TACKLING MISINFORMATION

A COLLECTION OF RESEARCH AND RESOURCES FOR SCIENCE ENGAGEMENT PROFESSIONALS

ADDRESSING THE SPREAD OF INACCURATE INFORMATION ABOUT SCIENCE AND SCIENTISTS

20
ANNIVERSARY
THE
KAVLI
FOUNDATION

ecsite
EUROPEAN NETWORK
SCIENCE CENTRES & MUSEUMS

TACKLING MISINFORMATION

A collection of research and resources for science engagement professionals addressing the spread of inaccurate information about science and scientists

20
ANNIVERSARY
THE KAVLI FOUNDATION

ecsite
EUROPEAN NETWORK
SCIENCE CENTRES & MUSEUMS

FOREWORD

By Brooke Smith - Director of Public Engagement with Science,
Eric Marshall - Vice President, Public Engagement & Prizes,
The Kavli Foundation

It was 9.00, Saturday morning in Geneva, Switzerland. These early weekend morning conference sessions can be challenging, especially after late catch-ups with colleagues, or in our case – jet lag. The call of the content and the opportunity to network with global leaders in public engagement with science, as well as our passion and commitment to the field made it easy to be there. The complementary espresso bar helped too. We were walking into the "Science communication in the post truth world" session at the 2018 Ecsite Conference in Geneva. The room was packed. We shouldn't have been surprised given the remarkable collection of science centres and engagement leaders working on the frontlines of engaging the public in science, and the commitment and passion the Ecsite community brings to all their work.

The workshop, organised by Antonio Gomes da Costa, Director of Scientific Mediation and Education at Universcience, Paris, was beautifully planned and executed. It included talks and perspectives about the science of misinformation, what post-truth means for democracy and practical things science centres and engagement programmes are now doing to address misinformation. It also included a short time for participants to workshop ideas, based on ideas and research in books by experts such as "The Debunking Handbook" by John Cook and Stephan Lewandowsky. We watched the Ecsite community devour the content and discuss, learn and ask questions together. In small groups, we heard questions that dug into social science research – yet we noted the lack of researchers in the room to help discuss their work.

Later that afternoon (over more delicious Swiss coffee), we reflected on this workshop with Catherine Franche, Ecsite Executive Director,

and Antonio Gomes da Costa. We acknowledged the feeling of urgency from the Ecsite community to understand how they can address these issues. We commented on the enormous appetite to understand misinformation and disinformation, especially including the social science that helps us make sense of how information spreads, the role of culture and cognition, trust in science and more. And we knew the community wanted more than 20 minutes to workshop ideas.

It was then that the idea for the workshop summarised here was born. We wanted a chance for the Ecsite community to have ample time to workshop efforts or initiatives in this space. We wanted social scientists there in person, to share their knowledge, but especially to share their insights about why they know what they know, to listen to what questions and challenges practitioners have and most importantly to co-create ways forward to address these issues together. We were honoured to sponsor, partner and participate in this workshop. We are grateful to Antonio Gomes da Costa and Brian Southwell for co-leading the planning – demonstrating the power of researcher and practitioner co-development even in the planning stage. We are grateful to John Besley, John Cook, Didier Michel, Jaron Harambam, Laura Smillie and Sara Yeo: researchers and experts who travelled to the Ecsite Conference in Copenhagen in 2019 to share their work, the questions that motivate them and to listen carefully and empathetically to what practitioners are considering and doing. We are grateful to the participants who shared their own work, asked challenging questions and worked together to advance their shared learning. Finally, we are grateful to Catherine Franche and Ecsite leadership for creating a trusting, respectful space for everyone to share, learn and listen to each other and for creating this remarkable summary. Others in the community can now learn from these conversations to inform their own efforts to share the excitement, insights and questions science brings to society.

At the Ecsite Conference held in Copenhagen, Denmark, in June 2019, a pre-conference workshop was held entitled "Beyond fact checking: addressing misinformation." This workshop brought together 23 practitioners in science engagement alongside researchers on the topic of misinformation from across Europe and beyond to focus on the topic of misinformation: what does the research tell us about it and how can it be tackled? What are science engagement organisations doing about it: from science centres, science museums, natural history museums, aquariums and zoos to research organisations, private companies, science festivals and other key players? And how can we bring research and practice closer together on the topic? In the workshop we explored a number of ways this has been done and discussed how our sector could take these promising practices further.

Something became very clear in Copenhagen: there is an appetite in our sector to directly address the topic of misinformation. We were left with a striking sense that this is a part of our community's mission that we have neglected for too long; we are faced with a global challenge that requires a strategic approach and coordinated effort.

A key part of science centres and museums' role has always been as communicators of science, a reliable source of scientific facts and reasoning. If our institutions want to tackle misinformation, what is now apparent is that simply providing access to science is not enough. To address the challenges of misinformation, we must go beyond fact checking and engage in real dialogue with our communities[1].

'' Tackling misinformation is a global challenge that requires a strategic approach and coordinated effort ''

This poses clear challenges. Many of our institutions are complex and lack the agility to respond to current affairs. The development of exhibitions, for example, is a lengthy process. And yet, positioned as we are on the intersection between

---

1   A series of articles in the Ecsite magazine Spokes explore the role of science centres and museums when faced with misinformation.

science and the public, we have huge potential to play a key role in addressing this phenomenon which represents such a threat to our impact.

As a European network, we have a responsibility to take action. This is why Ecsite, the European Network of Science Centres and Museums, decided to put together this resource document, for anyone developing or implementing activities or exhibitions working to engage the public in science. We summarised the workshop outcomes and interviewed experts in research and practice from across the sector to put it together. It aims to help to build on the workshop's momentum by aligning our community on the issue of misinformation, ensuring we are clear on the challenges we face. We want to empower science engagement professionals to tackle misinformation, reflecting on our practices, collecting and sharing insight from researchers and practitioners and bringing together a set of tools that can be used as part of our work.

This document has been compiled based on interviews with the researchers and practitioners that participated in the workshop, as well as with other experts whose work was mentioned in these conversations. It is intended as a resource document rather than an academic text, sharing evidence, recommendations, practical tools and examples from across the sector while still acknowledging that consensus on many of the questions raised is not yet widespread.
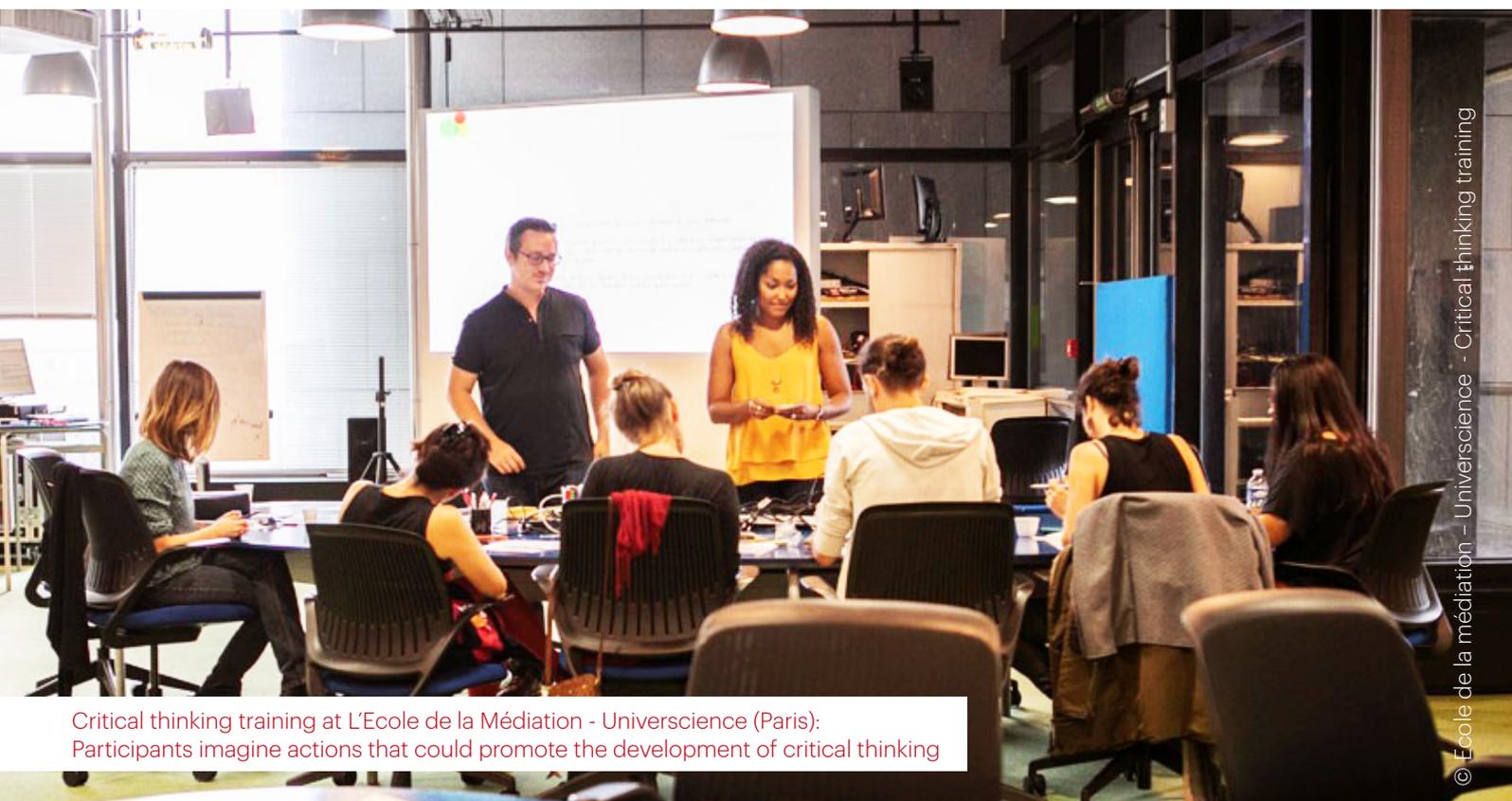
Critical thinking training at L'Ecole de la Médiation - Universcience (Paris): Participants imagine actions that could promote the development of critical thinking

© Ecole de la médiation – Universcience – Critical thinking training

ABOUT MISINFORMATION

Misinformation has existed as long as we have been communicating, from propaganda wars in Ancient Rome to the snake oil salesmen of the 1800s. But the rise of online communication in the last twenty years has led to a shift in the way information on science is shared. Individuals are empowered to share narratives on an unprecedented scale, while the media's traditional gatekeeper role has changed. To have a well-functioning society, we need to be able to make decisions based on sound science. Misinformation poses a threat to civil society. What does research tell us about the challenges of misinformation and how they can be tackled?

ABOUT THE TERM "MISINFORMATION"

The first issue to be addressed is that **misinformation varies**: as to the intention behind it, for example. A distinction is often drawn between "misinformation" that is false information spread regardless of an explicit intention to cause harm and "disinformation" which does involve malicious intent.[2] For the purposes of this document, we use "misinformation" to refer to both, since similar strategies presumably may be employed to address misinformation and disinformation.

Not all misinformation is equal in consequence, either.[3] The scale of the impact can vary, from the individual level to a broad societal impact. But the type of impact can vary too: misinformation can affect people's ability to make informed decisions in their daily lives. But it can also affect their engagement in society, their perception of scientists and their perception of the scientific method. Misinformation can affect policymakers' ability to implement evidence-based policy.

The second issue to consider is that **using the term "misinformation" attributes power.**[4] By framing an idea as misinformation, we categorise it as false according to a certain group of people or set of evidence. But as much as science strives to be value-free[5] , it often involves complex social and ethical elements.

---

2   Claire Wardle and Hossein Derakhshan discuss these differences in their Council of Europe report.

3   Brian Southwell explores this notion in his book Misinformation and Mass Audiences and his paper on misinformation and public health.

4   Jaron Harambam looks at these rhetorical power effects in his paper here. Similar effects of use of the term "conspiracy theorist" are discussed by Ginna Husting and Martin Orr here and by Mathijs Pelkmans and Rhys Machold here.

5   Kevin C. Elliott explores this notion in his work.

When using terms like "misinformation", it's useful to ask ourselves the question: to whom are we ascribing the power to determine whether something is true or false?[6]

HOW DOES MISINFORMATION SPREAD?

To understand the challenges of misinformation, it is helpful to think about the cognitive, societal and structural factors behind the phenomenon.

Cognitive research shows a number of ways the human brain struggles with misinformation[7]. It suggests **we are wired to generally accept information** presented to us, before we try to make sense of it. Plus, the more we are exposed to a piece of information, the more likely we are to believe it. If new information fits our existing worldview, we are even more likely to accept it (and if it doesn't, we are much more likely to resist it). The literature also suggests that correcting misinformation is very difficult: we would have to be exposed to the facts at least as much as we have been exposed to the misinformation. Plus, research shows that the effect of misinformation still lingers after it has been corrected.[8]

Of course, there are broader societal factors at play as well. **Membership of a community is a huge factor**, whether that group is united by identity, religious

KEY TERMS

MISINFORMATION

When false information is shared, but no harm is meant

DISINFORMATION

When false information is knowingly shared to cause harm

MALINFORMATION

When genuine information is shared to cause harm, often by moving information designed to stay private into the public sphere

MISCONCEPTION

A view or opinion that is incorrect because based on faulty thinking or understanding

"FAKE NEWS"

A term for disinformation that, according to the EU's High Level Expert Group, has been "appropriated and used misleadingly by powerful actors to dismiss coverage that is simply found disagreeable." As such this term is best avoided where possible.

---

6   Climate scientist Katharine Hayhoe discusses similar effects of the phrase "climate denier" here.

7   Elizabeth J. Marsh and Brenda W. Yang explore these cognitive biases in Misinformation and Mass Audiences.

8   See work by Emily A. Thorson.

CASE IN POINT : CONSPIRACY CULTURE

Conspiracy theories remain very popular across Europe. Communities have been formed around ideas which demonstrate a deep mistrust in authorities like science, media and politics. They focus on a wide range of questions, from vaccination to terrorist attacks. Jaron Harambam explores these communities further in his work.

CASE IN POINT : BELLE GIBSON

One example of the potential allure of misinformation is the case of Belle Gibson, a blogger who claimed to have cured terminal brain cancer just by changing her diet and lifestyle. She built an online community and sold millions of copies of a recipe book before admitting she never had cancer in the first place. Her pseudoscientific messages were followed by millions online and received broad media attention. Brian Southwell discusses the Belle Gibson case here.

CASE IN POINT : CLIMATE CHANGE

"Scientists disagree about what causes climate change." Myths like this became increasingly widespread in recent years through misinformation on climate science. The work of John Cook documents how this phenomenon spread.

belief, political values, or mistrust in the establishment. We are ideologically driven to share misinformation to reinforce our place in these communities. What is more, we feel more comfortable receiving information from people within our bubble, and so our views are reinforced.

We share and receive information through **structures that massively amplify the challenges of misinformation**. In the past we depended largely on the media to filter the scientific information we read and heard. But since the rise of social media, the role of curator increasingly belongs to the individual. It has never been easier for us to access and share information on a huge scale.[9] And as we saw in the Cambridge Analytica scandal[10], the way this information is shared depends on algorithms that are far from transparent and can be manipulated for financial and political gains.[11] There is very little regulation around misinformation on social media, and regulation tends to operate post-hoc, meaning most action is taken after misinformation has been circulated, to some extent.

---

9   Becca Lewis has studied this phenomenon in alt-right groups in the US.

10   Wired Magazine has a great explainer of the Cambridge Analytica scandal.

11   Naomi Oreskes and Erik M. Conway explore how these powers infiltrated the scientific community in Merchants of Doubt.

THE ROLE OF OUR ORGANISATIONS

As a European network of science engagement organisations, it is Ecsite's collective mission to work to bring science and the public together. Misinformation has been shown to pose clear barriers to engagement in science and therefore we must address it. In doing so, we are more than science communicators: we are social actors.

The evidence before us shows that to tackle misinformation, providing the public with good science is simply not enough. As science engagement organisations, we have to position ourselves differently. As a European community, this is a chance to come together to rise to that challenge.

ASSETS AND CHALLENGES

Our organisations have a number of key strengths that make us well-equipped to address misinformation. We are trusted by both the public and researchers as having scientific credibility. We have real access to people: they come in through our doors and to our outreach activities and spend their time with us. As such, we are rooted locally, connected deeply to local issues and culture. And thanks to our presence in countries across Europe, we reach tens of millions of people this way every year. We also have a privileged role as mediators between science and society: we have access to researchers, we have the passion to engage people with the science, and we have years of experience in doing so. Our institutions and activities allow our

audiences to take the time to explore, question and unpack complex ideas, and this is a key asset in itself. Our networks include not only scientists but civil society, policymakers, industry and other groups who also have a keen interest in addressing misinformation.

> *" Providing the public with good science is simply not enough: we have to position ourselves differently "*

We are also aware of our challenges. In general, our focus is largely on schoolchildren and families, for whom misinformation can be a difficult topic to address, touching on complex notions of cognitive biases and critical thinking. The range of audiences we engage can be limited: in terms of socio-economic background for example. As science

mediators we have traditionally been trained to simply provide facts, which as we now see is not the most effective way of countering misinformation.[12] Compared to the media, we are slow to respond to the latest scientific and societal developments: our activities and exhibitions take time to develop. And often, we simply lack the resources to work towards a strategic approach on topics such as misinformation.

---

12   Antonio Gomes da Costa explores this problem in <u>an article for Spokes</u> and a subsequent article on <u>post-truth</u>.

TOOLS FOR REFLECTION

The Behavioural Insights Team and RARE developed the 2019 toolkit Behavior Change For Nature: <u>A Behavioral Science Toolkit for Practitioners</u> which includes a set of tools that anyone working in science engagement can use and adapt to better connect their work to the behavioural outcomes that they aim to achieve.

The French network promoting scientific, technical and industrial culture, Amcsti, developed a <u>Médiathèque</u> with a wealth of resources in French for science engagement institutions as part of their Atelier Médiation et Critique.

The Natural History Museum London has a number of tools for reflection online on their <u>Visitor Research and Evaluation</u> page. Their <u>Nature of Science Terms</u> document can help to reflect on the language we use on misinformation topics.

The UK government designed a toolkit specifically for government and public sector organisations to counter disinformation called <u>RESIST</u>. It also contains some practical tools that could be adapted for use in our sector.

The Council of Europe put together a <u>self-reflection tool</u> on how to manage controversy in schools and an antirumours handbook for cities with plenty of relevant strategies.

The Center for Research on Environmental Decisions at Columbia University in the US has published a toolkit in 2009 called <u>Psychology of Climate Change Communication</u>. Much of its content can be used by science engagement organisations to reflect on and develop activities on misinformation.

WHAT TECHNIQUES COULD HELP TO TACKLE MISINFORMATION ?

Correction may not be the most effective strategy to address misinformation. The bank of evidence on what methods are successful is still growing, with some researchers exploring sociological perspectives while others focus more on cognitive effects.

A · ENGAGING PEOPLE IN CRITICAL THINKING

There is evidence to show that the spread of misinformation is more closely linked to lack of reasoning than deliberate bias[13]. This suggests that **critical thinking skills** could play a role in empowering people to recognise misinformation. Engaging the public with notions of statistical reasoning can help to shape these skills, and behavioural insights support them in reflecting on their decisions regarding misinformation.[14] Exploring the "scientific attitude" can help to reflect on how science uses evidence as the basis for fact.[15] Behavioural scientists are exploring concepts such as nudging (guiding people's behaviour through the design of choice architectures) and boosting (improving people's cognitive and motivational competences) as ways of activating people's critical thinking skills when faced with misinformation.[16]

EXAMPLE 1: CRITICAL THINKING

In an experiment carried out through a nationally representative survey of over 2,000 young people aged 15 to 27, youth were asked to judge the accuracy of one of several simulated online posts. Researchers investigated the influence of political knowledge and exposure to media literacy education. It was found that political knowledge did not improve judgments of accuracy but that media literacy education did.

EXAMPLE 2: NUDGING

Given that a user is about to post a tweet that contains bogus news, a nudging tool could notify the user with a message like: *"We estimate there is a 90% chance of the article containing false information. Are you sure you want to publish this tweet?".* Through instilling doubt, this nudge encourages users to reconsider the tweet's content.[17]

---

13   Gordon Pennycook and David Rand make this conclusion in their work.

14   These proposals are put forward on p17 of the EU Science Hub's report Understanding our Political Nature.

15   Lee McIntire's book The Scientific Attitude is a must-read on how science can be defended

16   Kozyreva, Lewandowsky and Hertwig study this in their report Cognitive tools for the digital world

17   This example comes from the EU-funded project Co-inform.

EXAMPLE 3: BOOSTING

Cancer patients often struggle to understand their diagnoses. One solution is to boost doctors' statistical prowess by training them to translate probabilities into a representation that is easier to visualise. So rather than saying *"81% of positive test results are false-positives",* doctors can say *"Imagine 1000 men like you are tested. Of those, 63 will have prostate cancer and, of those, 13 will test positive. Of the remaining 937 men who do not have prostate cancer, 56 will also test positive. Thus, 69 men will test positive. But only 13 of them have prostate cancer. This is the situation you are in if you test positive; the chance of you actually having prostate cancer is about one in five, or 19%."*[18]

B ENGAGING PEOPLE IN THE TECHNIQUES OF MISINFORMATION

The notion of **"debunking" misinformation** has been analysed and a number of practical recommendations have been drawn up by cognitive scientists[19]. First, the refutation must focus on core facts rather than the myth. Second, any mention of a myth should be preceded by explicit warnings. Finally, the refutation should include a scientifically accurate explanation. These steps are claimed to prevent the "backfire effect", where countering misinformation focuses so much on the myth that the misinformation is actually reinforced.[20]

These same cognitive researchers point to evidence supporting the idea that **we can be "inoculated"**[21] in a way that helps us recognise misinformation. For this inoculation to be effective, it is said to need to include an explicit warning about the danger of being misled by misinformation, plus counterarguments explaining the flaws in that misinformation. By explaining the techniques of denial, we help people spot attempts to mislead them.

EXAMPLE 1: DEBUNKING A CLIMATE MYTH

When debunking a climate myth, the core facts should be emphasised and reinforced before the myth is mentioned and explained. So to debunk the myth *"the sun is the cause of global warming",* an example text could be as follows:
- Sun and climate are going in opposite directions (Core fact emphasised in headline)
- Over the last few decades of global warming, the sun has shown a slight cooling trend. Sun and climate are going in opposite directions. This has led a number of scientists to independently conclude that the sun cannot be the cause of recent global warming. (Core facts reinforced in initial text)

---

18   Ralph Hertwig explores this example in When to consider boosting: some rules for policy-makers.

19   The Debunking Handbook from John Cook and Stephan Lewandowsky gives practical tips on this based on research into climate misinformation, among other topics.

20   Amy Sippitt at Full Fact UK casts some doubt on the existence of the backfire effect in a recent report.

21   Cook and Lewandowsky studied the effects of this technique.

- One of the most common and persistent climate myths is that the sun is the cause of global warming. (Myth)
- This myth cherry picks the data - showing past periods when sun and climate move together but ignoring the last few decades when the two diverge. (Explaining how the myth misleads)

EXAMPLE 2: "INOCULATION"

The research group DROG designed a psychological intervention in the form of an online browser game called Bad News.[22] In the game, players take on the role of a fake news producer and learn to master six documented techniques commonly used in the production of misinformation: polarisation, invoking emotions, spreading conspiracy theories, trolling people online, deflecting blame, and impersonating fake accounts. The game draws on an inoculation metaphor, where preemptively exposing, warning, and familiarising people with the strategies used in the production of fake news helps confer cognitive immunity when exposed to real misinformation. A large-scale evaluation of the game with 15,000 participants showed initial evidence that people's ability to spot and resist misinformation improves after gameplay, irrespective of education, age, political ideology, and cognitive style.

C REFRAMING THE ARGUMENT

Framing, metaphor and narrative are all methods used in how misinformation is presented, to make it more convincing.[23] Framing is about the context in which information is presented. Metaphor is how we use imagery to represent information, and narrative is about the story we tell. In order to successfully counter misinformation, there is evidence to suggest we should consider how to reframe the argument to avoid reinforcing the misleading framing, metaphor and narrative.[24] To achieve this, it is important to consider the values of the individuals involved: what frame will best convince a particular audience that our narrative comes from a credible source? Data visualisation, too, has been shown to be more effective than text in ensuring scientific claims are seen as reliable.[25]

EXAMPLE 1: METAPHOR AND FRAMING

Research has suggested that comparing global warming to a blanket focuses people's attention on the underlying causes and mechanisms of climate change. It is also "*stickier*"—or more memorable—than comparing it to a "*greenhouse*" gas,

22   The research group DROG developed Bad News, a game where players compete to create the most compelling fake news using these techniques.

23   P45 of the EU Science Hub's report Understanding our Political Nature explores these notions in more depth.

24   Paula Pérez-Sobrino's research explores how metaphors are used similarly in advertising. Andreas Musolff looks at how metaphor and narrative painted a picture of a "dying EU" in the pro-Brexit campaign.

25   Aner Tal and Brian Wansink make this claim in their article Blinded with science.

the dominant metaphor in the field. A study found that people were more likely to repeat and reason about climate change using language from the blanket domain than with language related to greenhouses. An example of the metaphor follows: *"When we burn fossil fuels for energy, such as coal, oil, or natural gas, we release carbon dioxide into the atmosphere. Carbon dioxide is a gas that traps heat. As CO2 builds up, it acts like a blanket, trapping in heat that would otherwise escape. This "blanket effect" is warming the planet's atmosphere, disrupting the balance that keeps the climate stable."* [26]

D — EMOTIONAL CUES

We often consider emotion and reason to be contradictory. But research shows that when information comes laden with emotion, it is much more memorable than neutral information.[27] Again, this is a technique that misinformation uses to great effect. And likewise, by thinking about how we use emotional cues - such as evoking feelings of empathy for example - in the way we present the facts, we can better help prepare people to later identify misinformation.[28] Humour, too, can be a way of helping the facts stick, when used effectively.[29]

A study conducted at the National Aquarium in Baltimore, US, attempted to determine to what extent visitors retained and acted upon the conservation knowledge, attitudes, and beliefs developed during their visit. The study revealed that visitors exiting the aquarium had clearly absorbed the institution's fundamental conservation message. Upon entering the aquarium, visitors talked about conservation in a variety of ways, but their descriptions lacked detail and emotion. Following their visit, they most commonly talked about conservation with great emotion and in terms of the complex interconnections between animals, people, and the environment.[30]
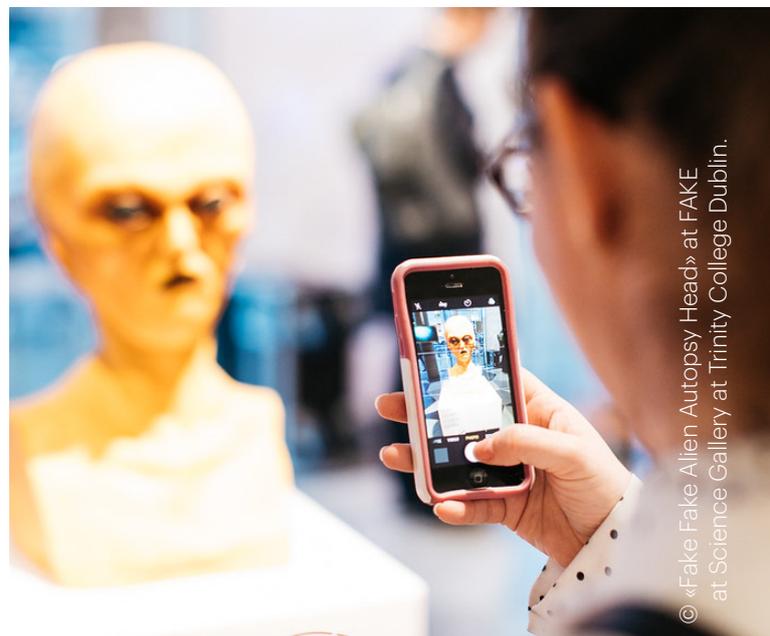
© «Fake Fake Alien Autopsy Head» at FAKE at Science Gallery at Trinity College Dublin.

---

26   This research comes from FrameWorks working with the US National Network for Ocean and Climate Change and the National Science Foundation: How to Talk about Climate Change and the Ocean

27   Rebecca J. Compton reviews the research on the interface between emotion and attention.

28   Hadas Okon-Singer et al show how emotion and cognition are linked. Luiz Pessoa also explores this in his study The Cognitive Emotional Brain.

29   Sara K. Yeo is working on how humour is used in science engagement.

30   This study is discussed in Falk and Dierking's Learning from Museums: Visitor Experiences and the Making of Meaning

PROMISING PRACTICES ON MISINFORMATION

Science engagement organisations have already developed and implemented a number of activities that address the challenge of misinformation. Here we present an overview of some of the most promising practices, together with how to find out more about them. The practices are grouped according to the main techniques they exemplify taken from our list in the earlier section "What techniques could help to tackle misinformation?"

UNIVERSCIENCE, PARIS, FRANCE

• **DATA SCIENCE VS FAKE**
2018 - present
OBJECTIVE: addressing misinformation in a catchy, visually-appealing way
KEY ELEMENTS: film, data visualisation, online, viral video, media partnership, impact
LANGUAGES: FR, DE
TECHNIQUES: C (Reframing the argument), D (Emotional cues)
MORE INFORMATION: find the videos here and contact Universcience, France

Data Science vs Fake is a collection of 20 short films, each 2 minutes long, developed by the editorial team of leblob. fr, Universcience's digital platform. The animated series is designed to address misinformation. It uses data visualisation techniques to transform statistics and scientific fact into animated, visually appealing and scientifically accurate images that counter misconceptions.

The range of topics is particularly broad: deforestation, HIV, life expectancy, brain, gender, oil, vaccines and overpopulation, to name but a few.

The series is developed in cooperation with Franco-German free-to-air television network Arte, France TV Education, French National Institute of Health and Medical Research INSERM, the French Research Institute for Development IRD and the French Ministry of Higher Education, Research and Innovation. The voiceover was recorded by a well-known young YouTuber, Baptiste Mortier-Dumont, also known as Experimentboy, who has over a million subscribers. The project received a special mention at the 2019 Mariano Gago Ecsite Awards for the way it partnered with media for impact.

© Universcience / Arte

• **CRITYK (WORKING TITLE)**
Planned for 2020 - 2024
OBJECTIVE: : to engage family audiences on critical thinking and cognitive biases
KEY ELEMENTS: travelling exhibition, critical thinking, cognitive bias
LANGUAGES: FR
TECHNIQUES: A (Engaging people in critical thinking)
MORE INFORMATION: Contact Universcience, France

A team of French science centres is working together to develop CRITYK (working title), a 500m² interactive exhibition on critical thinking and cognitive biases, for family audiences aged 10 and over. Upon arrival in the exhibition, visitors are given a bracelet with special cognitive properties and are told that their interactions in the exhibition will be tracked as part of an experiment.

Visitors then wander through the exhibition which takes the form of a city to explore. They encounter tests where they have to use their critical thinking skills. For example, in the city hall, they examine logical fallacies in political rhetoric. The supermarket is a chance to explore the biases at work in marketing, raising questions about how we consume information. And the newspaper kiosk looks at the spread of misinformation in the media. At the end of the visit, they can see their results of the "experiment" and compare them to others'. Finally it is revealed that the bracelet was simply a placebo and the experiment just a game, using humour to encourage them to take a critical look at the experience.

"The main challenge we're facing at the moment is: on a topic like critical thinking, how do we engage adults and children at the same time? A lot of the notions we are putting across are very complex. Our strategy has been to aim the exhibition at 10-year-olds who represent a kind of average visitor for us in terms of their level of science knowledge, while still giving some more adult-oriented details. We have had to come up with playful ways of making these complex concepts accessible, and the bracelet game is a good example of one of our solutions. In terms of atmosphere, we are using quirky humour – with all this questioning and uncertainty, we want to make sure our visitors feel at ease. Terminology has been an issue as well – we have a research group that came up with a good working definition of critical thinking. Another challenge has been how we position science within the exhibition, as the method that helps us address critical thinking, going beyond just exploring cognitive biases. We realised that several exhibits did not have much science behind them, such as the self-tests, and that's something we will address with the mediators. Mediation will also be crucial considering that critical thinking requires interaction and we are developing games with this in mind."

– Nathalie Puzenat, Exhibit Developer, Universcience

• CRITICAL THINKING AND MEDIATION
2019
OBJECTIVE: supporting the development of skills for science mediators in working with misinformation and critical thinking
KEY ELEMENTS: training, skills, critical thinking
LANGUAGES: FR
TECHNIQUES: A (Engaging people in critical thinking)
MORE INFORMATION: find the course website here, resource section here and contact L'Ecole de la médiation, Universcience, France

L'Ecole de la Médiation at Universcience runs training courses in cultural and scientific mediation for professionals working with non-expert audiences. A new two-day course has been developed, entitled Critical thinking and mediation, which deals specifically with how to tackle misinformation and citizens' lack of trust in scientific knowledge, inviting professionals to question their current practices and positioning. In addition to this course, professional meetings were organised including a workshop in cooperation with Les Petits Débrouillards on how to analyse and deconstruct conspiracy discourse, with a particular focus on climate change misinformation.

One particularly successful element of the thematic cycle about "Critical thinking" is the "Concours de mauvaise foi" ("Bad faith contest") where participants compete by developing an argument on an absurd theme such as "the moon is made of popcorn". They are given logical fallacies to use in their speeches. A jury then votes on which competitor has used the logical fallacies the best and is therefore the winner. This type of humorous contest can be held in front of an audience of professionals or non-experts to help them to analyse their own and others' speeches and therefore work on their critical thinking skills.

"Critical thinking is a relatively new topic for Ecole de la médiation – it's been a focus for just over a year. So our strategy with the course was: before we explore critical thinking with our audiences, let's examine our own critical thinking as cultural mediators. That was our committed position: to take this humble approach and acknowledge the fact that we are all affected by biases. I think that is why it prepares our mediators well to interact with the public: it ensures a more serene dialogue. It also helps to clarify how the scientific approach can overcome these biases. The greatest challenge for us as trainers is to provoke this reflexive questioning while at the same time accompanying the implementation of concrete actions"

- Catherine Oualian, Trainer, Ecole de la Médiation, Universcience

• **ATELIER MÉDIATION ET CRITIQUE**
2016 - present
OBJECTIVE: to empower science mediators on dealing with non-scientific beliefs
KEY ELEMENTS: debate, training, skills, MOOC, resources
LANGUAGES: FR
TECHNIQUES: A (Engaging people in critical thinking)
MORE INFORMATION: find the conference report in French here, the online platform here and contact Atelier médiation et critique, Amcsti

In 2015, after the terrorist attacks in Paris, the Board of Amcsti (the French network promoting scientific, technical and industrial culture) decided to organise a conference, and later an online platform, to explore how to work on the differences between scientific knowledge and beliefs. The conference, entitled "Science, Culture and beliefs: how can we talk about it?" was held at the Musée de l'Homme in Paris, France, in March 2016. Participants were invited to share experiences from debates on science and technology at their own science centres and museums.

In response to the discussions at the conference, the Amcsti team decided to develop an online platform on the topic, containing a resource section with scientific literature, articles, and videos. It also hosts a MOOC which has been

followed by more than 250 people with four modules including "Know & believe - critical thinking and judgement" and "Mediation techniques: preparing for peaceful cultural mediation". The MOOC engages science communicators in many aspects of how to deal with misinformation, including how science mediators can position themselves with regard to non-scientific beliefs.

"In opening up this discussion and developing tools, the biggest challenge has been simply getting museums to broach the subject. There is still a huge amount of reticence around the topic of misinformation. It's hard for many institutions because it involves a fundamental questioning of our role. We have to reinvent our position in order to engage in real debates and accept differences in a way we traditionally haven't. One approach that does work very well as a way in is for museums to address critical thinking as a means to tackle misinformation. The impact for those that do engage is very clear – organisations have started to embed critical thinking into their processes and develop training programmes on the topic for their staff."

- Didier Michel, director, Amcsti, France

• **FAKE NEWS: THE LIES BEHIND THE TRUTH**
November 2017 – January 2018
OBJECTIVE: to engage family audiences with the topic of misinformation
KEY ELEMENTS: exhibition, objects, debate
LANGUAGES: EN
TECHNIQUES: B (Engaging people in the techniques of misinformation)
MORE INFORMATION: See the exhibition website here, watch the debate recorded here and contact the Science Museum Group, UK

The UK's National Science and Media Museum developed an exhibition that explored how and why misinformation is created and the ways new technologies are changing the ways information is spread across the globe. It also looked at the historical perspective: how propaganda, doctored images and unverified statistics can be found throughout the history of human communications. The exhibition drew comparisons between outrageous headlines in the 1830s and social media 'click farms' in the present day, for example. Visitors could compare original photographs to altered newspaper images and footage from the State Opening of Parliament with contrasting tabloid headlines.

A live debate was held in conjunction with the exhibition that brought together a panel of guests to debate how museums and the media can deal with the challenges of 'post-truth' reporting. They addressed questions around who is responsible for the phenomenon, how the authority of information can be maintained in a fast-changing media landscape, and what strategies can be adopted to respond.

"In 2016 when the project was conceived, the media landscape was changing and what was happening with misinformation was extremely complex. It was clear to me that misinformation posed a serious threat to museums. Our role was to use our collection to give historical context, engaging visitors and exploring misinformation with them. What museums do well is taking time to unpack concepts, breaking down complex ideas, raising questions rather than providing answers. By gathering examples from the past, we highlighted how different the phenomenon is now, for example in the speed at which misinformation circulates. In developing the exhibition, speed was important too: to ensure it remained up-to-date we had to work in a journalistic way, saving time and budget by using digital reproductions instead of loans for example. The whole exhibition was developed in a third of the usual time and made available as a blueprint pack to be recreated."

**– John O'Shea,
former Senior Exhibitions Manager,
National Science and Media Museum,
Bradford, UK and now Associate Director
(Creative) at Science Gallery London**

• **IMMERSIVE NEWSROOM**
In progress
OBJECTIVE: to develop methods to engage teenagers with topics linked to misinformation
KEY ELEMENTS: co-creation, multi-stakeholder, design thinking
LANGUAGES: DE
TECHNIQUES: B (Engaging people in the techniques of misinformation)
MORE INFORMATION: contact NaturErlebenisPark Graz

Immersive Newsroom is a co-creation project carried out by a consortium of science educators and artists. It gets a wide range of potential user groups involved: science mediators in informal educational institutions, employees of museums and cultural institutions, social workers, architects and so on. The aim is to develop methods that can equip teenagers to deal with controversial topics that are important to their lives in a democratic society. The project focuses on digital sources (social media, internet) as well as newspapers, books and talks, and aims to open up spaces for becoming aware of one's own opinion-forming.

The first development phase was implemented as part of a project funded by the Austrian Research Promotion Agency. The entire process was designed as an iterative process of development and feedback loops, in which creative, open phases alternate with focusing, evaluating phases. The project moved step-by-step from problem specification through creative planning to usability testing of prototypes. The individual steps were based on a classical design thinking process with a multidisciplinary team. The project thus offered a wide variety of perspectives, approaches and expertise paired with openness and the joy of experimenting, as well as the ability to think in terms of hybrid thinking. The result is a prototype that combines performance elements, installations and a workshop.

"It was a real challenge to develop a format that fit within an acceptable timeframe while still addressing all the aspects of misinformation, from the credibility and accessibility of information sources to the cognitive and emotional process of forming an opinion. What worked well in general were the playful, self-determined methods we developed for each of the various topics we covered. What we also learned was that for some of the more controversial topics, self-instructed activities were less successful and a mediator can play a key role in engaging teenagers on these subjects. The prototype was evaluated with a mixed design of self-evaluation and external evaluation (by students of the Institute for Education of the University of Graz) and the findings will be published and made available."

- Dr Andrea Frantz-Pittner, Director, NaturErlebnisPark, Graz

• **FAKE**
March – June 2018
OBJECTIVE: to explore the notion of "fake" within science
KEY ELEMENTS: art and science, objects, experiment
LANGUAGES: EN
TECHNIQUES: B (Engaging people in the techniques of misinformation)
MORE INFORMATION: find the Fake website here and contact Science Gallery Dublin, Ireland

Science Gallery Dublin develops its exhibitions by putting out a call for artists to co-create exhibits around a certain theme, in this case: "fake". As such, the exhibition did not only explore misinformation but a whole range of science-related topics, from biomimicry to virtual reality. However, many of the exhibits did raise the topic of misinformation and critical thinking.

They included "Die Sammlung" from Heather Beardsley, a project that presented fictional specimens in antique jars alongside actual biological specimens, encouraging viewers to think more critically when viewing and interacting with museum displays. The object "Fake Fake Alien Autopsy Head" was sent to a magazine claiming it was used to fake footage of an alien autopsy. It was proved be a double fake - it was not the head used in the fake autopsy and had been made to try and discredit it. "Fauxgram" presented the results of an experiment on Instagram to fake a social media persona and "Lie 2 Me" was an interactive exhibit allowing visitors to try out an experiment about deception, developed by experimental psychologists, a game designer and a physicist.

"One element that worked well was at the entrance to the exhibition where we set up a delicatessen where visitors could try food products for themselves and discuss what makes them fake. It was an accessible starting point that sparked conversation and primed the visitor with some of the language and concepts explored in the exhibition. We had to be careful about the tone we took in the exhibition. We actually hesitated about calling the exhibition "Fake" - were the connotations too negative? We were aiming at 15-25 year olds, and so with exhibits like Fauxgram we didn't want to be overly critical of people's social media use. The aim was very much to avoid a preachy or patronising tone; rather to explore key concepts with our visitors around fakery and misinformation, raising questions with them and encouraging discussion."

- Aisling Murray, Head of Programming, Science Gallery Dublin

• **SCIENCE MEDIA SPEED DATING**

2014 - present

OBJECTIVE: to bring researchers and journalists together in the science centre to discuss science journalism

KEY ELEMENTS: dialogue, partnerships, networking, media

LANGUAGES: PL

TECHNIQUES: B (Engaging people in the techniques of misinformation)

MORE INFORMATION: See the project webpage and Science Media Congress webpage in Polish and contact Copernicus Science Centre

The Science Advocates project was set up to strengthen cooperation between scientists and journalists. Central to this cooperation are meetings of representatives of both communities which take the form of speed dating. These events build relationships between a number of key scientists and high-profile science journalists, allowing them time to discuss key issues around science reporting and misinformation. The speed dating events have been held in Warsaw and across Poland, with around 80 researchers and 40 journalists from national and local media taking part. The format is simple and familiar – researchers and journalists are paired up and have just a few minutes to get to know each other and discuss a topic related to science journalism. At the end of the event, all participants choose who they felt they "matched" with, and can then stay in contact for future cooperation.

"By opening up the conversation by using prompts such as 'how do you communicate climate change?' and 'how can we engage people on the topic of vaccination?' this type of activity can have significant impact on how science media works to tackle misinformation. What works well at this event is that everyone benefits: the journalists, because they have a new source of knowledge, inspiration and access to scientists who know the specifics of the media; scientists - because they reflect on how to engage media and the public; and society - because science becomes closer and more understandable. It has created long-lasting collaborations and the project has evolved into an annual Science Media Congress that we now hold at Copernicus."

**– Wiktor Gajewski, Events Director,
Copernicus Science Centre**

• **CRANKY UNCLE**
In development
OBJECTIVE: gamifying engagement to tackle misinformation
KEY ELEMENTS: climate, app, interaction, humour, inoculation
LANGUAGES: EN
TECHNIQUES: B (Engaging people in the techniques of misinformation)
MORE INFORMATION: See the website here and contact John Cook

Cranky Uncle is a free smartphone game that uses cartoons and gameplay to interactively explain the techniques used to cast doubt on climate science. It's based on the principle of "inoculation" described earlier in this document – engaging people on how to spot attempts to mislead by first learning the techniques of denial. Players are guided by a cartoon Cranky Uncle who explains the various techniques of misinformation, using quizzes and reward feedback to encourage users to keep playing, developing their resilience against misinformation.

The idea is to make this non-profit game available in classrooms and to the general public around the world. There is also a 176-page Cranky Uncle vs. Climate Change cartoon book in development which will be made available in print or as an e-book. Cranky Uncle is an interdisciplinary collaboration between the Center for

Climate Change Communication, Center for Ocean-Land-Atmosphere Studies, Computer Game Design, Department of Computer Science, Creativity and Graphics Lab, and Department of Communication at George Mason University, along with Reed College of Media at West Virginia University and Autonomy Co-op.

VALLADOLID SCIENCE MUSEUM,
VALLADOLID, SPAIN

• **INCREÍBLE... PERO FALSO**
2011 - present
OBJECTIVE: to engage adults on questions and evidence around misinformation and pseudoscience
KEY ELEMENTS: researchers, talks, inspiration
LANGUAGES: ES
TECHNIQUES: C (Reframing the argument), D (Emotional cues)
MORE INFORMATION: find reports and recordings of many of the talks in Spanish here and contact Valladolid Science Museum

Every year, Valladolid Science Museum programmes a cycle of four or five talks under the title "Increíble... pero falso" ("Strange... but false") that all address misinformation in science. These talks are organised together with the University of Valladolid's Buendía Center. Speakers are invited from a broad set of backgrounds and specialisations, addressing topics from the moon landings to homeopathy.

Talks have included "Science, pseudoscience and the media" in 2017 where the well-known Spanish science communicator Manuel Toharia explored the pitfalls of the relationship between journalists and research. In a 2017 talk entitled "The numbers don't lie, but liars use numbers too," José María Marbán, PhD in Mathematics and full professor at the University of Valladolid looked at statistics as a language with which to understand the world. He looked at how the numbers can be manipulated, taking a historical perspective as well as examining current-day fallacies.

In 2019 one of the talks "'Fraud in Science. A touch of self-criticism" took another approach: Alfredo Marcos, professor in Philosophy of Science at the University of Valladolid explored how science can be affected by fakes and frauds, including Piltdown Man, the Fleischmann-Pons experiment on cold fusion and Hwang Woo Suk on stem cells. By discussing how these cases are corrected, he demonstrated the scientific community's mechanisms of self-criticism and correction; procedures that are, in turn, subject to criticism. The scientific method is not a magical procedure, nor a kind of guaranteed algorithm, but is based on intellectual honesty. Its fallibility and limits must be acknowledged.

Copies of the Weekly World News from early 1990s, on display in the «Fake news: the lies behind the truth» exhibition at the National Science and Media Museum, Bradford, UK

© National Science and Media Museum

TAKE-HOME MESSAGES

As organisations working in science engagement, there are a number of conclusions we can draw on how best to tackle misinformation in our work. These points can be taken into account when developing activities and exhibitions for science engagement organisations, when training staff and when reflecting on science engagement strategies more broadly.

IN YOUR INSTITUTIONAL STRATEGY:

STEP UP TO THE CHALLENGE

Don't shy away from tackling misinformation: be clear about your role as a trusted institution for science engagement. Integrate addressing misinformation into your organisational mission and strategy as a challenge that cuts across the work of your institution. Play a part in the public discourse about misinformation in the media, online and in academia. It is crucial that our organisations are seen and heard, raising the issue but also raising the profile of science in the process.

BRING OTHER STAKEHOLDERS INTO THE DIALOGUE

Science communicators are not the only ones that need to be seen to be listening. By bringing researchers into conversation with the public we can help to further improve perceptions of science as open and engaged with society. This is true of

any authority involved in misinformation: if the topic you want to address concerns local policymakers or the media, why not get them involved in the science engagement activities – or better still, engage with them on a systematic basis? The more we work across sectors, the more impactful our work will be. Misinformation aims to polarise opinions: by engaging in dialogue we make our institutions a space that actively resists this polarisation.

IN YOUR ACTIVITY DEVELOPMENT:

ENGAGE PEOPLE IN THE PROCESSES AROUND SCIENCE

As institutions, one of our strengths lies in giving people time to break down complex notions. To address misinformation, we can use this to explore notions of scientific consensus with our audiences. Examine with them how scientific facts are validated, what makes science distinctive in its emphasis on evidence and scientists' willingness to change theories on the basis of new evidence.

SHOW HOW FACTS CAN BE DISTORTED

Exploring, demonstrating and engaging people in how evidence can be framed and misused can certainly help them to reflect on the misinformation they are exposed to. As science engagement organisations we can help people understand where unscientific information is coming from, who is behind it and what motivates them, as well as the techniques they use.

UNDERSTAND THE PEOPLE INVOLVED

All science engagement activities are tailored towards their intended audiences, and on misinformation it is helpful to think beyond the usual demographics. A useful exercise is to break down the target audiences in terms of their views on the subject: in the case of vaccination these groups could include "the majority in favour of vaccination" and "the undecided" etc. Research your audiences to determine for each of them, what are the main issues to be addressed, and what approaches are the most appropriate? It is important to understand who are the knowledge communities at play: who is generating and spreading the misinformation you want to address, and what motivates them? By researching the people involved, you can ensure you give a realistic portrayal of the spectrum of opinion, without further polarising the debate.

TAKE BEHAVIOURAL GOALS AS YOUR STARTING POINT

It is helpful to start with the question: what behaviour am I aiming to change with my science engagement work? When it comes to misinformation, that behavioural goal might include "to change the way people process the information they read online" or "to change the way people talk about the scientific method." These behavioural goals then become the starting points from which we can start to think about how we can engage people in science. Formative research can help us identify the areas where we can act to be most effective in making behavioural change.

IN YOUR PRACTICE:

ENSURE YOU ARE LISTENING

Engaging in dialogue means a two-way conversation. And as institutions of public engagement, we have a responsibility to be aware of what is going on around us, sensitive about current affairs, leading the dialogue and learning about people's reactions. That doesn't mean that we need to accept non-scientific beliefs, but we do need to show that we are listening. By articulating their reasoning, people often bring up the assumptions on which their beliefs are based, which can be useful to discuss. But by listening we can also better understand what the values are that drive people and thereby get a better understanding of the societal issue at stake. This positioning also helps to demonstrate that science is iterative, always questioning itself and striving for improvement.

REFLECT ON THE WORDS YOU USE

The vocabulary of misinformation carries significant weight. Consider whether you might want to avoid terms like "fake news" which have been co-opted to undermine media reporting, for example. Be aware of the rhetorical power effects of words like "misinformation". Reflect on the way you use framing, metaphor and narrative to engage people in scientific fact that does not reinforce the framing, metaphor and narrative used by misinformation.

EVALUATE YOUR PRACTICES

Conduct front-end, formative and summative research to assess to what extent you have achieved your goals in your work on misinformation and to help us as a community better understand what works. Engage with social scientists on this research and share your results.

THANKS AND NEXT STEPS

We are grateful to The Kavli Foundation for its support of the Copenhagen workshop and to all those who participated and contributed to the development of this resource document for their insight. A special thanks to Antonio Gomes da Costa and Brian Southwell for co-leading the workshop at the Conference and reviewing this document.

At Ecsite, we are keen to continue this conversation, through future discussion and dialogue around misinformation, via the Ecsite events and communication channels and the Ecsite magazine, Spokes. We would also like to continue updating this document to reflect the latest research and practical examples from across the field. If you are working on misinformation and are interested in getting involved, please contact us at info@ecsite.eu.

LIST OF CONTRIBUTORS

Besley John, Ellis N. Brandt Professor, Michigan State University, United States
Cook John, Research Assistant Professor, Center for Climate Change Communication, George Mason University, United States
Frantz-Pittner Andrea, Director, NaturErlebnisPark, Austria
Gajewski Wiktor, Events Director, Copernicus Science Centre, Poland
Harambam Jaron, Postdoctoral Researcher, Institute for Information Law, University of Amsterdam, The Netherlands
Michel Didier, Director, Amcsti, France
Murray Aisling, Head of Programming, Science Gallery Dublin, Ireland
Oualian Catherine, Trainer, Ecole de la Médiation, Universcience, France
O'Shea John, Associate Director (Creative) at Science Gallery London, United Kingdom
Pasquero Vincent, Scientific Mediator, Universcience, France
Petitpré Jacques, Scientific Mediator, Universcience, France
Puzenat Nathalie, Exhibit Developer, Universcience, France
Smillie Laura, Policy Analyst, European Commission
Southwell Brian, Senior Director, Science in the Public Sphere, RTI International, United States
Yeo Sara, Assistant Professor, University of Utah, United States

EDITORIAL TEAM

Michael Creek, Co-founder, Stickydot, Belgium
Antonio Gomes da Costa, Director of Scientific Mediation and Education, Universcience, France
Catherine Franche, Executive Director, Ecsite, Belgium
Marie Couëdic, Special Projects Assistant, Ecsite, Belgium