# DEMOS

# BEYOND THE BUBBLE

## THE ONLINE CONVERSATION ON RESEARCH AND DEVELOPMENT

ELLIOT JONES
JOSH SMITH
ELLEN JUDSON
RACHEL HU

DECEMBER 2019

This project is supported by the Wellcome Trust:

# CONTENTS

# ACKNOWLEDGEMENTS

# EXECUTIVE SUMMARY

In this report, we examined how research and development is discussed and communicated about online, surveying a wide range of platforms and taking a deep-dive into the discussion on Twitter. Below is a summary of our main findings from the report, with many of these points coming up time and again across a range of platforms and research areas:

- Different communities, both across and within platforms, will engage with content in different ways. Blanket promotion of the same content across platforms may not an effective way to engage the public. Linking work to the lived experience of each community may see better engagement with research.

- There are already many popular science and research personalities out there who have an existing audience and understand what makes research appealing to them, who translate scientific findings for the general audience.

- People favoured a person-centred framing and related to the idea of exceptional and admirable individuals (e.g. 'living legend', 'you changed the world'). In some cases, they even personified R&D outputs (e.g. offering 'birthday wishes' to the Internet).

- People want to engage with things which are personally relevant to them, or in ways which draw on references they already know: perhaps because of a personal experience they have had, or because it is a salient public issue. People will engage with research by relating them to literature, film, or other pop culture reference points. And people want to have fun in their engagement with content.

- Analogies were frequently used when people were engaging with complex research. Most people online are not familiar with technical language and won't try to decipher it.

- Images are important in framing research in an accessible way, particularly on Twitter where words are limited. Social media users will reuse images present in articles in their own discussions.

- People are invested in developments which are groundbreaking, completely new, cutting-edge, particularly relating to exploration or innovation.

- However, people are also cynical and sceptical about the possible applications of new research and sometimes to motivation behind it. People value clarity and transparency from those carrying out research.

- Social media platforms offer an opportunity to continually engage others long after publication in a journal and a conference slot. Social media content has a short lifetime but can bring back research when relevant long after it is published.

- On Twitter, the majority of research discussion is neutral statements of research findings, with only a third presenting a positive or negative opinion on the research.

- Those discussing R&D very rarely mentioned who funded it, and narratives were more often shaped by researchers and publishing organisations. The ~4000 tweets specifically mentioning funding usually came from within the research community itself.

# INTRODUCTION

The drive to increase human knowledge, and find new ways of thinking about problems, using resources, and understanding society, has always been integral to the UK's success. This is reflected in the appearance of ambitious targets for expenditure on Research and Development (R&D) in Party manifestos, such as reaching 2.4% of GDP by 2027.[1]

If this is to be a success, it is not enough for government to believe it is necessary. Those conducting R&D across all sectors, from the development of new medical devices to novel historical studies, will need to capture the public's imagination, tell effective stories about their work, and inspire support for innovation.

This report aims to support this effort, by looking at the ways in which people engage with and discuss research online, on social media, video platforms, web forums and news sites. This report sets out findings from our quantitative and qualitative analysis of discussions of research and development across Twitter, complemented by qualitative assessments of other platforms, such as Mumsnet, Facebook, and YouTube. We then set-out what best practice we can learn from the discussions we observed.

Discussions of R&D online exist across a broad spectrum, from expressions of positive feelings such as pride, inspiration and amazement, to more negative feelings such as fear, doubt, and mistrust. People relate the stories they are reading about R&D to their own personal experience and speak about them using popular references, e.g. celebrities, superheroes, films, TV and literature.

There is no one-size-fits-all answer to the question of how people discuss R&D online. Not only do discussions change according to the specific content of the research story, but the content, form, and interactivity of discussions vary greatly depending on the structure of the platform.

It is also important to note that this report only covers public discussion. While public discussion of R&D may express certain perspectives, it is possible that private groups and messages may contain differing discussion. However, the public discourse around research and development online will frame and inform any private discussions. Further, the public space is the one in which researchers themselves can intervene and attempt to shape.

Although this short review cannot produce definitive conclusions about the totality of online discussions of R&D, we have aimed here to identify existing features of online discussions and highlight areas for further investigation.

---

1        (Rhodes, 2019)

# CHAPTER 1
# PLATFORM SURVEY

To understand how research and development (R&D) is discussed in the public sphere online, we examined a range of online platforms, with an emphasis on those which enable the sharing and discussion of news, and on which R&D may therefore be shared and discussed. These were Facebook (public posts), Twitter, YouTube, Mumsnet, Buzzfeed, Reddit and Google News (to locate news sites).

For each of these platforms, we list the platform-specific measures (e.g. 'Shares' on Facebook) which were used to get an initial measure of engagement. A selection of pages were extracted from the search results to be examined in more detail for examples of R&D discussions.[2]

The search results examined here were not a representative sample of online discussions about R&D issues. What results were observed will have depended upon the date and time at which searches were carried out, and on the technical platform structures which display, demote or exclude certain results. The high numbers of search results also mean that only a tiny proportion of all results could be examined. Moreover, only English language results were examined. Many relevant results also would not have been found using the general search terms.

Where a quote could be used to identify an individual user, the quote has been modified to preserve the sense but not the exact words used.

# KEY FINDINGS

The platform survey uncovered a number of key findings about the nature of research communication online, which are summarised here and highlighted through the section.

- Different communities, both across and within platforms, will engage with content in different ways. Blanket promotion of the same content across platforms may not be the most effective way to facilitate discussion. People related content to their own personal experience and sought familiarity by speaking about it using popular cultural references from film, TV and literature (e.g. 'Black Mirror', 'Brave New World', 'horror movie'), so linking work to the lived experience of each community may see better engagement with research.

- User content expressed a wide range of emotional connection with research topics. This included pride, inspiration, hope and amazement ('invaluable', 'changing the world'), as well as fear, doubt, and mistrust (e.g. 'unnatural', 'reckless').

- People particularly enjoyed focussing on forward-looking themes, including future applications and the concepts of exploration and innovation.

2    See Methodological Appendix 1 for further details

- People showed a desire to have fun and be playful with their content, with organic and light-hearted content often attracting more reaction. Official pages promoting R&D, or pages promoting R&D on behalf of organisations, are not engaged with as well as 'unofficial' or organic posting, particularly by light-hearted or humorous accounts. Organisations should consider how they can access these channels but they must do so in a transparent way or risk undermining their own and their partners credibility with the public.

- People favoured a person-centred framing and related to the idea of exceptional and admirable individuals (e.g. 'living legend', 'you changed the world'). In some cases, they even personified R&D outputs (e.g. offering 'birthday wishes' to the Internet). Getting individuals to communicate about their research personally, in a way that relates science to popular culture, and to engage with other users on the topic, rather than relying on organisational tweets of the headline of the article, may be more effective in sparking substantive discussion.

# FORUMS

## KEY FINDINGS

- People related content to their own personal experience and sought familiarity by speaking about it using popular cultural references from film, TV and literature (e.g. 'Black Mirror', 'Brave New World', 'horror movie').

- Awareness of how different platforms operate and the kinds of discussion that organisations seek to provoke is important.

- Different communities even within one platform will engage with content in different ways, and so blanket promotion of the same content across channels may not be the most effective way to facilitate discussion.

### Mumsnet

**ENGAGEMENT INDICATORS:** *number of replies to a post*

The topic of R&D discussed often focus on issues specifically relevant to parents, and parents of young children, such as new recommendations on health, breastfeeding, autism research, vaccine research, and schooling research.

The reporting of health issues such as cancer is a subject of regular discussion, with some criticism of it being either too cheerful, too shocking, or advertising which people with personal experience of the illness may find difficult. However, there is an understanding that these issues need to be reported on.

When R&D is discussed as a general area of activity, there was a lot of support for funding and positivity about the economic and general benefits R&D brings to the UK. However, there were noticeable fears expressed about Brexit which could negatively impact R&D and funding streams. There is interest in more R&D for products which could meet the users' specific needs (for instance, better products for people with periods).

However, there are also some areas in which R&D is not so favourably spoken of. This is particularly if animal testing is involved, where companies are seen to be unfairly using R&D as a means to attain tax breaks, and discussions over whether R&D costs are what companies portray them as.

## Reddit

**ENGAGEMENT INDICATORS:** *posts: submission score (upvotes minus downvotes); comments; subreddits; members*

Reddit had by far the most engagement and depth of substantive engagement across the platforms examined. It is worth bearing in mind that this is partly due to the nature of the platform. Reddit is explicitly a community-forum platform intended for discussions to occur (rather than other platforms which are focused more on content-sharing). Those with expertise can also apply to Reddit to be given 'flair' upon verification of their expert credentials, meaning users can identify expert comments vs non-expert comments.

Discussions on futuristic topics, such as advances in artificial intelligence, on subforums like r/futurology, appeal to a sense of these advances being exciting but scary, with frequent references to dystopias, e.g. '1984', 'Brave New World' or 'Black Mirror'. People discuss fears about health and safety in relation to more future-facing topics (using words like 'danger' 'worrisome' 'careful' 'exposure'). However, they are just as likely to express fascination with details and relate their personal experience to discussion topics.

People are supportive of government and philanthropists (again, focusing on individual exceptional personalities) funding research (comments cover the value of the support, and the expected) impact ('invaluable' 'good to see'

'will go a long way') , though this is accompanied by cynicism about motives e.g. corporations or outcomes (including limits of impact, and profit motivating action ('not nearly enough' 'profitable').

People are often engaged with the detail of the science and through e.g. AMAs ('Ask me Anything' interviews, often by those working in a specific field) and discussion panels with experts. Positive support is expressed on Reddit for more information being shared and more data being available. People want more details, and honesty from researchers on the potential of their research ('cannot believe it'll be released so quickly', public domain data is 'a perfect policy).

However, it was also noted in the review that the subreddits which produced many relevant search results, e.g. r/science, r/futurology, r/technology, have varying levels of content moderation rules. On r/science, for example, with 21.5 million members, rules include research being over 6 months old, 'no jokes or memes' 'no off-topic comments' 'no anecdotal comments' and no unsubstantiated fringe comments. Hence it is not possible for this review to establish whether the higher level of scientific discussion is because those who are engaging are self-selecting as scientifically engaged, or whether these discussions initially involved other comments removed by moderators.

# NEWS SITES

## KEY FINDINGS

- It is difficult to infer the impact of news sites from looking at just those sites themselves. Mainstream news sites like the Guardian and the Daily Mail are demonstrably read by millions every day and the way in which they frame research is no doubt important in shaping the narrative around a subject area.

- Their impact may be better understood through observing how they linked to and discussed on more social platforms.

- Additionally, directly engaging with their readers through interviews, focus groups and polling may be more productive than attempting to divine much from the sites themselves (especially without insight into the news sites own analytics).

## Mainstream News

### ENGAGEMENT INDICATORS: *comments*

While researchers found a large number of articles around new R&D published by news outlets, these were not found to be good sources of public reaction to new research. This is due to the fact that many articles hosted on websites (such as CNN, Sky, ITV, the Express, the Guardian) often lacked a comments feature, and stories (e.g. company press releases) were often hosted on specialist sites or magazines rather than in mainstream news.

## Buzzfeed

### ENGAGEMENT INDICATORS: *comments*

Some content on Buzzfeed is published on R&D, by Buzzfeed and by external authors (e.g. Intel). This includes compilations of breakthroughs to stories on discoveries about the natural world, some in-depth pieces, some shorter humourously written pieces. However, although there is a comments feature, the amount of interaction is extremely low, with no comments on many pieces and very few on others.

When there were comments, the content included corrections, questions, appreciation ('cool') but also wariness ('unnatural', 'unnecessary') and contested content e.g. fake cure adverts. Stories about gene editing in China saw negative comments about the ethics and the lack of consideration of possible implications, ('reckless' 'unethical') and comparisons to popular culture, such as horror movies.

# VIDEO SHARING SITES

## KEY FINDINGS

- Content which focuses on the human impact of new R&D, and the personalities involved in bringing it about may be more engaging.

- Communications should aim to reach people where they are. Relating the new research to shared narratives or experiences may be more effective in engaging the public positively.

- User content expressed pride, inspiration, hope and amazement ('invaluable', 'changing the world'), as well as fear, doubt, and mistrust (e.g. 'unnatural', 'reckless').

## YouTube

**ENGAGEMENT INDICATORS:** *Channel subscriptions, video views, video likes, video dislikes.*

There are some limits to searching content on YouTube, such as the prevalence of films, music and products with similar names to the search terms, and also unverified videos labelled under a broad 'research' heading.

A notable example of R&D discussion was in response to the European Commission's video of the first ever image of a black hole, with over 3 million views. Comments on this video focused on themes of pride, of history being made, of amazement and congratulations to those involved, ('born just in time' 'historic moment' 'history being made' 'goosebumps' 'proud' 'insanely amazing') and frequently used references to well-known figures and cultural references such as to Stephen Hawking or to Lord of the Rings.

## CASE STUDY: THE TED YOUTUBE CHANNEL (13 MILLION SUBSCRIBERS)

This channel appeared consistently in search results of the keywords relating to R&D and so was selected for further review.

Reviewing comments on some of the 'most watched' videos relating to R&D (such as new technologies to help people with disabilities and new kinds of drones) on this channel, with between 3.9 and 8.9 million views, revealed the following themes under discussions:

*Cultural references*

- References to superheroes and fantasy or sci-fi (generic and specific) were common ('Black Mirror' 'Iron Man' 'Avengers' 'Thanos')

*Temporality*

- References to history, to the significance of these moments in history, to the greatness of being alive in the present time, and looking forward to the future either optimistically or with some trepidation ('Born in the right generation' 'happy to be alive' 'what a time to live in' 'how far we've come')

*Emotional engagement*

- People spoke of being inspired, amazed, offering congratulations ('unbelievable' 'incredible' 'bravo')

- Related their personal experiences to it (e.g. tech to help people with disabilities) and their hope for the future

- In some cases, of their fear of potential applications, or cynicism ('army' 'destruction' 'death')

- People also spoke of pride, in particular when someone was from their country, they invoked a sense of national pride

*Amazed at people's potential*

- People spoke about their hope in humanity, and the potential of science to help humanity ('changing the world' 'hope again in humanity')

*Focused on exceptional personalities, how people showed genius and intelligence ('genius' 'intelligent' 'inventor' 'legend')*

# SOCIAL MEDIA SITES

## KEY FINDINGS

- Official pages promoting R&D, or pages promoting R&D on behalf of organisations, are not engaged with as well as 'unofficial' or organic posting, particularly by light-hearted or humorous accounts.

- Organisations should consider how they can access these channels, but they must do so in a transparent way or risk undermining their own and their partners' credibility with the public.

- Getting individuals to communicate about their research personally, in a way that relates science to popular culture, and to engage with other users on the topic, rather than relying on organisational tweets of the headline of the article, may be more effective in sparking substantive discussion.

- However, there is a fine line to tread between popularity and being seen to 'dumb down' content.

- People favoured a person-centred framing and related to the idea of exceptional and admirable individuals (e.g. 'living legend', 'you changed the world'). In some cases, they even personified R&D outputs (e.g. offering 'birthday wishes' to the Internet).

- People showed a desire to have fun and be playful with their content, with organic and light-hearted content often attracting more reaction.

- People enjoyed focussing on forward-looking themes, including future applications and the concepts of exploration and innovation.

## Facebook

**ENGAGEMENT INDICATORS:** *for posts: reactions, comments and shares; for pages: likes and followers*

There were limited relevant search results and little engagement with the posts that did surface. Searches returned some pages specifically on specialised topics such as particular health conditions, rather than general discussion.

### CASE STUDY: THE BBC RESEARCH AND DEVELOPMENT PAGE (1,794 LIKES)

This page was selected as a high-profile and reputable organisation running a dedicated R&D news page. Despite this notoriety, engagement on posts was very low (as expected from the low number of likes), with e.g. some comments tagging friends to see the post, but very little substantive discussion. This did not seem to be an anomaly. It was similar across other Facebook pages which promoted R&D topics, such as the Medical Research Council, University of Arts London, Green Energy Innovation and Technology, EU Science and Innovation, and the FinTech Innovation Lab.

## CASE STUDY: SCIENCE MAGAZINE (3,895,951 LIKES)

Posts examined had generally under 1000 reactions, with low numbers of comments (often below 100). Some posts had over a hundred comments, e.g. on pregnant women reaching the limits of human endurance, to which many people replied with positive comments, tagging friends with jokes (presumably) about their own or their friends' pregnancies ('we're running marathons every day' 'get back on the couch'), or offering congratulations and pride. On a video analysing the size of Godzilla over time, there were many jokes or comments about Godzilla, but also some comments that this wasn't relevant for a science page ('this is very relevant research!' 'Godzilla on Science?' 'why is this even on a science page?)

On a post about the Trump administration restricting fetal tissue research, reactions varied between many people expressing regret at the slowing down of research progress ('frustrating' 'regressing' 'dark ages') and their concerns about how the US would fall behind other powers as a result, and some others who welcomed the decision ('I'm all for the ban' '[clapping emojis]').

## CASE STUDY: 'I FUCKING LOVE SCIENCE' (25,366,342 LIKES)

'IFLS' is a public Facebook page which primarily posts images and videos related to breakthroughs in science, including content on historical research and memes on science-related topics, e.g. aversion to vaccines. While this page itself has a high number of likes, individual posts tended to receive relatively low engagement (reactions in the low thousands.)

To put this in context, the Lad Bible page, with over 36 million followers, also publishes many posts with between 1k and 5k reactions, with a few as high as 19k (e.g. when about celebrities, dogs, Harry Potter…). The Game of Thrones' page has around 23 million followers, with many posts gaining around 25k reactions, and the highest at over 200k reactions. Hence, IFLS is doing around as well, or slightly less well, as other popular meme/news pages, but not as well as other popular culture pages.

Comments on R&D posts on this page include:

- Health and Safety Concerns about health/ safety implications of new technologies (e.g. new 5G networks). Language used focused on danger, the potential for abuse, and worries about bodily harm or illness that could result. ('danger', how the 'government' could abuse the tech, 'cancer', 'harm', 'human body' 'brain'). The debate seeks to engage with scientific research and scientific basis for claims, but this sometimes results in pseudoscience being claimed as 'scientific' or people claiming that they have evidence on the basis of limited experience (having been to a lecture or read a report)

- Discussions of neutrality in research, including a criticism of the page itself for engaging in a 'paid partnership' with a tech company (since removed)

- On a discussion about new research into converting CO2 into oxygen billed as new technologies enabling life on Mars, comments divided between those who felt this was good and necessary research, e.g. 'pushing frontiers', an 'adventure', a place to 'explore', and those who felt it was a mistaken priority, as it focused on Mars rather than Earth, saying we should 'take care' of Earth first, we don't 'deserve' Mars travel, we would 'destroy' that planet too.

- On historical research, e.g. a project reconstructing the face of a women from 3,800 years ago, comments focused on the research/ face as 'cool' 'fascinating' 'lovely'.

Other discussions included themes such as: positive comments on kids doing innovative projects in STEM, criticisms, personal experiences on health posts, cultural references on futuristic posts, jokes and spam.

## Twitter

**ENGAGEMENT INDICATORS:** *profiles: followers; posts: likes, retweets, replies*

There is a significant body of relevant content on Twitter. However, searches for e.g. 'new research' turns up a lot of pseudoscience or spam/irrelevant material, and a number of research stories posted get zero measurable engagement on the platform. More technical scientific posts get little engagement, even when from high-profile accounts e.g. National Geographic. Posts generally about R&D and science e.g. a video of a new research vessel, or about new treatments or glaciers, see low levels of engagement or discussion.

These results, however, may not represent the character of discussion about research which occurs within, for instance, the Twitter academic community, as these conversations are harder to find using general search terms. Science personalities have high levels of engagement. For instance, Neil deGrasse Tyson (13.3 million followers, but doesn't tend to tweet about R&D), Brian Cox (2.9 million followers), or Tim Berners-Lee (331.2k followers). Tim Berners-Lee tweeting about the anniversary of the web showed much more positive engagement: as seen on e.g. YouTube, people offering congratulations ('happy birthday' 'thank you') and applauding him as an individual and his relevance to the world ('living legend' 'you changed the world'). The Nobel Prize tweeting about the scientist Gerty Cori saw some congratulatory/praising comments, but in low volume.

We see cynicism towards some personalities. e.g. Ben Goldacre tweeting about a new R&D job opening has commented that it is 'wrong' or accused him of being involved in 'quackery', which leads to disagreement but no evolution in discussion. Similarly, a piece on Mars retweeted by Brian Cox has scientific disagreement, but without a great deal of productive discussion. A retweet by Tim Berners-Lee of a post on data research by Sadiq Khan sees replies saying it is a 'wast[e] of time and money'.

Companies posting about their R&D, e.g. Intel, see mixed engagement, i.e. with scepticism ('power hungry'), some positive engagement ('I wanna work for intel'), comparison with competitors as well as spam/junk content.

R&D organisation pages, such as Google Developers, NASA, CERN, were also reviewed. Google Developers, although with 2.2 million followers, frequently has <10 replies on its tweets.

NASA, which has 31.4 million followers, frequently has under 100 replies on its tweets. A tweet of a selfie by the Mars Curiosity Rover saw replies calling her a 'queen', expressing amazement, calling it surreal, being proud, and looking forward to the future (see also the Curiosity Rover page). A pinned tweet by NASA's about developing infrastructure on the Moon sees much higher engagement with 2.7k replies. They saw other brands such as Amazon Prime and MoonPie engaging and positive replies about what this means for humanity and pride. However, there were also comments that the money would be better spent on cancer research, or that NASA's timing ambitions are 'absurd'.

CERN, with 2.6 million followers, frequently has below 20 replies to tweets. Elon Musk, as a notable personality, is frequently mentioned in replies to tweets on these pages, and Space X, with 8.5 million followers, with replies to tweets often in the hundreds, with frequent positive support ('loving life' 'in musk we trust' 'best of luck').

In some instances, replies tended to follow the lead of the original poster: new research into superconductivity, posted as the second 'biggest breakthrough in India' did not have many replies but picked up on the sentiment of it being novel with some proud ('superb!' 'nobel prize') with others more sceptical ('let's wait' 'what is the significance'). Another tweet on the cost of gene therapy saw replies focusing on the cost, leading to general debate about the cost of drugs.

News about topics which have positive engagement on other forums seem to be less consistently positive on Twitter e.g. discussions of space research, which shows people posing questions/criticisms, calling it 'mysticism' or asking how the research can be done, or giving religious or scientific explanations of the phenomenon. Similarly, a tweet from Harvard University about new cancer research (health topics see much engagement on e.g. Mumsnet) has few replies, sceptical about the applicability of the research, and even claiming that 'your inner conscience is dead'.

**CASE STUDY: SCIENTIFIC AMERICAN -
3.7 MILLION FOLLOWERS**

Research posted varies from new discoveries in physics, to social science, to ecology, to marine biology. Many tweets have 50-70 likes, with some garnering a few hundred.

A tweet about how we cannot maintain friendships with >150 people, illustrated with emojis, garnered 870 likes. Many of the replies focused on how surprised/sceptical people were by how high the number was as they themselves maintained a much lower number. Others felt this was old news.

A tweet about carbon dioxide levels had 621 likes, 510 retweets and 29 replies though many were skeptical of the findings ('junk science')

An article about the science of storytelling in Game of Thrones had 772 likes, 319 retweets and 53 replies, including not overly positive replies, comments like 'does it matter' and 'lol no', though with some affirmations for the article.

However, when the article was tweeted by the author (who has 311.9k followers), the tweet received 4.9k likes, 1.8k retweets and 173 comments, such as 'beautifully written' 'this nails it' with more expansive comments, which were then replied to by the initial tweeter and beginning conversations.

# CHAPTER 2
# DISCUSSIONS OF R&D ON TWITTER

Due to the availability of large-scale programmatically accessible data, we decided to use Twitter to undertake take a deep dive looking at the discussion of R&D on a single platform over the period of several months.

As noted above, different platforms exhibit different cultures and their architectures encourage different kinds of discussion. Further, users of Twitter do not necessarily represent the whole population, being younger and more middle-class than the general population. The analysis should, however, provide insights which could then be tested across other platforms and raise questions for further investigation.

We collected 371287 tweets using R&D-relevant keywords (see Appendix for full list) between the 12th of June and the 14th of October identified as likely originating in the United Kingdom. We used then a natural language classifier to filter out irrelevant content such advertisements, events, marketing etc. This left us with 290449 tweets we believe to relevant discussion of R&D.[3]

Where a quote could be used to identify an individual user, the quote has been modified to preserve the sense but not the exact words used.

# KEY FINDINGS

The deep dive into Twitter uncovered a number of key findings about the nature of research communication on Twitter and implications that may have for wider research communication, which are summarised here and highlighted through the section.

- Only around a third of tweets were classified as opinionated (expressing either positive or negative sentiment), with the majority being neutral. The act of sharing and amplifying research may carry an implicit value judgment, even if the content itself is neutral. The context of who is sharing the research and who they are sharing it to can drastically change the impact of the same content.

- Many pieces of scientific research are discussed in political context and used as a way to endorse an existing view with new research findings. This is true even when specifically looking at funding, where the most common topic was high-level commentary about research funding, often bound up in discussion of politics, including the potential loss of European Union funding and the importance of research for combatting climate change.

- Human connection is an important part of generating engagement with research. People were drawn to causes and high-level concepts (e.g. 'humanity') and sharing in an important moment in history (e.g. 'what a time to be alive', 'how far we've come').

- Analogies were frequently used when people were engaging with complex research.

- Images frame the sharing of research and are often sourced from articles or Google images. Researchers should consider adding their own visuals to ensure visual depictions of their research topic are accurate and providing visuals for those covering their work to improve the framing of their work.

- Specialist publications still have a significant influence on the R&D conversation, although mainstream news sites like the Guardian, NY Times, BBC etc. are a prominent source. Further, there appears to be a willingness to engage with detailed findings from a primary source, i.e. the author of a study, when done in an accessible and engaging format.

- Those discussing R&D very rarely mentioned who funded it, and narratives were more often shaped by researchers and publishing organisations. The ~4k tweets specifically mentioning funding usually came from within the research community itself.

- Tweets questioning the research findings, or the source of funding were very rare.

# OPINIONATED TWEETS

**KEY FINDINGS**

- Only around a third of tweets were classified as opinionated (expressing either positive or negative sentiment), with the majority being neutral.

- The act of sharing and amplifying research may carry an implicit value judgment, even if the content itself is neutral. The context of who is sharing the research and who they are sharing it to can drastically change the impact of the same content.

We then examined whether the relevant tweets were opinionated versus neutral, i.e. did users make some value judgement about the research or its findings, whether positive or negative, or was the discussion mostly reporting of the facts themselves.

Opinionated tweets cover the whole range of feelings and topics, but are typified by expressing some view or personal feeling in relation to the research. Examples of opinionated tweets include:

*Brilliant new research which shows how much carbon can be sequestered through reforestation around the world. I suggest everyone who has no job or a #bullshitjob should have the opportunity to change to tree planting until we hit the whole 1.2 trillion.*

*Heart-breaking & cruel: "#China is deliberately separating Muslim children from their families, language and faith in the far western region of #Xinjiang, according to new research."*

**TABLE 1.**

OPINIONATED TWEET
CLASSIFICATION BREAKDOWN

| Classification | Number of Tweets | Percentage of Total Tweets |
|---|---|---|
| Opinionated | 96,933 | 33.4% |
| Neutral | 193,516 | 66.6% |
| Total | 290,449 | 100% |

A significant majority of the tweets we found were neutral. It may be that with the limited number of characters Twitter allows in a single tweet, users focus on reporting and sharing headline statistics as their sentiment to it can be inferred from wider context. For example, there may still be an implicit value judgment from the act of sharing research in the first place and thus amplifying it and users may make assumptions about how their followers would view that research.

It also highlights difficulties in identifying discussion about research at a high-level, as many expressing particularly emotional reactions may not mention research at all in their tweets and its connection can only be inferred through the media present in the tweet, e.g. photos of infographics, or links to outside sources.

However, understanding this requires a more in-depth look at the reactions to particular studies and qualitative analysis of individual accounts. We have therefore conducted a series of case studies on different topics and at different levels of focus, from a single study to a whole field, which allow us to understand discussion of research in greater depth. These case studies are summarised later in the section.

Some discussion of research is not linked to a particular study or finding but addresses the field in a more abstract manner, e.g. research funding. We explore this further later in the section.

# ENGAGEMENT

**KEY FINDINGS**

- Many pieces of scientific research are discussed in political context and used as a way to endorse an existing view with new research findings. This gets a significant amount of traction compared to other presentations of findings. much of the most retweeted and liked tweets engaged with research in a wider social and political context.

- People were drawn to causes and high-level concepts (e.g. 'humanity') and sharing in an important moment in history (e.g. 'what a time to be alive', 'how far we've come').

Retweets and likes as well as clicking on the links or media shared are the main forms of interaction between Twitter users and helping them engage with ideas. Retweets and likes might serve to endorse an idea, but not exclusively.

Several studies define retweets and likes as the main ways to measure engagement in Twitter. Therefore, this report considers retweets and likes as 'engagement indicators' and examines the top ten most retweeted and liked tweets as a case study to understand the context "research" is discussed in Twitter. Engagement metrics don't necessarily indicate positive or negative feelings but they are a good proxy for what gets people's attention.

## Most liked and retweeted content

The contexts in which "research" is presented are quite different: five of the most retweeted tweets are on scientific research such as biology, three of them are about international politics like Iran and nuclear research, one tweet is about finance and the last one is about fundraising for a patient. Although tweets referring to scientific research find a greater place in the top ten table, these categories are not concrete and mutually exclusive.

Many pieces of scientific research are discussed in political context and used as a way to endorse an existing view of new research findings. The most retweeted tweet, for instance, shares an article published on Vox.com about the possible positive outcome of Medicaid under the Affordable Care Act if it is implemented in every state in the US. This tweet is sent from the former President of the US Barack Obama's official Twitter account and is retweeted 13,859 times.

Most tweets either announce the release of research or commemorate a scientific development. These tweets often discuss scientific discoveries share research findings on social phenomenon. For example, the following tweet discussing research findings on the hike in prices to explain the decrease in the support for Brexit, a highly salient political event at the time of tweeting and with findings that directly relate to the individual's life:

*This is why support for Brexit has collapsed.*

*Brexit-related price hikes see UK families spend billions more on everyday goods, new research finds | The Independent https://t.co/Llhc4yNbjo*

Similar to retweets, the most liked content related research is mixed and there is no one significant category emerging from the table. Four of the most liked tweets discuss scientific research, three of them are about political developments and the remaining three present research on other matters.

The most liked tweet is about the Mission Chandrayaan-2 and congratulates the Indian Space Research Organisation's (ISRO) attempt to continue lunar exploration despite the failed attempt. Although this tweet does not refer to a discovery, it still commemorates a significant moment in which research played a major role and centres the importance of research in going forward.

*This is not tantamount to failure. In Research & Development there'll be a learning curve. This is that precious, learning moment. Soon we will be on the moon thanks to #ISRO. The Nation believes and applauds ISRO.*

By examining retweets and likes in our dataset, we aimed to understand how the Twitter users engage with content discussing "research" online. Our findings suggest that there is no single most popular type of research across Twitter. However, much of the most retweeted and liked tweets engaged with research in a wider social and political context.

However, our research is not conclusive and further research is needed to identify why some tweets receive more engagement than others and why people choose over retweets or likes. Greater depth of engagement metrics that only those posting the tweets have access to, such as link clicks, might also shed greater light on what kind of content drives people most towards actually engaging further with research beyond the Twitter platform.

# MEDIA AND LINK SHARING

## KEY FINDINGS

- Human connection is an important part of generating engagement with research. Photos of people provide a clear human connection to topics that feel distant or abstract. Infographics that individuals can relate to their own lives provide a tangible way for individuals to see the importance of research to them. Furthermore, users appear to share links primarily to accessible presentations of topics with direct relevance to their daily lives.

- Media used by users is often drawn from articles or top results of keywords on Google image search. Researchers need to understand what pop culture images their research evokes in communicating findings. Researchers should also see media as another lever to influence the framing of their work in the public sphere.

- Specialist publications still have a significant influence on the R&D conversation, although mainstream news sites like the Guardian, NY Times, BBC etc. are a prominent source.

- Open-access journals appear to be linked more often than traditional publications, possibly because ordinary users can actually read the content linked.

- The Conversation, a site which allows researchers and academics to write about their own findings in a non-journal format, proved very popular. There appears to be a willingness to engage with detailed findings from a primary source when done in an accessible and engaging format.

## The use of media

Images are used to excite feelings regarding the tweets sent or make a more vivid portrayal of the event celebrated. A minority of tweets in our dataset contains a media content, with less than 10% of all tweets having a photo, video or gif attached.

Photos are the most common type of media used in our dataset. The majority of media attached to tweets, 8.21%, contain at least one. Less than one percent of tweets with media contains videos or gifs.

In order to understand how media is used to create engagement, we analysed top ten most retweeted and liked tweets with media. Many tweets in the case study include photos from the research, a significant moment in the research or shared the infographics of research outcomes.

### TABLE 2.

BREAKDOWN OF MEDIA USED IN TWEETS BY TYPE

| Types of Tweets | Number of Tweets | Percentage of Total Tweets |
|---|---|---|
| All | 290,449 | 100% |
| Tweets with media | 23,832 | 8.21% |
| Media tweets with gifs | 355 | 0.47% |
| Media tweets with photos | 22,126 | 7.26% |
| Media tweets with videos | 1,351 | 0.47% |

The most retweeted and liked tweets with media are the same which is retweeted 890 times and liked 4,271 times. The tweet contains the following text and the photo:



🐦 *111 years ago, what was likely a meteor exploded over Siberia, flattening 500,000 acres of forest. The event sent shockwaves around the world, but new research indicates that asteroid impacts may be less frequent than previously thought: https://t.co/O3o4wRzwbu #AsteroidDay*

Many tweets with media have photos of meetings or gatherings attached to them, as seen from the examples below:



🐦 *On the sidelines of #G20 Health and Finance Ministers' meet today, I interacted with Japanese officials at Suita Hospital in #Osaka on the latest research and development in medicine like new centrifugal blood pump and portable heart-lung machine. @PMOIndia @MoHFW_INDIA*

Another common way of sharing media is attaching visuals of research findings themselves:



**The cost of renting in the capital**

This map shows the average monthly rental cost of each London borough as a percentage of the average monthly salary.

Camden 59% · Haringey 67% · Hackney 83% · Islington 58% · Barking & Dagenham 65% · Enfield 64% · Harrow 59% · Barnet 63% · Waltham Forest 62% · Redbridge 56% · Havering 53% · Hillingdon 62% · Brent 77% · Newham 75% · Tower Hamlets 61% · Ealing 62% · Westminster 60% · Hounslow 60% · Southwark 70% · Greenwich 52% · Bexley 46% · Hammersmith and Fulham 61% · Lewisham 56% · Wandsworth 53% · Merton 55% · Richmond upon Thames 57% · Bromley 46% · Kingston upon Thames 51% · Sutton 51% · Croydon 50% · Lambeth 62%

- Research by Howsy.
- Kensington and Chelsea was excluded due to a lack of current salary data.
- Source: Gov.uk and ONS.

*Look at Hackney!*

One thing that stands out again is that human connection seems an important part of generating engagement with research discussion using media. Photos of people provide a clear human connection to topics that might otherwise feel distant or abstract. Secondly, infographics that individuals can relate to their own lives, e.g. the Hackney example above, provide a tangible way for individuals to see the importance of research to them.

Another noticeable trend in the sample of media tweets we looked at is that often the photos used are drawn from articles or top results of keywords on Google image search. Some of this is organisational accounts reusing content from their articles but equally many members of the public default to using images most easily available to visualise their discussion.

This points to the importance of researchers understanding what pop culture images their research might be associated with in communication of the findings, e.g. discussions of artificial intelligence being conflated with the Terminator. Further, consideration should be given to including and thinking more deeply about images in press releases about research. This could give researchers another lever to influence the framing of their work in the wider online discussion.

## The use of links

Approximately 30% of all tweets we collected shared a link to a website and we looked at the top 10 most shared links across the dataset. Three of the links direct the audience to research about health, two of them refer to research about space, two of them to research cited in news websites and the rest share links to other research.

The most shared link is an article outlining findings of research conducted by the University of Nottingham on the impact of coffee in improving overall health and longevity whilst fighting obesity. The article is written in a non-academic tone, but nonetheless provides background on medical implications of coffee consumption on the body. Again, users appear most attracted to accessible presentations of topics with direct relevance to many people's daily lives.

The report also looked at the top 20 most shared websites. Links to specialist publications appear to be significant part of conversation, although mainstream news sites like the Guardian, NY Times, BBC etc. are still a prominent source.

Frontiers Media, a controversial open access journal publisher, does surprisingly well, particularly as none of their links appear in the top ten individual links. A lot of this appears to result from aggressive self-promotion through their own channels but that content does seem to get reasonable engagement - hundreds have shared their content at least once.

In comparison, traditional publishers don't seem to be linked to nearly as often with none breaking the top 20. We speculate that open-access nature of the journals may lead to them being linked more often as readers of the tweets can them actually click through and read the content. However, The Conversation, a site which is accessible to the general public and which allows researchers and academics to write about their own findings, also proved very popular, demonstrating the willingness of people to engage with detailed presentations of findings from a primary source when done in an accessible and engaging format.

# RESEARCH FUNDING ON TWITTER

## KEY FINDINGS

- The most common topic of funding discussion was high-level commentary about research funding, often bound up in discussion of politics, including the potential loss of European Union funding and the importance of research for combatting climate change.

- There was little questioning who was funding a piece of research. Criticism was mainly directed at corporates, e.g. pharmaceutical companies not reinvesting into R&D. However, this was not a prominent part of the data.

- Those discussing R&D very rarely mentioned who funded it, and narratives were more often shaped by researchers and publishing organisations. The ~4k tweets specifically mentioning funding usually came from within the research community itself.

We separated out discussion of funding in research from the wider conversation using a broad selection of funding-related keywords. From the 290449 tweets we believed to be relevant discussion of R&D, we found 3762 number of tweets we believe to be specifically related to discussions of research funding.[4]

We took a sample of 155 tweets from the funding-related dataset and manually coded them by topic, to get a more fine-grained understanding of what people talk about when they mention research funding. The most common topic was high-level commentary about research funding, often bound up in discussion of politics. Within this, the two most significant areas of discussion were on the potential loss of European Union funding due to Brexit and those emphasising the importance of research funding being directed towards combatting climate change and clean energy. Below are a couple of examples of these sentiments:

---

4    See Methodological Appendix 2 for more details

🐦 @[user] @[user] & much more besides, EU social fund, the protection of human rights, accessibility of life-preserving medicine, free movement to study or travel, , funding for research and development and on and on

🐦 @[user]What I think should be done, as a lay-person, is funding increased for research and development of alternative energies, including the re-education of people in affected industries, and wean off fossil fuels, by 2035 hopefully, but by 2050 more realistically.

There was also a noticeable number of tweets discussing research on funding in other areas, rather than research itself. Besides these two categories, a majority of the discussion appears to be either funders announcing funding or research they had funded; those receiving funding talking about receiving it; and occasionally researchers bemoaning the lack of funding available. This seems to underline the fact that discussion of research funding, at least on Twitter, is a rather insular discussion within the research community itself, except when funding is linked to topics the Twitter public feels a connection to.

We found very little in terms of questioning who was funding a particular piece of research, in the vein of e.g. Who Funds You, which public policy research institutes sometimes face. However, it is unclear whether this reflects existing transparency by and within the research community, an implicit trust of research from academia, or a lack of concern on behalf of the Twitter public. Where criticism did occur, it was directed at corporates, e.g. of pharmaceutical companies for taking large profits rather than reinvesting funding in R&D, particularly in relation to taking state research funding. However, this was not a prominent part of the data. You can see a sample of the negative reactions to pharmaceuticals below:

🐦 @[user] @[user] EU and the state already provide funding for research and development. We fund it, and then big pharma profits from it. That's going to stop.

🐦 Do not fix the corrupt system, just take our money and pay for it indirectly. The hospitals and pharmacies are criminals. If they're taking government funding & grants for the research and development of drugs then the government should have a say in what the prices are.

We also looked for mentions of notable non-commercial British research funding bodies in the relevant discussion of R&D more broadly. It was generally hard to find mentions of individual funders outside of this e.g. Wellcome was only explicitly mentioned 30 times in whole dataset.

The mentions of funders seemed to be primarily by themselves or researchers who were in receipt of their funding. Those discussing research more generally very rarely mention or engage with those who funded the research rather than the authors or publishing organisation.

The notable exception to this is Cancer Research UK, who during the collection period drew fire for their campaigning activity based on their funded research, which we explore in greater depth below as part of a case study on cancer research.

## TABLE 3.

### FREQUENCY OF DISCUSSION TOPIC IN SAMPLE

| Topic | Frequency |
|---|---|
| Commentary about research funding | 34 |
| Celebrating receiving funding | 26 |
| Reseach on other funding | 25 |
| Funding for research available | 25 |
| News about research | 14 |
| Announcing research | 9 |
| Awarding funding | 8 |
| Reseach on research funding | 6 |
| Fundraising | 4 |
| Lacking funding | 3 |
| Information for funding applications | 1 |
| Total | 155 |

# SUMMARY OF CASE STUDIES

**KEY FINDINGS**

- Analogies were frequently used when people were engaging with complex research.

- Across all studies, tweets questioning the research findings were very rare.

- Images frame the sharing of research and are often sourced from articles or Google images. Researchers should consider adding their own visuals to ensure visual depictions of their research topic are accurate and providing visuals for those covering their work to improve the framing of their work.

Due to the diversity of research topics discussed across social media and the heterogeneity in the ways which they were discussed, we also conducted three case studies of the digital reception of different types of research. These findings from these case studies are summarised here.

The case studies investigated research discussion on cancer, microplastics and 'superflares', a type of massive explosion from stars. For each of these topics, tweets were collected over a period of over a month. This yielded 69951 tweets mentioning terms relevant to cancer research, 126993 tweets mentioning terms relevant to microplastics and 1068 tweets mentioning superflares. Using natural language processing, the tweets were categorised in those expressing a positive, negative or neutral sentiment. In addition, a qualitative analysis of popular tweets sought to identify patterns in engagement.

The case study about cancer highlighted the diverse ways in which social media users engage with research. Most tweets were positive (41%) or neutral (59%) with negative tweets only a small subset. Many positive tweets about cancer research concerned fundraising efforts, which received significant online attention especially when a celebrity was involved. Others were neutral, copying news items about new treatments, although these types of tweets were generally less popular. There was also a body of negative tweets related to Cancer Research UK, which at the time of data collection was running a

campaign warning the public about the cancer risks associated with obesity. Twitter users discussed whether this campaign constituted fat-shaming.

Generally, the public engaged thoughtfully with discussions on cancer research, and took an interest in research, especially in the context of a campaign, a fundraising effort or a political news story.

Where tweets about cancer research were often positive, responses to microplastics studies are mostly neutral, simply quoting the results, or negative, expressing outrage at the levels of pollution identified in these studies. Negative tweets very often use words like 'risk' and 'crisis' to describe plastic pollution. Sarcasm features in another group of negative reactions, sarcastically describing plastic ingestion as a 'delicious meal'. Sarcasm also appeared in response to the superflares study, with people tweeting a link to the research along with statements such as 'In case you needed something else to worry about at night'. Across all studies, tweets questioning the research findings were very rare.

The case studies have several implications for researchers who might look to promote their findings on social media. The study about the likelihood of 'superflares' shows that research can have a longer shelf life online. This particular piece of research examined whether superflares can occur from slowly rotating sun-like stars and points to the possibility of the Earth experiencing such a potentially devastating

superflare from the sun. The study received most attention when it was first published, but met with renewed interest several weeks later, as it was reshared by several Twitter accounts.

The microplastics case study demonstrates the power of analogies and plain language. The most-shared tweet about microplastics translated a research finding, that people may ingest as many as 5 grams of plastics per week, according to a study by the World Wide Fund for Nature, into a relatable visualisation, equating it to eating a credit card worth of plastic every week. The WWF explicitly made this analogy in publicising its study, which was widely shared by Twitter users. One popular tweet including this analogy and a very strong reaction to it is below:

> *just read that the average person ingests approx. 5 grams of plastic every week through the air and water (bottled AND tap). that's the equivalent in plastic of EATING AN ENTIRE CREDIT CARD every week. we're actually fucked (4596 likes and 6712 retweets)*

Although using analogies and accessible language can help research find a wider audience on social media, there is also an argument for discussing scientific results in a matter-of-fact way. Scientific authority in both the source and content of the tweets was an important factor in determining the attention a tweet received. The top two most liked and retweeted tweets about the superflares study were both published by Science News:

> *By comparing the frequency of superflares with star age, the scientists predict that the approximately 4.6-billion-year-old sun may experience a superflare 100 times as strong as usual flares in the next 1000 years' (194 likes, 65 retweets)*

> *A superflare 100 times as strong as usual flares would likely be very damaging to society on Earth. https://t.co/sKKQVsxfZd. (114 likes, 46 retweets)*

@ScienceNews was more popular than other scientific accounts. This account neutrally described the research findings in scientific terms with some details on how the results were obtained.

Across the case studies, only a minority of users included media or links in their tweets about research. Users sometimes added static images, for instance to visualise a superflare, or gifs to express an emotion or a reaction. These images were often directly sourced from the articles describing the study. Researchers may want to consider adding their own visuals to their tweets to ensure visual depictions of their research topic are accurate. They may also want to provide visuals for press outlets covering their work to gain greater control over the framing of their work.

# CONCLUSION

So, what can we take away from this survey of different platforms and deep dive into discussion on Twitter?

There is clearly great potential for the internet to allow researchers to reach a much wider range of audiences, directly connecting with the public. It also offers an opportunity to take back control of the narratives around their field of research and create a more informed public debate.

At the moment, often when research is shared on platforms like Twitter, findings are simply stated and yet opinionated and personal content appear to be that which gets the most engagement, especially from those outside the research bubble. Further, some areas of research discussions still appear quite insular. Those discussing R&D very rarely mentioned who funded it, and narratives were more often shaped by researchers and publishing organisations. The ~4000 tweets specifically mentioning funding usually came from within the research community itself.

So, we have ten key points we think those using digital channels to communicate about research can take away from this report:

1. **Know your audience: Different platforms have different ways of operating, audiences and goals. If you want detailed scientific engagement with research, a Reddit AMA or discussion panel may be more useful than a post on a public Facebook page. If, however, you want to reach audiences which may not generally be engaging with scientific developments broadly, YouTube or Mumsnet may be a better platform.**

2. **Make partnerships with existing influencers: There are already many popular science and research personalities out there who have an** existing audience and understand what makes research appealing to them. Start by partnering with them rather than rushing into spending a lot on developing your own platform. That can come later if things go well. But be transparent with audiences about your partnership. People don't want to feel like they've been manipulated, or that the presentation of the research has been secretly influenced.

3. **Focus on people: People are engaged with exceptional personalities who display admirable qualities. People are engaged with large-scale concepts like 'humanity' and 'history'. People are engaged with ideas about time. How research would have changed the past, how it could impact the future and the significance of the present moment. People are proud of exceptional R&D and the people behind it.**

4. **Make it relevant and fun: People want to engage with things which are personally relevant to them, or in ways which draw on references they already know: perhaps because of a personal experience they have had, or because it is a salient public issue. Particularly when discussing tech developments, people will engage with them by relating them to literature, film, or other pop culture reference points. And people want to have fun in their engagement with content.**

5. **Don't forget about the power of analogies and plain languages: Most people online will not be familiar**

27

with technical language and will not take the time to decipher it. Instead, speak to people in a way they already understand, drawing on real-life examples they can relate to.

6. **Be visual when you can:** Provide images when communicating about work to help frame research in an accessible way. This is true when communicating the research directly through social media channels or when communicating with the press, as journalists will often use images provided to them and social media users will use images present in articles.

7. **Highlight the future applications:** People are invested in developments which are groundbreaking, completely new, cutting-edge, particularly relating to exploration or innovation.

8. **Mitigate scepticism through integrity:** People are also cynical and sceptical about the possible applications of new research and sometimes to motivation behind it. People value clarity and transparency from those carrying out research.

9. **Be specific:** Looking for general terms results in coming across a lot of noisy, contested and even totally irrelevant content. When looking for people's reactions to a story, or trying to engage people with new content, being specific in determining the locations and the terms which engage the audience you want is crucial.

10. **Extend the shelf-life:** Social media platforms offer an opportunity to continually engage others long after publication in a journal and a conference slot. Don't be afraid to repost old work if it is relevant to current narratives being discussed on a platform or reframe findings to make them relevant again. Social media content has a short lifetime, so don't be afraid to repeat your messages.

These are only the start of successful research communications in the internet age. An important thread through our research is the importance of adaption and making content tailored to the field and the audience.

Individual researchers and research institutions need to take ownership of ensuring that their voices are heard, and their work reaches the wider public in an accessible way.

# APPENDIX 1
## QUALITATIVE PLATFORM CASE STUDIES

We examined a range of online platforms, with an emphasis on those which enable the sharing and discussion of news, and on which R&D may therefore be shared and discussed. These were Facebook (public posts), Twitter, YouTube, Mumsnet, Instagram, Buzzfeed, Reddit and Google News (to locate news sites). Each of these platforms offers users a different way to interact with content, and therefore has a different definition of what constitutes engagement (e.g. 'Shares' on Facebook vs 'Upvotes' on Reddit). These platform-specific engagement measures are listed in the analysis above for each platform, and were used to get an initial measure of engagement.

Initial scoping searched for documents containing one of the following keywords:

- breakthrough
- new discovery
- new research
- research
- R&D
- innovation
- science

These generic terms yielded some discussion of R&D, which is included in the analysis above. However, it was notable that the relevant search results were limited. Search results included entirely irrelevant content, as users of platforms used terms in contested ways. For instance, 'breakthrough' turned up discussion on personal breakthroughs or breakthrough bleeding, 'discovery' was used

in reference to the Land Rover Discovery or to discoveries people had made themselves. 'Research' produced research job adverts and non-scientific research pages or claims, or very specialised/technical results, or results with very low engagement, and the term 'science' on Mumsnet produces many discussions about science GCSE's, or home science experiments on YouTube. This may be an attempt to increase the audience - many posts contain the term or tag 'science' without relevant scientific content.

As this section consisted entirely of qualitative analysis, it was left the researcher's subjective judgment to determine what counted as relevant. The researcher confirmed with the wider research team in cases where relevancy was ambiguous.

When considering the wording of communications regarding R&D, it is worth considering what alternative uses of this word are common amongst target audiences and how that may affect audience reach.

'New scientific discoveries which went viral' and 'celebrities tweeting about science' were used to find more examples of popular discussions, and recommendations from platforms (e.g. Twitter's 'Who to follow' tool) were followed.

A selection of pages were extracted from the search results to be examined in more detail for examples of R&D discussions. These were analysed and include:

- The TED channel on YouTube
    - https://www.youtube.com/user/
    TEDtalksDirector/

- BBC Research and Development's Facebook page
  - https://www.facebook.com/BBCResearchAndDevelopment/

- The Reddit subforums 'r/science', 'r/futurology' and 'r/research'
  - https://www.reddit.com/r/science/
  - https://www.reddit.com/r/futurology
  - https://www.reddit.com/r/research/.

## Limitations

The search results examined here were an extensive but not representative sample of online discussions about R&D issues. Results observed depend necessarily upon the date and time at which searches were carried out, and on the technical platform structures which display, demote or exclude certain results. The high number of search results returned also mean that only a small proportion of all results could be examined, and relevant pages which did not use these generic terms will not have been picked up through these methods. Moreover, only English language results were examined.

# APPENDIX 2
## TWITTER IN-DEPTH

In order to understand how research and development is discussed on Twitter, we collected tweets mentioning R&D-related keywords between June 2019 and October 2019. We then used natural language classification to create a subset of tweets containing discussion actually relevant to R&D. This subset was then analysed in several ways.

1. Using further natural language classification to determine what percentage of those tweets expressed an opinion

2. A qualitative analysis of engagement, media usage and links to external websites by users.

3. Using keyword annotation and qualitative analysis to look at discussion of research funding. This also included using keyword annotation to look at the mentions and discussion of specific British funding bodies.

A diagram showing the annotation and classification process to generate the datasets used in this report is shown in Figure 1 on the following page.

### Collection

In order to understand how research and development is discussed on Twitter, the platform's streaming API was used to collect 371287 tweets between the 12th of June and the 14th of October using one of the R&D-related keywords in Table 4.

These tweets were collected using Method52, a suite of tools for collecting and analysing large free-text datasets developed by Demos in partnership with the University of Sussex. Tweets using these keywords included marketing material, advertisements, events and other content irrelevant to the kinds of research discussion this report was interested in.

### TABLE 4.

R&D KEYWORDS

| research and development | research and technological development |
|---|---|
| scientific discovery | scientific breakthrough |
| new treatment | groundbreaking science |
| groundbreaking research | new research |
| research breakthrough | new innovation |
| breakthrough innovation | |

**FIGURE 1.**

TWITTER
PROCESSING
PIPELINE
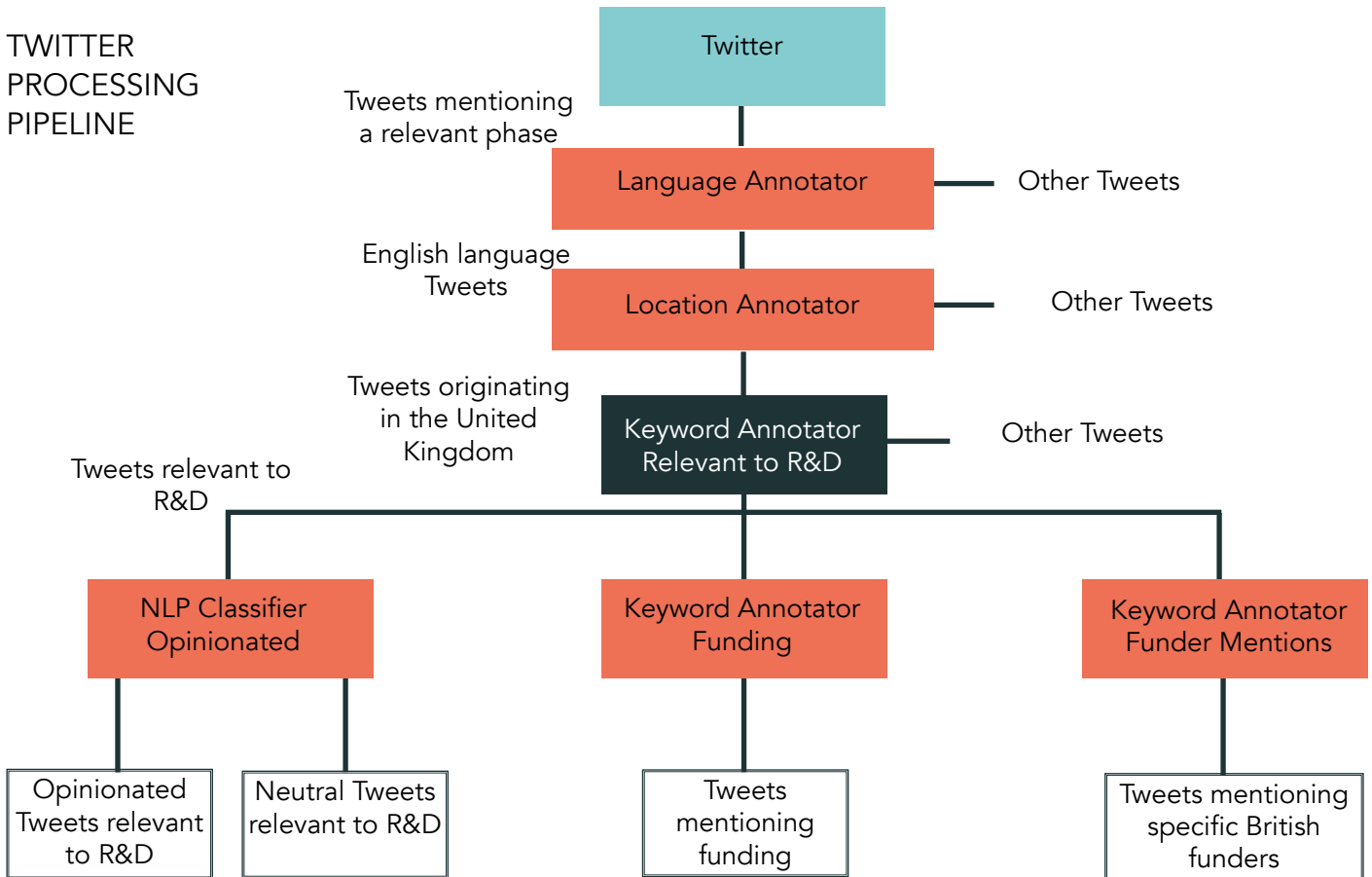


## Relevancy Classification

To filter this noisy dataset down, analysts trained a Natural Language Processing (NLP) algorithm to identify tweets relevant to R&D. These classifiers were trained using Method52, which allows analysts to train NLP algorithms to make decisions about pieces of text, in this case, whether or not a given tweet is relevant to R&D, within large, free-text datasets.

This process involves manually labelling a random sample of documents. By recording the terms occurring within each category, a classifier 'learns' how to sort Tweets, and can provide feedback on its performance to the analyst. Once a satisfactory performance has been obtained, the classifier can then apply rules developed for sorting to the entire dataset, allowing complex decisions to be made across the totality of datasets too large for manual analysis. Classification of natural language is an inherently probabilistic process, and no classifier of this type will be 100% accurate. Where a satisfactory level of accuracy cannot be reached, classifiers were retrained or discarded entirely. The end of this section contains a description of the classification process in greater depth for those interested.

The first classifier built for this report was trained primarily to remove tweets from not directly related to R&D discussion. Tweets classified as relevant to R&D included the following categories:

- Mentions of scientific papers

- Studies of applications of technology

- Mentions of journalistic coverage of R&D

- Discussion of R&D in the abstract, i.e. without mentioning a specific field

- Criticism of research

- Discussion of individual researchers and research organisations in the context of their research

Tweets classified as irrelevant to R&D included the following categories:

- Market research

- Adverts

- Police investigations

- Opinion polling

- Job adverts

- Jokes without reference to actual research

- Event adverts about people rather than research

- Content directly about politics rather than research

Our classifier was tuned to ensure that the dataset of relevant tweets was as accurate as possible. Some tweets proved difficult for the NLP classification to disambiguate at scale between relevant and irrelevant, and so we geared the training towards leaning on the side of caution.

As we aimed to capture discussion around a broad and ongoing topic, rather than a specific event in time and space, we felt it acceptable to aim for a relatively high-precision sample of all relevant tweets rather than attempt to include all relevant tweets over the time-period and risk including a large number of irrelevant datapoints in our analysis.

## TABLE 5.

RELEVANCY CLASSIFIER
ACCURACY

| Classification | Precision | Recall | F-Score |
|---|---|---|---|
| Relevant | 0.744 | 0.817 | 0.779 |
| Irrelevant | 0.409 | 0.310 | 0.353 |
| Overall Accuracy | | | 0.670 |

The maximum score for precision, recall, F-score and accuracy is 1. There is an inherent uncertainty, bias and error in the NLP methods we use and so a score of 1 on any metric would be cause for suspicion. Scores between 0.7 and 0.9 are what we would expect for an acceptable classifier.

## Classification of Opinionated Tweets

The second classifier built for this report was trained primarily to distinguish tweets expressing an opinion about R&D rather than simply reporting findings or stating facts. Tweets classified as opinionated on R&D included the following categories:

- Concern about research, e.g. 'dismayed'

- Excitement, e.g. "research breakthrough!!! Yippeeeee!!"

- Surprise, e.g. "shocking new research claims"

- Reference to a personal connection or personal feeling about the research, e.g. "One of my favourite scientific discovery stories."

Tweets classified as neutral on R&D included the following categories:

- Statement of research findings without commentary

- Links to studies or journalistic articles without further comment, often clearly autogenerated by from the site's share function.

Our classifier was successful at differentiating between neutral and opinionated tweets, partly due to clear linguistic differences between the two kinds of tweets. Opinionated tweets often contained references to the user themselves, e.g. 'I' or 'me', and heavily featured certain kinds of adjectives and exclamations.

## TABLE 6.

OPINIONATED TWEETS
CLASSIFIER ACCURACY

| Classification | Precision | Recall | F-Score |
|---|---|---|---|
| Opinionated | 0.690 | 0.769 | 0.727 |
| Neutral | 0.915 | 0.878 | 0.897 |
| Overall Accuracy | | | 0.850 |

## Engagement, media usage and links to external websites by users.

Using the subset of tweets relevant to R&D, we generated lists of top 10 most retweeted and top 10 most favourited tweets. A researcher then qualitatively analysed the contents of these tweets to understand what about them had driven their high levels of engagement.

## Discussion of research funding and funders

To analyse discussions of research specifically relating to funding of research, we filtered the dataset of tweets classified as relevant using a list of keywords related to research funding (See Table 7).

### TABLE 7.

#### FUNDING-RELATED KEYWORDS

| | | |
|---|---|---|
| funding | grant for research | we funded |
| research grants | research opportunities | haldane principle |
| funds | research opportunity | haldane report |
| seed-funding | awarded | grants for research |
| award grants | grants scheme | research funding |
| awards grants | grant scheme | we fund |
| award grant | grant funding | |

We then analysed the media content of R&D relevant tweets. The dataset was already tagged with the media types present in each tweet from Twitter's metadata. So, we exported the data to Excel and used pivot tables to calculate the proportion of each kind of media across the dataset. We then generated lists of top 10 most retweeted and top 10 most favourited tweets using media and qualitatively analysed these to see how media had been mostly effectively deployed in an engaging way with regard to research.

We further looked at the links that were shared to external websites in the relevant tweets. We generated a list of the top 10 most shared links in the dataset, looked at what article or study each link directed to, and summarised the content we found. We then qualitatively assessed the content of the individual links that were most shared, and focussed on the websites that were most shared, rather than just the individual links. We then used Method52 to extract the domains from each link in the dataset and then generated a list of the top 20 most linked to domains in the dataset. Finally, we summarised what kind of website each of the top 20 domains were and qualitatively assessed the implications of the prominence of individual websites.

We then took a sample of the 155 tweets receiving the most engagement in funding-related dataset and a researcher manually coded these tweets by topic. The researchers did not start out with a predefined list of topics and the list of topics evolved as the researchers reviewed the data, reflecting what the researchers found in the dataset without being overly narrow or overgeneralising. Another researcher then qualitatively analysed the contents of these categories to determine specific findings.

Researchers also manually examined this sample and another random sample from the wider funding-related dataset, looking to establish the nature of the accounts posting the tweets.

To analyse how often funders were mentioned and how they were discussed in the context of research, we filtered the dataset of tweets classified as relevant using a list of names of prominent British funding bodies and common abbreviations, automatically tagging each tweet with the funder or funders it mentioned:

**TABLE 8.**

PROMINENT BRITISH FUNDERS
KEYWORDS

| Economic and Social Research Council | ESRC | Strategic Priorities Fund |
|---|---|---|
| Arts and Humanities Research Council | AHRC | National Institute for Health Research |
| Biotechnology and Biological Sciences Research Council | BBSRC | Research England |
| Engineering and Physical Sciences Research Council | EPSRC | Innovate UK |
| European Research Council | ERC | Wellcome |
| Scottish Funding Council | SFC | Nuffield Foundation |
| Medical Research Council | MRC | Leverhulme Trust |
| National Environment Research Council | NERC | Industrial Strategy Challenge Fund |
| Science and Technology Facilities Council | STFC | The Royal Society |
| UK Research and Innovation | UKRI | The British Academy |
| Global Challenges Research Fund | GCRF | The Roal Academy of Engineering |
| Cancer Research UK | CR_UK | The Academy of Medical Sciences |
| Asociation of Medical Research Charities | AMRC | Newton Fund |

This generated a dataset of 184 tweets mentioning prominent British funding bodies (although some bodies we searched for did not appear at all in the dataset). We then used pivot tables in Excel to calculate the number of mentions for each funder using this filtered dataset.

As the dataset was comparatively small, we decided to qualitatively analyse the whole dataset by hand, which one of the researchers reviewing all the tweets manually using Excel.

## Case Studies

We also performed three case studies that looked at specific areas of research, collecting data from mid June until mid August. One examined a single study on superflares, a second look at a collection of studies on microplastics, and a third looked at cancer treatment and research broadly.

Each of the case studies went through a similar process to that described above, utilising relevant keywords to generate a dataset and using a natural language classifier to filter for relevancy, then examining engagement, media usage and links to

external websites. In this work, however, we were able to code for sentiment - e.g. whether an opinion was positive, negative or neutral – in addition to coding for presence of an opinion. This was possible as the kinds of language used in different kinds of emotion was more distinct in this narrower area of discussion.

We generally did not look at funding and funders specifically in those datasets, in contrast to the general R&D dataset. However, in the case study focusing on cancer treatment and research, Cancer Research UK and their anti-obesity campaign featured prominently. Therefore, this was analysed in greater depth, feeding into the analysis of CRUK in the funding section of this report.

## Natural Language Processing and the NLP Classifier

Building algorithms to categorise and separate tweets formed an important part of the research method for this paper. This responds to a general challenge of social media research: the data that is routinely produced and collected is too large to be manually read.

Natural language processing classifiers provide an analytical window into these kinds of datasets. They are trained by analysts on a given dataset to recognise the linguistic difference between different kinds of data, in this case between tweets. This training is conducted using a technology called 'Method 52', developed by the project team to allow non-technical analysts to train and use classifiers.

Classifiers are built to analyse two kinds of text, (a) the content of the tweet itself, and (b) the profile of the tweeter. Both pieces of information are contained in every tweet produced by Twitter's API. Each classifier was built by using Method 52's web-based user interface to proceed through the following phases:

## PHASE 1: DEFINITION OF CATEGORIES.

The formal criteria explaining how tweets should be annotated is developed. Practically, this means that a small number of categories – between two and five – are defined. These will be the categories that the classifier will try to place each (and every) tweet within. The exact definition of the categories develops throughout the early interaction of the data. These categories are not arrived at a priori, but rather iteratively, informed by the researcher's interaction with the data – the researcher's idea of what comprises a category will often be challenged by the actual data itself, causing a redefinition of that category. This process ensures that the categories reflect the evidence, rather than the preconceptions or expectations of the analyst. This is consistent with a well-known sociological method called 'grounded theory'.

## PHASE 2: CREATION OF A GOLD-STANDARD TEST DATASET

This phase provides a source of truth against which the classifier performance is tested. A number of tweets (usually 100, but more are selected if the dataset is very large) are randomly selected to form a gold standard test set. These are manually coded into the categories defined during Phase 1. The tweets comprising this gold standard are then removed from the main dataset, and are not used to train the classifier.

## PHASE 3: TRAINING

This phase describes the process wherein training data is introduced into the statistical model, called 'mark up'. Through a process called 'active learning', each unlabelled tweet in the dataset is assessed by the classifier for the level of confidence it has that the tweet is in the correct category. The classifier selects

the tweets with the lowest confidence score, and these are presented to the human analyst via a user interface of Method52. The analyst reads each tweet, and decides which of the pre-assigned categories (see Phase 1) that it should belong to. A small group of these (usually around 10) are submitted as training data, and the NLP model is recalculated. The NLP algorithm then looks for statistical correlations between the language used and the meaning expressed to arrive at a series of rules-based criteria, and presents the researcher with a new set of tweets which, under the recalculated model, it has low levels of confidence for.

## PHASE 4: PERFORMANCE REVIEW AND MODIFICATION

The updated classifier is then used to classify each tweet within the gold standard test set. The decisions made by the classifier are compared with the decisions made (in Phase 2) by the human analyst. On the basis of this comparison, classifier performance statistics – 'recall', 'precision', and 'overall' (see 'assessment of classifiers', above) - are created and appraised by a human analyst.

## PHASE 5: RETRAINING

Phase 3 and 4 are iterated until classifier performance ceases to increase. This state is called 'plateau', and, when reached, is considered the practical optimum performance that a classifier can reasonably reach. Plateau typically occurs within 200-300 annotated tweets, although it depends on the scenario: the more complex the task, the more training data that is required.

## PHASE 6: PROCESSING

When the classifier performance has plateaued, the NLP model is used to process all the remaining tweets in the dataset into the categories defined during Phase 1, using rules inferred from data the algorithm has been trained on. Processing creates a series of new data sets – one for each category of meaning – each containing the tweets considered by the model to most likely fall within that category.

## PHASE 7: CREATION OF A NEW CLASSIFIER (PHASE 1), OR POST-PROCESSING ANALYSIS (PHASE 8)

Practically, classifiers are built to work together. Each is able to perform a fairly simple task at a very large scale: to filter relevant tweets from irrelevant ones, to sort tweets into broad category of meanings, or to separate tweets containing one kind of key message with those containing another. When classifiers

work together, they are called a 'cascade'. Cascades of classifiers were used for both case studies. After Phase 7 is completed, a decision is made about whether to return to Phase 1 to construct the next classifier within the cascade, or, if the cascade if complete, to move to the final phase - post-processing analysis.

## PHASE 8: POST PROCESSING ANALYSIS

After tweets have been processed, the new datasets are often analysed and assessed using a variety of other techniques.

## CLASSIFIER PERFORMANCE

No NLP classifier used on this scale will work perfectly, and a vital new coalface in this kind of research is to understand how well any given algorithm performs on various measures, and the implications of this performance for the research results. Each classifier trained and used for this paper was measured for accuracy. In each case, this was done by:

1. Randomly selecting 100 tweets to comprise a 'gold standard'.

2. Coding each of these tweets by hand, conducted by an analyst.

3. Coding each of these tweets using the classifier.

4. Comparing the results and recording whether the classifier got the same result as the analyst.

There are three outcomes of this test. Each measures the ability of the classifier to make the same decisions as a human in a different way:

*Recall*

Recall is a measure of the correct selections that the classifier makes as a proportion of the total correct selections it could have made. If there were 10 relevant tweets in a dataset, and a relevancy classifier successfully picks 8 of them, it has a recall score of 80%.

*Precision*

Precision is a measure of the correct selections the classifier makes as a proportion of all the selections it has made. If a relevancy classifier selects 10 tweets as relevant, and 8 of them actually are indeed relevant, it has a precision score of 80%.

*Overall – F SCORE*

The 'overall' score combines measures of precision and recall to create one, overall measurement of performance for the classifier. All classifiers are a trade-off between recall and precision. Classifiers with a high recall score tend to be less precise, and vice versa.

# ANNEX
## DATA TABLES

**TABLE 9.**

TOP 10 MOST RETWEETED R&D
RELEVANT TWEETS

| Rank | Tweet | Number of Retweets |
|------|-------|-------------------|
| 1 | Here are a couple of articles backed by new research that are worth taking a look at: A new study on the Medicaid expansion my administration fought for under the Affordable Care Act- and how these policy decisions affect lives in real terms: https://t.co/Lj4g7lGFnq | 13,859 |
| 2 | This is not tantamount to failure. In Research & Development there'll be a learning curve. This is that precious, learning moment. Soon we will be on the moon thanks to #ISRO. The Nation believes and applauds ISRO. | 4,303 |
| 3 | New research suggests that some men avoid "green" behavior "like using a reusable shopping bag at the grocery stores" because they don't want to be perceived as gay. https://t.co/mZ5BzjGSCn | 3,908 |
| 4 | Iran announced it will violate all limits on nuclear research and development. The fact that Iran retains massive uranium enrichment capacity reveals a core weakness of the Iran deal. | 2,927 |
| 5 | NEW RESEARCH: Women-led films made more at the box office from 2014-2017. https://t.co/3dhazPksB2 | 2,629 |
| 6 | This is why support for Brexit has collapsed.<br><br>Brexit-related price hikes see UK families spend billions more on everyday goods, new research finds \| The Independent https://t.co/Llhc4yNbjo | 1,482 |
| 7 | This spectacular drone footage shows humpback whales "socialising" off West Cork. The video was captured by the Irish Whale and Dolphin Group for a new research project. Read more: https://t.co/IWVguzVcyS | 1,439 |

| | | |
|---|---|---|
| 8 | Twitter, do your thing please! My father has two types of cancer, a blockage in his intestine, and had a broken leg one year ago, so it's really hard to walk. His new treatment has to come out of pocket & has to be paid sooner. Anything helps. I will leave a link to his gofundme. | 1,392 |
| 9 | 1/ New Research from us @BitwiseInvest. As part of 226 slides presented to the SEC on our ETF filing, we did a first-of-its-kind analysis of *order book data* from all 81 exchanges reporting >$1M in BTC volume on CMC.TLDR: 95% of reported volume is fake but LOTS of good news! | 1,380 |
| 10 | As with other behavioral traits such as personality, there is no single "gay gene". Instead, same-sex sexual behavior appears to be influenced by perhaps hundreds or thousands of genes, each with tiny effects, according to new research. https://t.co/bkBvSau6Xu | 1,287 |

## TABLE 10.

TOP 10 MOST FAVOURITED R&D
RELEVANT TWEETS

| Rank | Tweet | Number of Likes |
|---|---|---|
| 1 | This is not tantamount to failure. In Research & Development there'll be a learning curve. This is that precious, learning moment. Soon we will be on the moon thanks to #ISRO. The Nation believes and applauds ISRO. | 32,966 |
| 2 | Iran announced it will violate all limits on nuclear research and development. The fact that Iran retains massive uranium enrichment capacity reveals a core weakness of the Iran deal. | 8,439 |
| 3 | 111 years ago, what was likely a meteor exploded over Siberia, flattening 500,000 acres of forest. The event sent shockwaves around the world, but new research indicates that asteroid impacts may be less frequent than previously thought: https://t.co/O3o4wRzwbu #AsteroidDay | 4,271 |
| 4 | What created the small methane-filled lakes on Saturn's moon, Titan? New research using data from our @CassiniSaturn mission suggests these lakes are actually explosion craters. Pockets of liquid nitrogen warmed up, and... ! More on the latest theory: https://t.co/MTnRKsEEbP | 3,076 |
| 5 | @user Not dumbstruck - though indeed most of the claims were true! Many of the claims tonight needed new research (as opposed to Trump's repeated or immediately obvious lies), & we ran them through a rigorous process before publishing. | 1,311 |

| | | |
|---|---|---|
| 6 | Republicans, Congratulations - 'Nuclear Update, North Korea has been test launching missiles with regularity, and now Iran is saying it will begin research and development of new nuclear weapons.' @politico | 1,310 |
| 7 | Would anyone disagree with me if I asked you to email your MP and say how disgusting it is not to charge overseas patients for NHS treatment? Meanwhile refusing to fund new treatment for UK children who have cystic fibrosis, whose parents pay tax and national insurance to fund the NHS. | 1,290 |
| 8 | New research has found that lonely people have superior social skills compared to people who aren't lonely. | 817 |
| 9 | New innovation for fans who can't attend a fans gathering. Awesome! You are super clever. #SaintxMyanmarBeautyBuffet #Saint_sup | 792 |
| 10 | Research Breakthrough Encounters for August & July | 723 |

## TABLE 11.

TOP 10 MOST SHARED LINKS
IN RELEVANT TWEETS

| Link | Tweets with Link | Summary |
|---|---|---|
| [https://www.inc.com/geoffrey-james/scientists-just-discovered-that-drinking-coffee-does-something-absolutely-amazing-to-your-body.html?cid=sf01001] | 440 | Link to Inc.com article discussing research findings on the benefits of coffee consumption on overall health |
| [https://www.physics-astronomy.org/2019/09/new-research-says-physical-pain-is.html] | 336 | Link to Physics-astronomy website which discusses new research on the relationship between physical pain and emotional stress |
| [https://www.bbc.com/pidgin/institutional-49954778] | 286 | Link to BBC website reporting on YouGov poll findings about millennials and loneliness |
| [https://www.salon.com/2019/09/17/donald-trump-king-of-chaos-new-research-on-right-wing-psychology-points-toward-big-trouble-ahead/] | 264 | Link to Salon.com writing about new research on right-wing psychology |
| [https://abcnews.go.com/US/asteroid-wiped-dinosaurs-powerful-10-billion-atomic-bombs/story?id=65537028&cid=social_Twitter_abcn] | 246 | Link to abcnews reporting on research findings about asteroid that wiped out the dinosaurs |
| [https://phys.org/news/2019-09-planet-primodial-black-hole.html] | 243 | Link to phys.org article about research on Planet Nine which could be a primordial black hole |

| | | |
|---|---|---|
| [https://onlinelibrary.wiley.com/action/cookieAbsent] | 220 | Link to online library portal |
| [https://www.socialmediaexaminer.com/igtv-for-business-new-research-for-marketers/?utm_source=dlvr.it&utm_medium=Twitter] | 217 | Link to socialmediaexaminer.com discussing the new research about adding IGTV for marketing activities |
| [https://www.lifecoachcode.com/2017/02/26/emotion-shapes-reality/] | 204 | Link to lifecoachcode.com site about new research findings on human emotion and its relation to the idea of reality |
| [https://Twitter.com/cbcnews/status/1174058025809862656] | 199 | Link to a CBC News tweet (through quote-tweeting) fact-checking Canadian Conservative tax plans, with those quote-tweeting discussing or questions the research behind the fact-check. |

**TABLE 12.**

TOP 20 MOST LINKED TO
WEBSITES IN RELEVANT TWEETS

| Website | Type of Website | Number of Tweets Citing the Website |
|---|---|---|
| [frontiersin.org] | Open access publisher | 4,400 |
| [Twitter.com] | Social media | 2,192 |
| [theguardian.com] | British general news | 1,097 |
| [phys.org] | Science news aggregator | 1,043 |
| [theconversation.com] | Media site which publishes academics and researchers | 1,041 |
| [inc.com] | American business news | 945 |
| [nytimes.com] | American general news | 934 |
| [sciencedaily.com] | Science news | 825 |
| [bigthink.com] | Media site on research news | 751 |
| [forbes.com] | American business news | 739 |
| [youtube.com] | Social media | 733 |
| [medicalxpress.com] | Medical research | 611 |
| [medicalnewstoday.com] | Medical news | 484 |
| [bbc.com] | British general news | 467 |
| [physics-astronomy.org] | Physics and astronomy news | 460 |
| [instagram.com] | Social media | 460 |

| [thinkprogress.org] | News | 447 |
|---|---|---|
| [hubs.ly] | Anti-abuse website | 425 |
| [consent.yahoo.com] | Lifestyle | 413 |
| [socialmediaexaminer.com] | Social media marketing | 404 |

**TABLE 13.**

NUMBER OF MENTIONS OF
BRITISH FUNDING BODIES IN
RELEVANT TWEETS

| British Funder | Number of Appearances |
|---|---|
| Leverhulme Trust | 87 |
| Wellcome Trust | 27 |
| European Research Council/ERC | 21 |
| UK Research and Innovation/UKRI | 8 |
| The Royal Society | 6 |
| Nuffield Foundation | 5 |
| Innovate UK | 5 |
| Cancer Research UK/CRUK | 6 |
| Arts and Humanities Research Council/AHRC | 5 |
| Science and Technology Facilities Council/STFC | 4 |
| Medical Research Council/MRC | 3 |
| National Institute for Health Research | 2 |
| UKRI | 2 |
| Engineering and Physical Sciences Research Council/EPSRC | 2 |
| The Royal Academy of Engineering | 1 |
| Economic and Social Research Council | 0 |
| The British Academy | 0 |
| Total | 184 |

Licence to publish

Demos – License to Publish
The work (as defined below) is provided under the terms of this licence ('licence'). The work is protected by copyright and/or other applicable law. Any use of the work other than as authorized under this licence is prohibited. By exercising any rights to the work provided here, you accept and agree to be bound by the terms of this licence. Demos grants you the rights contained here in consideration of your acceptance of such terms and conditions.

1 Definitions
a 'Collective Work' means a work, such as a periodical issue, anthology or encyclopedia, in which the Work in its entirety in unmodified form, along with a number of other contributions, constituting separate and independent works in themselves, are assembled into a collective whole. A work that constitutes a Collective Work will not be considered a Derivative Work (as defined below) for the purposes of this License.
b 'Derivative Work' means a work based upon the Work or upon the Work and other pre-existing works, such as a musical arrangement, dramatization, fictionalization, motion picture version, sound recording, art reproduction, abridgment, condensation, or any other form in which the Work may be recast, transformed, or adapted, except that a work that constitutes a Collective Work or a translation from English into another language will not be considered a Derivative Work for the purpose of this License.
c 'Licensor' means the individual or entity that offers the Work under the terms of this License.
d 'Original Author' means the individual or entity who created the Work.
e 'Work' means the copyrightable work of authorship offered under the terms of this License.
f 'You' means an individual or entity exercising rights under this License who has not previously violated the terms of this License with respect to the Work, or who has received express permission from Demos to exercise rights under this License despite a previous violation.

2 Fair Use Rights
Nothing in this licence is intended to reduce, limit, or restrict any rights arising from fair use, first sale or other limitations on the exclusive rights of the copyright owner under copyright law or other applicable laws.

3 License Grant
Subject to the terms and conditions of this License, Licensor hereby grants You a worldwide, royalty-free, non-exclusive, perpetual (for the duration of the applicable copyright) licence to exercise the rights in the Work as stated below:
a to reproduce the Work, to incorporate the Work into one or more Collective Works, and to reproduce the Work as incorporated in the Collective Works;
b to distribute copies or phono-records of, display publicly, perform publicly, and perform publicly by means of a digital audio transmission the Work including as incorporated in Collective Works; The above rights may be exercised in all media and formats whether now known or hereafter devised. The above rights include the right to make such modifications as are technically necessary to exercise the rights in other media and formats. All rights not expressly granted by Licensor are hereby reserved.

4 Restrictions
The licence granted in Section 3 above is expressly made subject to and limited by the following restrictions:
a You may distribute, publicly display, publicly perform, or publicly digitally perform the Work only under the terms of this License, and You must include a copy of, or the Uniform Resource Identifier for, this License with every copy or phono-record of the Work You distribute, publicly display, publicly perform, or publicly digital-ly perform. You may not offer or impose any terms on the Work that alter or restrict the terms of this License or the recipients' exercise of the rights granted hereunder. You may not sublicence the Work. You must keep intact all notices that refer to this License and to the disclaimer of warranties. You may not distribute, publicly display, publicly perform, or publicly digitally perform the Work with any technological measures that con-trol access or use of the Work in a manner inconsistent with the terms of this License Agreement. The above applies to the Work as incorporated in a Collective Work, but this does not require the Collective Work apart from the Work itself to be made subject to the terms of this License. If You create a Collective Work, upon notice from any Licensor You must, to the extent practicable, remove from the Collective Work any reference to such Licensor or the Original Author, as requested.

b You may not exercise any of the rights granted to You in Section 3 above in any manner that is primarily intended for or directed toward commercial advantage or private monetary compensation. The exchange of the Work for other copyrighted works by means of digital file sharing or otherwise shall not be considered to be intended for or directed toward commercial advantage or private monetary compensation, provided there is no payment of any monetary compensation in connection with the exchange of copyrighted works.
c If you distribute, publicly display, publicly perform, or publicly digitally perform the Work or any Collective Works, you must keep intact all copyright notices for the Work and give the Original Author credit reasonable to the medium or means You are utilizing by conveying the name (or pseudonym if applicable) of the Original Author if supplied; the title of the Work if supplied. Such credit may be implemented in any reasonable manner; provided, however, that in the case of a Collective Work, at a minimum such credit will appear where any other comparable authorship credit appears and in a manner at least as prominent as such other comparable authorship credit.

5 Representations, Warranties and Disclaimer
a By offering the Work for public release under this License, Licensor represents and warrants that, to the best of Licensor's knowledge after reasonable inquiry:
i Licensor has secured all rights in the Work necessary to grant the licence rights hereunder
and to permit the lawful exercise of the rights granted hereunder without You having any obligation to pay any royalties, compulsory licence fees, residuals or any other payments;
ii The Work does not infringe the copyright, trademark, publicity rights, common law rights or any other right of any third party or constitute defamation, invasion of privacy or other tortious injury to any third party.
b Except as expressly stated in this licence or otherwise agreed in writing or required by applicable law, the work is licenced on an 'as is' basis, without warranties of any kind, either express or implied including, without limitation, any warranties regarding the contents or accuracy of the work.

6 Limitation on Liability
Except to the extent required by applicable law, and except for damages arising from liability to a third party resulting from breach of the warranties in section 5, in no event will licensor be liable to you on any legal theory for any special, incidental, consequential, punitive or exemplary damages arising out of this licence or the use of the work, even if licensor has been advised of the possibility of such damages.

7 Termination
a This License and the rights granted hereunder will terminate automatically upon any breach by You of the terms of this License. Individuals or entities who have received Collective Works from You under this License, however, will not have their licences terminated provided such individuals or entities remain in full compliance with those licences. Sections 1, 2, 5, 6, 7, and 8 will survive any termination of this License.
b Subject to the above terms and conditions, the licence granted here is perpetual (for the duration of the applicable copyright in the Work). Notwithstanding the above, Licensor reserves the right to release the Work under different licence terms or to stop distributing the Work at any time; provided, however that any such election will not serve to withdraw this License (or any other licence that has been, or is required to be, granted under the terms of this License), and this License will continue in full force and effect unless terminated as stated above.

8 Miscellaneous
a Each time You distribute or publicly digitally perform the Work or a Collective Work, Demos offers to the recipient a licence to the Work on the same terms and conditions as the licence granted to You under this License.
b If any provision of this License is invalid or unenforceable under applicable law, it shall not affect the validity or enforceability of the remainder of the terms of this License, and without further action by the parties to this agreement, such provision shall be reformed to the minimum extent necessary to make such provision valid and enforceable.
c No term or provision of this License shall be deemed waived and no breach consented to unless such waiver or consent shall be in writing and signed by the party to be charged with such waiver or consent.
d This License constitutes the entire agreement between the parties with respect to the Work licensed here. There are no understandings, agreements or representations with respect to the Work not specified here. Licensor shall not be bound by any additional provisions that may appear in any communication from You. This License may not be modified without the mutual written agreement of Demos and You.

# DEMOS

**Demos** is a champion of people, ideas and democracy. We bring people together. We bridge divides. We listen and we understand. We are practical about the problems we face, but endlessly optimistic and ambitious about our capacity, together, to overcome them.

At a crossroads in Britain's history, we need ideas for renewal, reconnection and the restoration of hope. Challenges from populism to climate change remain unsolved, and a technological revolution dawns, but the centre of politics has been intellectually paralysed. Demos will change that. We can counter the impossible promises of the political extremes, and challenge despair – by bringing to life an aspirational narrative about the future of Britain that is rooted in the hopes and ambitions of people from across our country.

Demos is an independent, educational charity, registered in England and Wales. (Charity Registration no. 1042046)

Find out more at **www.demos.co.uk**

# DEMOS