, modify or adapt the innovation or is it the kind of innovation that will be protected by patents and owned by private companies?
4. As a group, select one of the potential applications of one of your group's research.
5. Imagine a 'future scenario' - the world 50 years in the future. Ask each person in your group to represent a different 'level' at which the application is impacting the world. Make sure possible benefits and harms are considered at each level.
    - Individual level – how does it impact people's daily lives?
    - Societal level – how does it impact people's work and society overall?.
    - National level – how does it impact laws and policy at a national level?
    - Global level – how does it impact global policy and international affairs?
6. Invite responses from each 'level'.
7. Reflect on the activity, using the following questions to guide discussion:
    - Did the activity help you become aware of potential impacts and implications that you had not previously considered?
    - Were there any groups of people in the 'future scenario' who were impacted by the innovation that you had not previously considered?
    - Did this activity change how you think about who should be consulted and engaged about your research?
    - What are the potential issues that could arise if you don't engage publics in your work?
    - What might some of the challenges be, for researchers and for the public, in doing public engagement?

This activity is adapted from the PERFORM toolkit for teachers. If you are interested in running this activity with young people, you will find that activities in the teacher toolkit are designed for this purpose.

References and additional resources

- EC Horizon 2020: Responsible Research and Innovation, https://goo.gl/ghzLpK
- National Coordinating Centre for Public Engagement. What is public engagement? https://goo.gl/SpZPSA
- Priest, S. (2014). Critical Science Literacy: What Citizens and Journalists Need to Know to Make Sense of Science. *Bulletin of Science, Technology & Society, 33 (5-6), 138 – 145*. DOI: https://goo.gl/35e5GQ
- Reinsborough, M. (2017) Science fiction and science futures: Considering the role of fictions in public engagement and science communication work. Journal of Science Communication, 16 (4). https://goo.gl/x87pr9
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Performance Approaches for Exploring Responsible Research and Innovation

PERFORM brought together early career researchers (ECRs), performers, teachers and secondary school students to develop performance-based activities that explored Responsible Research and Innovation (RRI) and the human dimension of science. Performance methods, including the use of tools such as narrative and character, can be effective for opening up discussion on complex ethical issues in an engaging manner. This section explores the rationale for these approaches and proposes a straightforward performance activity for you to use, taken from the PERFORM project.

Creative Approaches to Public Engagement

Viv Kuh
Public Engagement Associate, University of Bristol

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to support your work on this topic >>

Narrative and ethics

Storytelling and drama are powerful ways of helping people understand the societal and ethical implications of science and to explore what that means for them on a personal level. Humans have always used stories, narrative and character as a means of exploring scientific advancements, as well as how we might feel about the changes and societal and ethical issues that they might bring. Creating stories with the public is a powerful way for scientists to explore the implications of the work that they are doing.

Narrative, I argue, is at the heart of ethical life and learning. We live and learn by virtue of the stories we tell and the stories that are told to us. This is possible not only because these stories present us with vivid ethical content, but also because successful engagement with and enjoyment of these narratives requires the exercise of capacities that also help us lead good lives. Narrative is central, in two respects, to learning how to live a good live and living it: it is both source and a method of ethical knowledge and understanding.

Robinson, G. (2014). You Live and Learn: Narrative in Ethical Enquiry with Children. *Childhood & Philosophy 10 (20), 305-330.*

PERFORM researcher reflection

> “Performance is a particular type of art that connects you with yourself and with the audience in a very human way. Performing is all about expressing emotions and expressing them to the audience in order to trigger emotions in them as well. Ethical issues are called “issues” precisely because they generate a struggle inside us. As human beings, this makes us emotional. This is exactly the link between performing arts and ethics. When you are a performer preparing for a show, you usually ask these questions: “how does my character feel?”, “why?”, “what is their context?”, “what actions should they take to solve their issues?”. In the show, the performer places those same questions in the audience’s mind. All the people involved (both the performers and the audience) connect with the topic on an emotional level.”

The PERFORM performance approaches

PERFORM brought together early career researchers (ECRs), performers, teachers and young people to develop performance-based activities that explored Responsible Research and Innovation (RRI) and the human dimension of science. Partners in Spain, France and UK used different performance approaches; in Spain young people developed stand-up comedy monologues, in France they explored improvisation and clowning, and in the UK young people created science busks.

Science monologues (The Big Van Theory, Spain)

Science monologues share enthusiasm about science through humorous performances, which may take place in places that normally hold scientific events (e.g. schools, museums, festivals) but also in places that are usually out of the scientific circuit (e.g. theatres, pubs, or discos). This approach has proven to be an effective way to engage people with STEM (Science, Technology, Engineering and Maths) topics as part of their general culture, to inspire the next generation of scientists and engineers, and to strengthen the connection between researchers and the public.

Improvisation and clowning (TRACES, France)

The clown character brings a new perspective on science and the traditional science demonstration. By using the clown character and improvisation theatre (the spirit of the clown is in the art of improvisation), the audience and the participants can develop their creativity and imagination, in order to step into science in a different way than in more formal contexts.

Science busking (Science Made Simple, UK)

Science busking uses portable science demonstrations alongside theatre skills to attract, hold and inspire a passing audience with science. Busking harnesses the spirit of play to engage young and old alike with a fascination for and enjoyment of science. Busking is adaptable: it can work with small or large audiences, and can be made into a show of defined duration or developed as a drop-in experience for passing audience traffic.

Activities

Hot-seat a researcher

This activity is adapted from the PERFORM project. It is a role-play activity that helps explore a dilemma faced by an imaginary character, in this case a science researcher. It uses common ethical dilemmas that face researchers as the starting point and as such, can be useful for allowing researchers distance and anonymity to explore the kinds of challenges they may face, whilst considering their personal response to such problems.

1. Select one person to be in the hot-seat. They should sit in a chair at the front of the group.
2. Select one of the starting points (listed below) and present it to the group.
3. The person in the hot-seat acts as an imaginary scientific researcher in the starting point scenario, rather than as themselves (though they can draw upon their own experience if appropriate).
4. Invite the rest of the group to ask the hot-seated person questions to help build up the story, for example, "How did you get into this situation?" "What are you going to do now?" "How do you feel about it?"

Starting points:

These starting points leave out many important details so that these can be created during the role-play.

- The latest findings of your research have been exaggerated in the media and you are now being interview by a news channel.
- You are under pressure from your supervisor to publish.
- You are concerned that your research could be used for a harmful application in the future.

This activity could also be adapted as part of a public engagement project with young people. In this case, your own research area or personal story could be used as the scenario.

Plan a public engagement project

Working in small groups, follow the steps below to develop a plan for a public engagement project:

1. Invite each person to consider and share their response to the following questions:
   - What are the ethical or human-centred aspects of your work that you think it is important for people to think about?
   - Who are the groups who are likely to be affected by your research, now or in the future?
   - Outside of academic networks, who might be interested to find out more about your work and why?
2. From these answers, invite each participant to outline a public engagement proposal. For example, 'engaging with fire fighters on the potential application of swarm robotics for search and rescue missions in burning buildings.'
3. Select one person's ideas to develop further.

continued >>

Activities continued

1. Collectively discuss the following questions to build up a public engagement plan for the idea you have selected:

   How might the proposed project benefit the group you want to engage with and your research?

   - How is the issue relevant to the group you would like to engage with?
   - Why would they want to engage with you?
   - What would they gain from the collaboration?
   - What do you hope to learn from engaging with this group of people?
   - What expertise can they share with you that will enrich your work?

   Could you incorporate creative approaches?

   - Is there an ethical, societal or personal dimension that you want to explore that might be effectively explored through creative expression? For example, if you want to explore a personal viewpoint, who would the characters be and what would happen to them? How could you most effectively tell that story?
   - Which creative practitioners could you collaborate with to develop these ideas further? In PERFORM we used performance, however there are many types of creative approaches that can be used, that will be more or less relevant to your chosen audience and your research topic.

   Consider expertise

   - What expertise will you need within your project team?
   - If you want to collaborate with creative partners, who could you seek out with an art practice that inspires you? If you want to work with schools, who could you work with who has experience of school contexts? If you are new to public engagement, is there a public engagement team within your institution ready to offer support?

5. Remember, it is best to start with a small and manageable project and give yourself time and space to explore how collaborations of this kind work.
6. If you decide to pursue your public engagement plan, consider whether you will require funding, and if so, where you could apply. Then, decide what the first steps are in making your plan happen!

References and additional resources

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- Robinson, G. (2014). You Live and Learn: Narrative in Ethical Enquiry with Children. *Childhood & Philosophy 10 (20), 305-330*. https://goo.gl/4vPR76
- Invincible - a participatory theatre production produced by Kilter Theatre in partnership with researchers from University of Bristol SynBio (funded by Synenergene EC FP7): https://goo.gl/HZtHjk

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