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Motivations and deterrents in contemporary science communication: a questionnaire survey of actors in seven European countries

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ABSTRACT

As the ecosystem of actors communicating science has become more complex, there is a need to understand the motivations and deterrents of those involved in the communication of science, technology and health topics. This article reports on a survey of 465 communication actors based in seven European countries. The findings suggest strong commonalities between role and country, with personal enthusiasm a key motivator, and from a theoretical perspective, these motivations can be viewed as relatively pragmatic. More variation was found between countries and roles in barriers to communication, though these suggest a perception that institutions do not value this work.

KEYWORDS

Science communication; motivation; professional development

Introduction

The purpose of science communication as a field has come sharply into focus in recent years. Intentions identified include ensuring the accountability and legitimacy of publicly funded science, to enhance democracy, provide cultural enrichment, fulfil economic purposes, promotion or marketing of science as a discipline, as well as practical functions, such as sharing knowledge on which to base personal decisions (Davies, 2021). These drivers for science communication have implications for science communicators, who have an increasingly obvious role to play in current and future societal challenges such as the COVID-19 global pandemic and the climate crisis. Arguably the role of communicators is particularly complex in an era where trust in expertise, though still relatively high in public surveys, can easily be swayed around high-profile political issues, or amongst ones' own digital 'echo chamber'. The impact of digitalisation and the increasing opportunities for online science communication means roles for science communicators have evolved, with boundaries between the activities of different science communication roles shifting, and entirely new roles emerging (Fahy & Nisbet, 2011; Milani et al., 2020a). Amongst these Autzen and Weitkamp (2020) argue for wider consideration of the roles of organisations in particular. This calls for contemporary research into science communication working practices and the motivations and deterrents for communication.

Who are the science communicators?

Changes to the science communication landscape in recent decades have inevitably altered who is shaping science, technology and health communication. Science journalists are no longer the

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dominant source for scientific knowledge in the public domain (Trench, 2007) and now scientists, research centres, funding bodies, scientific publishers, science centres and museums, charities and amateur enthusiasts, are equally able to communicate directly about science online (Milani et al., 2019; 2020b; Weitkamp et al., 2021). This has raised interest in the so-called organisational turn in science communication (Entradas et al., 2020; Koivumäki & Wilkinson, 2020; Marcinkowski et al., 2014; Ojeda-Romano et al., 2022; Schäfer & Fähnrich, 2020), but also created a need to better capture the complex range of individuals who are communicating science, technology and health issues, only some of whom may be working in organisational contexts, as well as their motivations for communication.

Greater access to communication mechanisms has inevitably affected science journalism; the volume of science news online means journalists are increasingly 'curating' news content, under pressure to locate entertaining stories quickly, rather than pursuing more extensive, investigative research (Fahy & Nisbet, 2011; Frost, 2010; Wilkinson & Weitkamp, 2016). Digitalisation has profoundly changed working practices in journalism, with science journalists around the world saying the quantity of online content they write has increased (Bauer et al., 2013; Massarani et al., 2021), and journalists integrating social media into their dissemination, with some media organisations also employing social media specialists (Neuberger et al., 2019). This has led to a science media ecosystem that is more 'pluralistic, participatory and social' (Fahy & Nisbet, 2011, p. 778). Nevertheless, scientists and researchers can be less willing or able to publicly share their research online using social media, blogs and other means (Milani et al., 2019; Wilkinson & Weitkamp, 2013), with a lack of knowledge or time often cited as reasons why such tools are not used (Collins et al., 2016).

Whilst the science communication landscape has grown and diversified, research into the working practices, motivations and barriers of those engaged in science communication is fragmented. With such a wide range of actors now involved in science communication including scientists, journalists and other types of content producer (Milani et al., 2019; Milani et al., 2020b; Weitkamp et al., 2021), it can be challenging to develop research studies that encompass more than a small group of actors, specific subject matter or the context of an individual country. Science communication as a discipline is also criticised for its presentation of a white, westernised and homogenised account of the field (Finlay et al., 2021). This global and cultural narrowness has led to criticisms that the focus of study tends to be on a narrow number of countries, though literature is emerging that seeks to develop a more representative global picture (Entradas et al., 2020; Gascoigne & Schiele, 2020; Massarani et al., 2021).

There is a need therefore, to understand the 'micro-level practices' of science communicators (Koivumäki & Wilkinson, 2020) which would include their motivations and deterrents, as well as studies which account for the changing science communication landscape and cultural context in which they are located (Ho et al., 2020). Using as our focus a Horizon 2020 funded RETHINK (RETHINK, 2021) examining the working practices of 'actors' communicating science, technology and/or health in seven countries – Italy, the Netherlands, Poland, Portugal, Serbia, Sweden and the UK, we were presented with an opportunity to examine this further. This leads us to our first research question:

> RQ1: Does the country in which a communicator is located relate to their ascribed motivations and deterrents for science, technology and/or health communication?

What are their motivations?

Existing research on science communicators has examined motivations to communicate; in particular the question of whether the intended aim is a one-directional communication of science to society, a 'deficit' approach, or a two-way dialogic response, often referred to as public engagement or participation. With a broad variety of functions now attributed to science communication, concerns are expressed that these can conflate educational and deliberative motives with political

intentions (Autzen & Weitkamp, 2020; Koivumäki & Wilkinson, 2020; Weingart & Joubert, 2019). However, many theorists and practitioners working in the field now recognise that it is not a simple binary in terms of motivation and that often such approaches, one-directional communication and engagement or participation, can exist in parallel (Cortassa, 2016; Simis et al., 2016).

Nevertheless, much existing research has suggested that those communicating science, including scientists and researchers tend to see a primary role for awareness raising in communication activities, rather than necessarily a desire for dialogue. One such survey of researchers in the UK found that 56% viewed informing the public and/or raising awareness of science as one of the principal benefits of science communication (TNS BRNB and University of Westminster, 2015), replicating a number of similar studies (BBSRC, 2014; Dudo & Besley, 2016; Horst, 2013; Royal Society, 2006; Wellcome Trust, 2000). Science journalists are also sometimes perceived as a 'kind of public-relations service existing purely to explain new scientific findings to the masses' (Nature, 2009). From the journalistic perspective, a global survey of science journalists found that many (43%) saw their work as informing others about science, followed by 'translating complex material' (23%) and educating (13%) (Bauer et al., 2013). Again, this echoes other studies which have used terms such as 'informers', 'advocates' and 'translators' to describe science journalists' self-perceived identities (Amend & Secko, 2011).

Whilst it is understandable that such motivations exist, this desire to inform can extend beyond the specifics of ones' area of research, or a particular science story, to broader motivations around the role of science within society (Dudo & Besley, 2016). Horst's (2013, p. 758) qualitative analysis of 20 leading Danish scientists' views on their own role in communication found they identified with both 'speaking on behalf of' science and symbolically 'standing for' science and its organisations. Dorothy Nelkin's, 1987 book Selling Science: How the Press Covers Science and Technology, was one of the earliest accounts of the complex relationship that can exist between research and science journalism, highlighting in particular concerns around sensationalism. Criticisms that science journalism tends to the extremes of 'cheerleader' or 'watchdog' has raised questions about the role of critical analysis, scrutiny and investigative journalism in the context of science journalism (Yong, 2009). A recent international study of science journalists suggested that whilst science and technology are becoming more interesting and advanced, leading to high quality science communication from journalists, this sits against a backdrop where the quantity of press releases from journals, universities and researchers, combined with budget cuts in the media, can diminish the quality of that which is reported (Massarani et al., 2021).

Organisational factors can therefore also affect how researchers think about, reflect on and represent what science, scientists, and scientific organisations are (Autzen & Weitkamp, 2020; Brass & Rowe, 2009; Entradas et al., 2020; Horst, 2013; Marcinkowski et al., 2014). This can also extend to social and cultural aspects, for example a sense of 'duty' and/or 'responsibility' can be a significant motivating factor amongst researchers (Casini & Neresini, 2012; Entradas et al., 2020; Peters, 2013). This means that much work on motivations for involvement in such activities amongst scientists and researchers identifies it 'as a form of volunteer work that … [is] auxiliary to their other responsibilities' (Andrews et al., 2005, p. 281), but this perception can also create conflicts with communication and public engagement seen as under-recognised or valued from an organisational perspective.

Many who communicate science are therefore doing so for perceived personal benefits, including for their career aspirations, personal enjoyment and satisfaction (Andrews et al., 2005; BBSRC, 2014; Besley et al., 2018; Wellcome Trust, 2000; Wilkinson et al., 2011), though a small number of studies have suggested extrinsic rewards such as funding and recognition play a more significant role in some contexts (Ho et al., 2020). Researchers can learn from communication experience, not only in terms of their subject specialisms but broader communication skills, which can also improve their teaching (Illingworth & Roop, 2015). And increased opportunities for digital communication also allow scientists to reach their audiences directly, bypassing gatekeepers such as journalists, communication officers or museums. Even on digital platforms, though, traditional

roles are evident. Brown Jarreau (2015) found that scientists and journalists who blog engage most frequently in the roles of science explainer, public intellectual and civic educator, whilst popular science bloggers often act as transmitters rather than engagers, predominantly motivated by their passion for science and the pleasure they gain from writing (Ranger & Bultitude, 2014).

Beyond researchers, scientists and journalists there is relatively limited knowledge of the motivations driving communication, though in health-based settings patient and public involvement (PPI) in health research encourages dialogic forms of communication (National Institute for Health Research, 2010). Despite much work on the motivations of visitors to locations such as science centres and museums there are still very few studies on the roles and motivations of curators, explainers and museum management (Judge, 2022; Kamolpattana, 2016; Tran, 2008). Research is however increasingly emerging on 'influencers', for example Science YouTubers who have been found to be motivated by the desire to improve understanding, empower and respond to misinformation (Velho & Barata, 2020).

In sum, existing research suggests those communicating science tend to be highly motivated to raise awareness, educate and to speak for research, often driven by personal motivations rather than organisational incentives. These motivations persist when using more recent digital mechanisms to communicate. However, there is limited research as to how this might compare between countries and also a lack of understanding as to how motivations may differ for some communicating science, in particular those who may have roles outside of science, research or journalism.

What are the deterrents?

Despite the many motivations to communicate, actors communicating science, technology and/or health issues face a range of barriers. For scientists and researchers, a lack of time is frequently reported as a reason that they do not communicate more (Andrews et al., 2005; Besley et al., 2018; Ho et al., 2020; TNS BRNB and University of Westminster, 2015). Science communication is often perceived to be a peripheral activity by researchers (Casini & Neresini, 2012; Royal Society, 2006; Tiffany et al., 2022) who may view science communication ' … as an adjunct to their research work, something that takes up time and resources that could instead be devoted to research' (Casini & Neresini, 2012, p. 58). In science journalism, increasing competition and fragmentation of the market means media organisations have sometimes shed specialist journalistic staff, such as science journalists, resulting in remaining journalists facing a higher workload also with limitations in terms of time (Massarani et al., 2021; Williams & Gajevic, 2013; Yong, 2009). This has left science journalists concerned about the growth of 'churnalism' (Bauer et al., 2013; Williams & Gajevic, 2013); with journalists expected to write more and with less time to check facts and conduct in-depth research but it has also led to calls for further research on so called 'peripheral actors' in journalism, content providers working in novel and often 'altruistic' ways (Schapals et al., 2019).

Beyond time factors, there can be gaps between the motivations for communication and engagement intended in science policy and how that is operationalised and 'enacted' at local organisational levels (Weingart & Joubert, 2019). This difference between policymakers' and funders' aspirations and institutional perceptions of the value of science communication can present a barrier, with a lack of funding and a lack of recognition of the value of public engagement reported as problematic or not considered as essential (Illingworth & Roop, 2015; Neresini & Bucchi, 2011; TNS BRNB and University of Westminster, 2015). Lack of support from departments and organisations, as well as information on how communication activities are supported, are also reported barriers to engagement (Andrews et al., 2005), as is the potential for communication and engagement to be siloed in regards to funding, and most commonly associated with raising awareness of research versus active involvement and partnership in it (Holmes et al., 2019). This complex range of constraints can mean that public engagement enablers within institutions, such as press and communication officers, or public engagement specialists, report a difficulty in encouraging researchers to participate in science communication activities (TNS BRNB and University of Westminster, 2015).

Opportunities to communicate directly with people via digital and social media have increased for journalists, scientists and researchers and other science communication actors, but there has often been a lag in the provision of training, sharing of best practice, and professional recognition for the use of such tools (Illingworth & Roop, 2015). Institutions continue to grapple with the role that digital and social media might play within communication activities (Koivumäki & Wilkinson, 2020), and there can be variations in whether it is considered a work-related activity. Even amongst experienced social and digital media users such as YouTubers, keeping up-to-date with changes to algorithms and the demands of high production values, can prove a challenge (Velho & Barata, 2020), one which is compounded by a lack of opportunities to generate significant revenue and the concomitant need for additional employment. Further, communication may become sanctioned if it is seen to pose a risk for organisational reputation (Brass & Rowe, 2009). In this sense, science communication has been described as being in a 'moment of transition' with 'a sense of flux and of new norms and practices emerging, albeit with results that remain unclear or uncertain' (Davies et al., 2021, p. 7; Fähnrich, 2021).

As a variety of actors now undertake science communication activities that were once the domain of others (Koivumäki & Wilkinson, 2020) and/or are taking different approaches to communicating science, including social and digital media, further study of the context of communicators is warranted. This brings us to research question 2 in this study:

RQ2: How do the motivations and deterrents for science communication vary based on a communicator's role?

Materials and methods

An online questionnaire was used to investigate the working practices of 'actors' communicating science, technology and/or health in seven countries – Italy, the Netherlands, Poland, Portugal, Serbia, Sweden and the UK. We use the term 'actors' in the survey to recognise that different countries were likely to have different individuals, organisations and industries, both professional and non-professional, involved in communicating science, as well as science communication fields at differing stages of maturity. The survey was conducted within the framework of the Horizon 2020 funded RETHINK project (RETHINK, 2021) and focused on the seven European countries in which RETHINK project partners were based, in order to utilise their knowledge and networks within their national science communication contexts.

The questionnaire covered different aspects of communicators' activities, including the types of topics communicated and why, the content communicated, communication practices, and finally, the focus of this article, what motivations and barriers actors face when carrying out science communication. Several questions were drawn from previous surveys and studies of scientists, and those who enable science to be communicated, such as press officers, as well as science journalists (NCCPE, 2019; Royal Society, 2006; Wellcome Trust, 2000). Additional questions were also based on a scoping study, which had previously examined the science communication ecosystem in the same seven countries (Milani et al., 2020a; Weitkamp et al., 2021). Questions reported here are provided in the Appendix. A copy of the full questionnaire is provided as supplemental material.

The questionnaire was developed in Qualtrics and pilot-tested between the 28th of August and the 7th of September 2019. Thirty-four professionals representative of the target participants were contacted by the research team to complete the pilot questionnaire. Twenty-two of these respondents completed the questionnaire and after editing to incorporate the pilot feedback, the questionnaire was then translated into the national language of the country in which it was to be distributed. Whilst there were no significant difficulties in translation of the questionnaire, receiving responses from multiple countries added to the complexity of the dataset and it is also possible that some key terminology may have had subtly different interpretations when translated, which we were not able

to identify. The translated questionnaires were uploaded to Qualtrics to collate the responses from the seven countries in the same dataset.

The questionnaire was distributed between the 30th of September and the 1st of November 2019; three mechanisms were used for distribution. Firstly, we distributed the questionnaire through official mailing lists, networks, associations, and societies of journalists, writers, press officers, communication officers, scientists, and public events organisers that communicate science, who were identified and had been contacted in advance in each country. Secondly, snowball sampling was also applied to increase the diversity of participants, with respondents invited to send the questionnaire to other potential participants. Thirdly, individuals who had been identified in the scoping study referred to above and with a public email address were also sent the questionnaire. By distributing the questionnaire in these ways, the diversity of participants increased. However, it also means it was not possible for us to estimate a response rate and we are only able to report on results from the selected European countries. Univariate and bivariate analysis, including Pearson Chi Square, was conducted using excel and SPSS. However, as a consequence of our recruitment method we were not able to make valid comparisons across countries and here we present observations around trends in our data rather than a detailed statistical analysis.

The questionnaire received ethical approval from UWE Bristol (Reference Number HAS.19.05.189). Respondents were provided with General Data Protection Regulation (GDPR) compliant consent and information materials, which met European data privacy and security legal requirements.

Results

Who are the actors?

465 respondents completed the questionnaire in full, comprising respondents from Italy (n = 77), the Netherlands (n = 62), Poland (n = 29), Portugal (n = 87), Serbia (n = 25), Sweden (n = 44) and the UK (n = 122). Although there was a relatively small response in some countries, in discussion with partners it was agreed that this was related to the scale of the science communication field within those locations. In addition, 12 respondents recorded locations outside the target countries, including Belgium, Ireland, Germany, Spain, France, Mexico or Canada, and seven did not provide their location.

59% (n = 272) of the respondents were women, and 40% (n = 182) were men. In all countries except for Poland, more women responded than men. The majority of respondents were aged under 45 years old (84%, n = 289), with Sweden being the only country with a higher proportion of its respondents being over 45 years old (75%, n = 33). Although, we recognise the importance of asking about the ethnicity of respondents, in some countries this was seen to be a culturally problematic question. We therefore made the decision not to include a question on ethnicity.

In relation to the roles of actors, a variety of responses were recorded. This included roles such as press officers or communication officers, freelance communicators or writers, journalists, and/or researchers, as well as more recent additions to the science communication landscape, such as bloggers and social media influencers, activists, illustrators and designers (Table 1).

Examining this by country (Table 1), we see roles distributed throughout. When considering academic roles, Poland, Portugal and Serbia for instance had higher numbers of reported 'Researchers', whilst respondents in Poland, as well as Sweden also frequently reported being 'Lecturers and Professors'. For those based in the media we also see some variations. The Netherlands for example, consistently had high responses to categories including 'Press Officer or Communication Officer' (42%, n = 26), 'Freelance Communicator or Writer' (37%, n = 23) or 'Journalist or Editor' (36%, n = 22) when compared to some other countries, though there is likely to be some overlap between these roles.

Table 1. Respondents' roles by country.

		Italy (n = 77)		Netherlands (n = 62)		Poland (n = 29)		Portugal (n = 87)		Serbia (n = 25)		Sweden (n = 44)		UK (n = 122)		Total (n = 458)	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Academic	Researcher	9	12%	4	6%	9	31%	30	34%	10	40%	10	23%	19	16%	91	20%
	University Lecturer/Professor	4	5%	7	11%	8	28%	13	15%	3	12%	11	25%	16	13%	63	14%
	Teacher	2	3%	3	3%	2	7%	9	10%	1	4%	3	4%	3	2%	22	5%
	Current UG/PG Student	0	0%	1	2%	0	0%	5	6%	3	12%	1	2%	2	2%	13	3%
Media	Journalist/Editor	43	33%	22	36%	9	31%	3	3%	7	28%	8	18%	12	10%	97	21%
	Documentary/Movie Maker	2	3%	3	5%	1	3%	2	2%	1	4%	0	0%	3	2%	12	3%
	Press Officer/Communication Officer	20	26%	26	42%	2	7%	26	30%	3	12%	17	39%	42	34%	143	31%
	Freelance Communicator/Writer	38	49%	23	37%	7	24%	23	26%	3	12%	1	2%	20	16%	118	26%
Practitioner	Curator/Explainer/Museum Employee	8	10%	6	10%	4	14%	14	16%	2	8%	1	2%	7	6%	43	9%
	Blogger/YouTuber/Social Media Influencer	3	4%	4	6%	6	21%	2	2%	2	8%	0	0%	2	2%	20	4%
	Artist/Illustrator	2	3%	0	0%	3	10%	2	2%	1	4%	0	0%	2	2%	13	3%
	Designer	3	4%	2	3%	0	0%	5	6%	1	4%	1	2%	2	2%	14	3%
	Health Professional	1	1%	0	0%	0	0%	1	1%	1	4%	5	11%	0	0%	8	2%
Policy	Policymaker/Adviser	0	0%	7	11%	1	3%	2	2%	2	8%	6	14%	2	2%	20	4%
	Activist	2	3%	1	2%	5	17%	1	1%	4	16%	0	0%	4	3%	19	4%

Notes – Respondents could select up to three roles. Percentages are based on the numbers selecting that role in each individual country. The total response column also includes those who answered the question but provided a location in a different country.

85% (n = 388) of respondents worked for an organisation. Just over half of those based with an organisation (52%, n = 202) worked for universities and research centres, 14% (n = 54) for museums and science centres and 10% (n = 40) for non-profit organisations and charities. Respondents also worked for the media and for publishers (6%, n = 23), in the business sector (5%, n = 19), for professional associations and learned societies (3%, n = 12). A number of freelance communicators or writers (63%, n = 74) also said they work for organisations at times; with universities and research centres being the most commonly cited organisation with which to work.

What are the motivations to communicate?

Respondents were asked to select their three most important motivations to communicate science, as well as offered the opportunity to provide a response that was not listed. Examining responses from all countries, the majority of respondents said they were motivated to communicate about science, health and technology because they are 'enthusiastic about these topics' (68%, n = 311), because it was 'part of their job role' (63%, n = 291), and/or because they are 'keen to educate others about science, technology and/or health' (62%, n = 286) (Table 2). These motivations featured amongst the three most common responses in the Netherlands, Sweden, and the UK. The three most common responses in Portugal and Italy also included 'keen to educate others about science, technology and/or health' (Portugal 61%, n = 53, Italy 64%, n = 49) and 'it is part of my job role' (Portugal 64%, n = 56, Italy 66%, n = 51) but this was coupled with 'because I want to counter misinformation on science, technology and/or health topics' (Portugal 70%, n = 61, Italy 54%, n = 42). In Poland, 'because I want to counter misinformation on science, technology and/or health topics' was the most recorded driver (76%, n = 22) followed by being 'enthusiastic about these topics' (62%, n = 18), and it is 'part of their job role' (62%, n = 18). Finally, in Serbia being 'keen to educate others about science, technology and/or health' (88%, n = 22) was the most recorded response, followed by being 'enthusiastic about these topics' (84%, n = 21) and 'because I want to counter misinformation on science, technology and/or health topics' (44%, n = 11).

32 respondents recorded 'other' as their motivation. The responses listed here included: for social justice, to democratise science, conduct science responsibly, to learn from publics, and to have conversations. There were also comments which alluded to a particular focus, for example 'compelled to share information on topics like climate change that require awareness and action'. Thus, whilst there were some variations in the priorities and combination of selected responses we can see a strikingly common picture of personal enthusiasm, a desire to educate and job role, featuring in the main motivations across all seven countries, coupled with an interest in countering misinformation, recorded as a factor by 52% (n = 241) of respondents and of high priority to actors in Poland and Portugal. However, in considering these trends it should also be acknowledged that the variations in science communicator roles amongst individual countries, and the limitations of our sample, may also have influenced the responses.

Next, we examined the motivations of actors by the types of role they identified themselves as having within science communication. Although respondents were given a number of categories by which they could identify (Table 1), here we have grouped them in order to more clearly identify any patterns in motivations on the basis of the type of role actors' play in science communication (Figure 1).

In relation to those with academic roles, including researchers, PhD students, lecturers and professors, teachers, and undergraduate and postgraduate taught students, there was very little noticeable difference in the key motivations, with all actors indicating enthusiasm for the subject, a desire to educate and counter misinformation as prominent drivers. In addition, with the exception of undergraduate and postgraduate taught students, all academic actors saw communication playing a part in their job role (43-54% identifying this as a motivation) though researchers (including PhD students) tended to more often identify communication as being recognised and valued. There was limited agreement around other personal motivations, such as communication's role in profile

Table 2. Motivations to communicate by country.

Motivations	Italy (n = 77)		Netherlands (n = 62)		Poland (n = 29)		Portugal (n = 87)		Serbia (n = 25)		Sweden (n = 44)		UK (n = 122)		Total (n = 458)	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Because I am enthusiastic about science, technology and/or health topics	41	53%	49	79%	18	62%	52	60%	21	84%	24	54%	95	78%	311	68%
Because I am invited to communicate	5	6%	5	8%	4	14%	12	14%	1	4%	12	27%	22	18%	62	13%
Because I am keen to educate others about science, technology and/or health topics	49	64%	36	58%	17	59%	53	61%	22	88%	26	59%	76	62%	285	62%
Because I want to counter misinformation on science, technology and/or health topics	42	54%	26	42%	22	76%	61	70%	11	44%	17	38%	54	44%	240	52%
Because my communication work is recognised and valued	6	8%	11	18%	5	17%	17	19%	1	4%	6	13%	27	22%	76	16%
It counts towards my career (e.g. professional memberships/promotion)	6	8%	1	2%	5	17%	6	7%	1	4%	4	9%	15	12%	38	8%
It helps my own career	7	9%	8	13%	3	10%	9	10%	2	8%	5	11%	19	16%	55	12%
It is part of my job role	51	66%	41	66%	18	62%	56	64%	9	36%	29	66%	76	62%	290	63%
It raises my profile	1	1%	8	13%	2	7%	3	3%	1	4%	3	7%	12	10%	30	6%
My manager/organization supports it	5	6%	5	8%	2	7%	14	16%	3	12%	8	18%	17	14%	55	12%
None of the above											1	2%			1	1%
The opportunity to win prizes or awards for my communication work	2	3%	1	2%			1	1%					5	4%	9	2%
The opportunity to work with other organisations (e.g. museums, science centres, schools)	16	21%	11	18%	6	21%	24	28%	9	36%	6	14%	37	30%	113	25%
There are financial benefits for me personally	2	3%	11	18%	5	17%	2	2%	1	4%	1	2%	8	7%	31	7%
There are financial benefits for my organisation	6	8%	6	10%	1	3%	2	2%	1	4%	3	7%	9	7%	29	6%
Other	1	1%	8	13%	1	3%	7	8%	2	8%	6	14%	7	6%	32	7%

Notes – Respondents could select up to three motivations.Percentages are based on the numbers selecting that motivation in each individual country. The total response column also includes those who answered the question but provided a location in a different country.

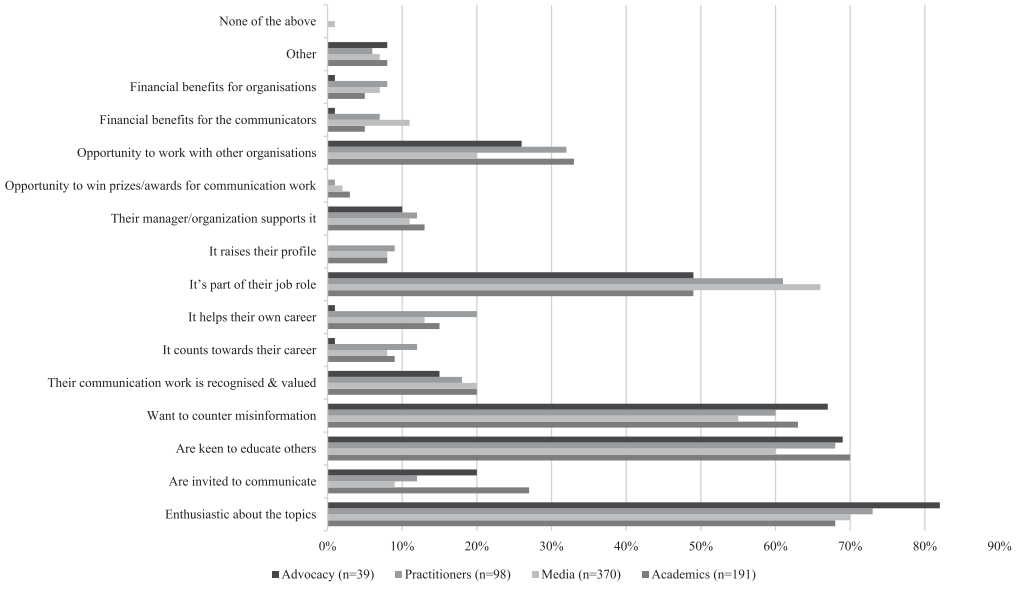

Figure 1. Motivations to communicate by Academic (n = 191), Media (n = 370), Practitioner (n = 98) and Advocacy Actors (n = 49). Note: Respondents could select a maximum of three roles, and a maximum of three motivations. Percentages therefore include actors selecting multiple roles and motivations.

raising, though both researchers (35%, n = 33) and lecturers/professors (35%, n = 22) appeared to be motivated to some degree by opportunities to work with other organisations. Though few undergraduate and postgraduate taught students (n = 13) completed the survey, it was notable that very few students identified financial benefits or counting towards their career amongst motivations but they did identify it as being recognised and valued.

Actors working in the media also recorded similar motivations, with freelance communicators and writers, as well as documentary or movie makers, recording enthusiasm for the subject, a desire to educate and counter misinformation as the most prominent motivations. Press officers and communication officers, journalists or editors were however more likely to record it 'being part of their job role', over the desire to counter misinformation. This might be expected given the nature of their roles. Freelance communicators and writers (17%, n = 20), and journalists or editors (13%, n = 13), were also more likely to record personal financial benefits as a motivation when compared to academics, although this was still only a factor for a small number of media actors.

Although fewer respondents were classified as practitioners, a grouping we used to define those in practice outside of media or policy settings (though we recognise in some countries these groups would also be recognised as practitioners), we nevertheless observe that like other actors, 'I am enthusiastic about science, technology and/or health topics' and 'I am keen to educate others about science, technology and/or health topics', were within the top two motivations across all five practitioner groups. Blogger, YouTuber, social media influencers (85%, n = 17), and health professionals (62%, n = 5) also recorded that they were motivated to counter misinformation. Whilst for curators, explainers or museum employees and designers, communication formed part of their job roles. Artist or illustrators (54%, n = 7) were the only type of actor to record 'because my communication work is recognised and valued' within the three most popular motivations, though this could be skewed by the relatively small number of respondents identifying with these types of role. It is also noted that artists or illustrators and health professionals were among groups (which also included university lecturers and professors) that were more likely to say they were invited to communicate.

Finally, some respondents communicated in policy settings, comprising, policymakers or advisors (n = 20), and activists (n = 19). As with all other actors, enthusiasm and education were important motivators, along with countering misinformation for activists (79%, n = 15). While policymakers or advisors also recognised communication as part of their job role (65%, n = 13).

What deters communication?

The survey also asked respondents about factors that deterred them from communication, once again providing a list of potential reasons to draw on as well as the opportunity to record other responses. In comparison with motivations, there appeared to be a greater range of reasons recorded as important across participating countries (Table 3). Across all seven countries the three most important reasons recorded were 'lack of time' (46%, n = 211), 'lack of resources for science communication work' (29%, n = 134) and 'difficult to get others (e.g. researchers) involved in science communication work' (19%, n = 86). These were also the three reasons recorded most frequently in the UK and therefore the number of responses we received from this country may have influenced the outcome. Nevertheless 'lack of time' featured in the three most popular responses from all countries. 'Lack of resources' also featured for Italy (39%, n = 30), Poland (31%, n = 9), Portugal (38%, n = 33), and Sweden (23%, n = 10). Whilst in Italy (23%, n = 18) and the Netherlands (27%, n = 17), despite rarely featuring amongst motivations, 'lack of financial rewards from science communication' was included as a barrier.

Amongst academic actors, 'time' is once again a key barrier to communication (Figure 2), and for researchers (including PhD students) and lecturers and professors, this was coupled with difficulty in getting others involved, lack of resources and lack of reward and recognition. For teachers, a variety of factors appeared, including insufficient support from communication specialists (18%, n = 4), managers and/or their organisation (18%, n = 4) and other staff at their organisations (18%, n = 4), with lack of opportunities also recorded (18%, n = 4). These were also recorded as reasons by other academic actors but did not feature as prominently. Finally, the small group of undergraduate and postgraduate taught students completing the survey included 'insufficient

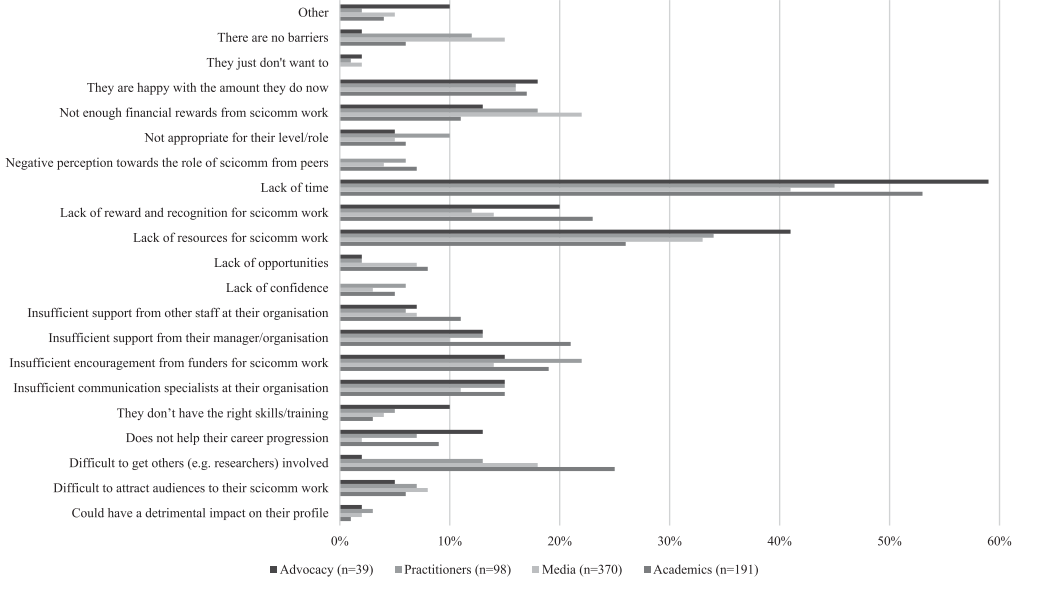

Figure 2. Deterrents to communicate by Academic (n = 191), Media (n = 370), Practitioner (n = 98) and Advocacy Actors (n = 49). Note: Respondents could select a maximum of three roles, and a maximum of three deterrents. Percentages therefore include actors selecting multiple roles and deterrents.

Table 3. Deterrents to communicate by country.

Deterrents	Italy (n = 77)		Netherlands (n = 62)		Poland (n = 29)		Portugal (n = 87)		Serbia (n = 25)		Sweden (n = 44)		UK (n = 122)		Total (n = 458)	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Could have a detrimental impact on my profile (e.g. drawn into controversy)	1	1%	3	5%					1	4%	1	2%	3	2%	9	2%
Difficult to attract audiences to my science communication work	5	6%	4	6%	2	7%	7	8%	5	20%	6	14%	7	6%	39	8%
Difficult to get others (e.g. researchers) involved in science communication work	16	21%	10	16%	6	21%	18	21%	6	24%	3	7%	23	19%	86	19%
Does not help my career progression	3	4%	6	10%	3	10%	2	2%	2	8%			8	7%	24	5%
I don't have the right skills/training	4	5%	3	5%	3	10%	1	1%	4	16%	3	7%	6	5%	24	5%
Insufficient communication specialists at my organisation	11	14%	8	13%	8	28%	11	13%	6	24%	4	9%	9	7%	59	13%
Insufficient encouragement from funders for science communication work	15	19%	2	3%	4	14%	28	32%	3	12%	3	7%	18	15%	74	16%
Insufficient support from my manager/organisation	10	13%	6	10%	10	34%	16	18%	4	16%	5	11%	13	11%	66	14%
Insufficient support from other staff at my organisation	7	9%	1	2%	3	10%	6	7%	7	28%	5	11%	11	9%	41	9%
Lack of confidence	4	5%	1	2%	2	7%	3	3%	2	8%	1	2%	7	6%	21	5%
Lack of opportunities	11	14%	3	5%	1	3%	7	8%	1	4%	3	7%	8	7%	36	8%
Lack of resources for science communication work	30	39%	10	16%	9	31%	33	38%	5	20%	10	23%	33	27%	134	29%
Lack of reward and recognition for science communication work	5	6%	15	24%	4	14%	19	22%	3	12%	6	14%	18	15%	71	15%
Lack of time	34	44%	18	29%	13	45%	36	41%	13	52%	28	64%	63	52%	211	46%
Negative perception towards the role of science communication from my peers	5	6%	1	2%	3	10%	4	5%	4	16%		8	7%	27	6%	
Not appropriate for my level/role	5	6%	4	6%	1	3%	4	5%	2	8%	3	7%	11	9%	30	7%
Not enough financial rewards from science communication work	18	23%	17	27%	5	17%	14	16%	1	4%			17	14%	76	17%
I am happy with the amount I do now	16	20%	12	19%	4	14%	11	13%	3	12%	7	16%	19	16%	74	16%
I just don't want to	0	0.0%	2	3%									1	1%	3	1%
There are no barriers	8	10%	14	23%	2	7%	5	6%			4	10%	19	16%	54	12%
Other	2	3%	8	13%	2	7%	1	1%	1	4%	1	2%	7	6%	22	5%

Notes – Respondents could select up to three deterrents. Percentages are based on the numbers selecting that deterrent in each individual country. The total response column also includes those who answered the question but provided a location in a different country.

encouragement from funders for science communication work' (31%, n = 4) and a lack of financial reward (23%, n = 3) amongst their reasons, suggesting that funders and organisations might be missing opportunities to further incentivise communication activities for this group.

For those based in media roles, lack of time was again a common barrier to communication, alongside lack of resources. 'Difficulty in getting others involved' proved particularly problematic for press and communication officers (29%, n = 41). In contrast to academic roles, those associated with the media commonly reported a lack of financial reward as a deterrent and this was the case for one in four of those working as a 'Freelance communicator or writer' (30%, n = 35), 'Journalist or editor' (26%, n = 25), or 'Documentary or movie maker' (25%, n = 3).

Practitioners reported a variety of deterrents, though time and resources continued to feature. 'Difficulty to get others involved' as well as 'insufficient encouragement from funders' were reported amongst artists or illustrators and designers as challenges, though the numbers completing our survey in these types of roles was relatively small. Features which emerged more strongly amongst practitioners were associated with their broader context, for example 'insufficient communication specialists' at their organisations was flagged by curators, explainers or museum employees (23%, n = 10).

Finally, a wide range of deterrents were reported by those in policy roles, including organisational deterrents (such as support from a manager), lack of resources, reward and recognition, as well as time. For activists, time, reward and encouragement were common deterrents.

Barriers recorded in open comments included those that were personally focussed, for example, the instability or low pay associated to some science communication job roles, that it was something they did alongside their primary income source or that they communicated in the time that was personally available to them and would not be in a position to do more. From a more strategic and organisational perspective, lack of funding for projects and/or training was mentioned, as well as working in institutional contexts where communication was not seen as a core activity and therefore it was challenging to get others involved.

Discussion

This study suggests that personal enthusiasm to communicate about science, technology and/or health, remains a highly motivating factor amongst communicators, combined with a desire to educate. This sits alongside an understandably instrumental factor in that for many of the respondents, the majority of whom (85%) work for organisations, it formed part of their role. Although we are not able to answer RQ1, 'does the country in which a communicator is located relate to their ascribed motivations and deterrents for science, technology and/or health communication?' with statistical certainty due to the limitations of our sample size, we were able to identify some trends. There was little variation in motivations amongst countries, despite expectations that science communication may have differing national contexts (Davies et al., 2021; Ho et al., 2020; Weitkamp et al., 2021), though a desire to counter misinformation was prioritised in Poland, Portugal, Italy and Serbia. These were countries where, with the exception of Italy, we had higher proportions of researchers completing our survey. Though in Italy, fake news, misinformation and anti-science movements have also had heightened prominence over recent years (Lovari, 2020; Moscadelli et al., 2020). These results suggest that despite some differences in the scale and make-up of the communication landscape, across the seven European countries that contributed to this research, the motivations for communication appear largely similar. With over half of actors in all countries citing educational motives, it is also clear that information dissemination and education still play a significant role in the science communication landscape (BBSRC, 2014; Davies, 2021; Dudo & Besley, 2016; Horst, 2013; Royal Society, 2006; TNS BRNB and University of Westminster, 2015; Wellcome Trust, 2000).

Though motivations were often shared across national boundaries, barriers appeared more nationally specific. Time was the main feature shared across actors in all nations, resources and

the ability to involve others, also being commonly shared problems. Again, these are challenges which have been identified in previous work at a national level (Andrews et al., 2005; Besley et al., 2018; Collins et al., 2016; Ho et al., 2020; TNS BRNB and University of Westminster, 2015). However, some national differences were evident, such as the apparent lack of institutional support in Serbia and Poland. Collectively, the deterrents indicate communicators perceive barriers presented by the context in which they work, rather than personal deterrents alone.

It was apparent that many of the incentives to communicate were shared across roles. Amongst academic, media, practitioner and policy roles, enthusiasm for the subject, a desire to educate and counter misinformation were all prominent drivers. For some, the nature of their professional role meant they were invited to communicate. Whilst many of the motivations were comparable amongst actor roles, more differences were apparent in considering deterrents. Time, lack of resources, and lack of reward and recognition were common features, with institutional support, including the difficulty in getting others (e.g. researchers) involved in communication work, also an identified barrier. It may be that researchers in particular have yet to recognise the pressure to communicate which their counterparts in other organisational science communication roles experience (Autzen & Weitkamp, 2020), making them appear reluctant to participate. The lack of recognition amongst students that communication could help profile building, or offer financial benefits, perhaps suggests that funders are overlooking ways that students can be further incentivised to participate in communication, including for skill development (Andrews et al., 2005).

Understandably, for those in certain media based roles, including freelancers, a lack of financial reward also played a more significant role in the reasons why they may not communicate more, and this was a factor reported more frequently in Italy and the Netherlands, where there were higher proportions of respondents identifying with media roles within the sample. Thus, whilst there were some differences, particularly in the variety of deterrents reported for some actors (for example, teachers, artists or illustrators, designers and policy makers) as being most significant, there was a great deal of common ground amongst the challenges actors faced. Barriers associated with attracting audiences were less commonly noted than might be expected, suggesting either an increased appetite for communication of this nature, or a greater understanding of how to reach and identify audiences than may have been the case in previous surveys (TNS BRNB and University of Westminster, 2015; Wellcome Trust, 2000). It is apparent that a complex ecosystem of communicators has evolved and further research may helpfully unpick how some actors' roles may complement and contradict the motivations of different actors as well as influence others (Milani et al., 2019; Schapals et al., 2019; Williams & Gajevic, 2013). This mirrors science communication more broadly, where multiple roles now exist, which are not mutually exclusive and co-exist alongside each other (Davies, 2021; Weitkamp et al., 2021).

There are two major weakness in relation to this analysis of how the country and the role of a communicator influences their ascribed motivations and deterrents for science, technology and/or health communication. Firstly, the limitations of the project meant that we were reduced to a European focus, and though seven countries were included within the survey work, an understanding of the motivations and deterrents of communicators in a wider range of countries, cultures and contexts is warranted (Davies, 2021; Finlay et al., 2021). Although our results report on a number of commonalities they suggest there is much to continue to explore about how national, as well as local organisational contexts, may affect science communication actors (Ho et al., 2020; Massarani et al., 2021) and in particular the barriers to communication they encounter. A more detailed understanding of the situation in each of the seven countries would aid further exploration of this and future data. It is also possible the representation of job roles was influenced by the networks and partners located in some national contexts and we were also limited by the sample sizes in certain countries. Though 9% (n = 43) of our sample were Curators, Explainers or Museum Employee's this was just one group that was likely under-represented. Increasing response rates in future research and considering this issue in approaches to sampling, would heighten the quality and opportunities for analysis of such data. Our work has also highlighted the need for increased

research on a greater range of roles within science communication and engagement contexts, beyond a focus on scientists, researchers and journalists.

Secondly, the majority of options for the questions focussed on motivations and deterrents related to what could be perceived as one-way communication mechanisms, and was also framed by work which has mainly been carried out with scientists, researchers and journalists. Creating dialogue about science and interaction with audiences appears to be a motivating factor shared by relatively few European science communicators, in keeping with its absence in other studies. However, it would have been useful to incorporate more options around the level of engagement aspired to by communicators within the survey. Therefore, though expectations for engagement were expressed in the open comments, the data would benefit from a fuller picture of the role that engagement might play as a motivating factor. In a separate question within the survey, we found that whilst informing and educating were strong drivers, creating 'conversations' between researchers and publics was relevant to the aims of 65% (n = 302) of respondents to that question (Milani et al., 2020a). In future research it would be useful to build more complex questions around relationships between motivating factors and deterrents, and to understand more about the views of actors and the context of some of their responses, for example via additional qualitative research. Therefore, these results should not be viewed in isolation or with an expectation that engagement was not a motivating factor amongst some communicators.

These data suggest that whilst the country in which a communicator is based may subtly relate to their ascribed motivations for science, technology and/or health communication, strong commonalities appear to remain. As we were also able to find actors spanning the majority of roles in each of the countries (albeit sometimes in small numbers) it suggests the time is right to expand understanding of the motivations for science communication beyond scientists, researchers and journalists. Furthermore, the motivations for science communication are also largely shared by a range of actors involved in communication, and these motivations from a theoretical perspective can be viewed as relatively pragmatic, supporting 'a growing body of research … [that] suggests that scientists think about public communication in relatively simplistic ways.' (Dudo et al., 2021). Taken one step further, this research may then suggest there are opportunities for increased learning and sharing of best practice, as well as training opportunities across a multiplicity of science communication actors, given that similar motivations were apparent.

There is more diversity in terms of barriers, both in terms of location and role, amongst actors, though as highlighted the roles identified in particular countries may also have influenced this. Several of the deterrents may indicate a lack of perceived value attached to science communication activities by institutions involved in research.

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