Department for
Business, Energy
& Industrial Strategy

Public attitudes to science 2019

Main report

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Ministerial Foreword

I am delighted to present Public Attitudes to Science 2019, the sixth in this series of studies. This survey will help us in understanding how the UK public feel about science, engineering and the new technologies that they increasingly encounter in their daily lives.

As well as the main survey, the study uses additional research methods including online dialogues and social media analysis. All of this helps to build a clearer picture of how the public feels about science and engineering, and what they think about key topics like climate change, artificial intelligence and trust in scientific advice. These are crucial areas that will have a growing impact in the coming years.

The knowledge we have gained from this research will also help inform the development of policy – both in Government and in scientific institutions across the UK – ensuring that the public's views can be fed into decision making.

If we are to achieve our ambition of increasing investment in Research and Development across the whole of the UK and making the UK a science superpower, we will need more people to take up careers in research, a private sector workforce with the skills and knowledge that meets the demands of the jobs of the future, and a public that feels they are proud to be part of this journey. It is already encouraging that the public is alive to the potential that science and engineering presents to the nation and have a positive view of scientists and engineers.

We want to inspire more of our young people to study STEM subjects and to take up STEM careers, while also attracting, developing, and retaining talent from around the globe. Diversity will be at the heart of this, we know it will be particularly important to engage those groups that have been historically underrepresented in science and engineering. Everyone should have the opportunity to realise their potential, so they can break boundaries in research and realise long-lasting benefits to communities across the UK.

We want to ensure that the public can understand and appreciate the huge benefits that researchers can bring to society. It is through studies like Public Attitudes to Science that we can begin to maintain and build that understanding, and help spread a simple message – science is for everyone.

Amanda Solloway MP, Minister for Science, Research, and Innovation

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Executive Summary

Background

Public Attitudes to Science 2019 (PAS 2019) is the sixth survey in a series of studies tracking attitudes to science, scientists and science policy among the UK public. The study was conducted by Kantar, on behalf of the Department for Business, Energy and Industrial Strategy (BEIS). Several strands of research were included:

- A literature review conducted by Dr Kevin Burchell which comprised an independent review and synthesis of existing literature, primarily since 2010 (Burchell, 2019).
- A face-to-face survey of 1,749 UK adults aged 16+ carried out in January-April 2019 using a random probability sampling approach. The survey comprised a core section of questions which have been tracked over time, and four topic-focussed modules: ageing society; AI, robots and data; genome editing; micro-pollution and plastics.
- Four waves of online qualitative research using a deliberative digital dialogue process, and 16 face-to-face qualitative group discussions with digitally excluded participants, focussed on four science-related topics (trust in science; AI and healthcare; robotics in the care sector; genomics in food production).
- Four waves of social listening, to track how four different science topics were discussed online over the last two years (veracity of online information; AI in healthcare; robots in the workplace; ocean plastic pollution).

This report primarily provides commentary on the findings of the survey. The full set of publications can be found at Kantar.com/uk-public-attitudes-to-science.

This summary first considers changes over time since the PAS 2014 survey, then provides a high-level summary of the 2019 findings by chapter, and finally discusses trends in relation to the variation in attitudes by demographic subgroups.

How have public attitudes changed over time?

On the whole, between 2014 and 2019, and in some cases over the longer term, people have become more positive in their attitudes towards science and scientists, although there are a few exceptions to this. In summary:

There is a shift in how people access science information from print to online

Although people still mainly rely on television for science information, there has been a considerable shift between 2014 and 2019 from print to online.   In 2019 13% (down from 28%) found out about science from print newspapers, 28% (up from 15%) from online news websites, and 15% (up from 4%) from Facebook.

Despite a backdrop of declining levels of trust in media reporting more generally people have become more trusting about science reporting

Despite wider evidence of declining levels of trust in the news over recent years, people are now more trusting in media reporting of science. Compared with 2014, fewer people in 2019 think that the media sensationalises science (from 71% to 61%) and that politicians are too easily influenced by media reporting of science (from 70% to 62%).

On the whole, people find science more accessible and feel better informed

Since 2014, people were more likely to feel very or fairly well informed about science (51%, up from 45%) and less likely to feel that science and technology are too specialised for most people to understand them (55%, up from 47%). Between 2014 and 2019 there was an increase in awareness in some specific technologies; for example, overall awareness of nanotechnology increased from 65% to 72%, and synthetic biology from 61% to 70%.

However, for some technologies, although awareness remains high, levels of understanding have fallen. Compared with 2014, the proportion of people who felt informed has fallen in relation to vaccination against diseases (71%, down from 77%), nuclear power (38%, down from 47%), and GM plants (32%, down from 43%). This could be linked to the amount of media coverage about these topics when the surveys were conducted.

While people increasingly see science as important they are less likely to see it is relevant to their own everyday life

There was a continuing upward trend in people thinking that scientists make a valuable contribution to society (49% strongly agreed, up from 27% in 2005). However, compared with 2014, people were less likely to think science will make our lives easier (74%, down from 81%), that it's important to know about science in their daily life (65%, down from 72%) and that the science they learnt at school has been useful in daily life (43%, down from 51%).

There are increased levels of trust in scientists and science regulation

Compared with 2014, people in 2019 were more positive about science regulation, with fewer people thinking rules won't stop scientists doing what they want behind closed doors (47%, down from 55%). There was also fall in the proportion of people having a sense of 'resigned trust': that is a feeling they have 'no option but to trust those governing science' (56%, down from 67%).

More specifically, there was a continuing increase in trust among scientists working for environmental groups (83%, up from in 72% in 2011) but a decline in the proportion trusting charity-based scientists (82%, down from in 88% in 2014); this latter finding could be linked to declining trust in the charity sector more generally over this period.

People are more positive about efforts to involve the public though they increasingly value expert-driven decision-making in science

Compared with 2014, people in 2019 were less likely to think that scientists are putting too little effort into informing people about their work (49%, down from 58%), and that the public is insufficiently involved in science decision-making (52%, down from 58%). However, between 2008 and 2019, there has been a decline in the proportion of people who feel that scientists should listen more to what ordinary people think (74% in 2008; 69% in 2014; 63% in 2019) but an increase in the proportion who feel that experts rather than the public should advise the government about scientific developments (61% in 2008; 70% in 2014; 69% in 2019).

People are less concerned about the pace of change

Between 2014 and 2019, and over a longer period, concerns about the pace of scientific and technological development have been falling. For example, in 2019 35% felt that the speed of development means that science cannot be properly controlled (down from 48% in 2005) and 27% felt that science makes our way of life change too fast (down from 52% in 1996). This may be a sign that UK adults are becoming more familiar with, and more adaptable to, an ever-accelerating pace of change.

People are more supportive of renewable energy but less supportive of the use of animals in medical research

Between 2014 and 2019, the belief that the benefits of renewable energy outweigh the risks, rose from 66% to 79% among those who had heard of this. However, there was a marked decline in the proportion who support the use of animals in medical research, from 67% in 2014 to 56% in 2019.

Science capital index (Chapter 1)

Science capital helps explain why people do or do not feel connected to science

In recent years the concept of 'science capital'[1] has been developed to better understand why some people feel that science is or isn't 'for me'. Using PAS 2019 data, an index was constructed based on eleven survey items which cover the main domains of science capital including science-related qualifications, knowledge, contacts, and informal science learning. Individuals with high science capital score highly across a range of these attributes, while individuals with low science capital tend to feel less connected to science.

Science capital is unequally distributed across the population

Based on the definition of science capital developed for SET 2019, 18% of people were classified as having low science capital, 50% as medium science capital, and 22% as high science capital. Demographic groups which contained the highest proportions of people with high science capital included degree-educated people (42% compared with only 1% without a degree), men (29% compared with 14% of women), people aged under 55 (26% compared to 18% aged 55-64 and 12% aged 65+), and people from BAME backgrounds (29% compared with 21% of white people).

Science capital is highly correlated with positive views about science

This science capital score has been used to help explain patterns of attitudes towards science throughout this report. Compared to people with low science capital, people with high science capital were:

- more knowledgeable and confident in their ability to understand science;
- more likely to trust media reporting of science;

[1] www.ucl.ac.uk/ioe-sciencecapital

- less in favour of public involvement in science and more in favour of expert-driven decision-making – although they were more likely to want to get involved personally;
- more likely to have trust and confidence in scientists and science regulation;
- more positive about the benefits of science both overall and in relation to specific technologies;
- more open to the take up of new technology such as robot caregivers and AI used in healthcare.

Awareness and knowledge about science (Chapter 2)

Most people are confident in their ability to understand science though knowledge of more specialised science topics remains low

Around half (51%) considered themselves to be at least fairly well informed about science; while only 26% did not feel clever enough to understand science. In terms of more specific science topics, people felt most informed about vaccinations, renewable energy, and the use of animals in research. People felt least informed about more specialised topics such as nanotechnology, genome editing and synthetic biology, with between 25% and 38% saying they had never heard of these topics.

There is a strong association between knowledge and confidence

There was a high correlation between objective and subjective knowledge of science, where objective knowledge was assessed using a 10-item true/false quiz. The mean quiz score was 6.6 out of 10, although this was higher among people who felt very well informed about science (7.8) and there was a large gap in scores for people who did (7.4) and did not (5.5) consider themselves clever enough to understand science.

The public do not understand how science is funded

The public lacked awareness about who funds scientific research, underestimating the role of the private sector. Although the private sector is the largest funder of science research and development in the UK, only 39% think the private sector funds science, with the overwhelmingly majority (67%) associating the government with scientific research funding.

Finding out about science (Chapter 3)

People continue to display an appetite for information about science and mainly use television, online news platforms and Facebook for this

Most people said they heard or saw enough (44%) or too little (47%) information about science. Although there is wider evidence that television viewing hours are falling, TV was still the main source of science information (35% accessed science through TV news, and 16% via other TV). Online news platforms (28% - mainly BBC) and Facebook (15%) were other relatively common channels for accessing science information. In line with changing patterns of readership more generally, only 13% now access science through print newspapers.

Trust in science reporting (Chapter 4)

People are confused about whether they can trust media reporting of science

Still only half (50%) felt that the information they hear about science is generally true, while 36% were unable to give an opinion on this. This relatively high level of ambivalence points to a degree of confusion, which is further reinforced by high proportions who agreed that there is too much conflicting information about science to know what to believe (65%) and that the media sensationalises science (62%).

Traditional media is more trusted than online-only media, though people have more trust in online science information they search for themselves

When it comes to trusting the accuracy of science information, people had more trust in traditional media such as newspapers, TV and radio news (including online or offline) (71%), and less trust in online-only media such as online-only news sites and blogs (45%). However, people were far more likely to trust online science information that they search for themselves (81%) than information shared via social media personalities (30%) or friends (30%).

People recognise that there are more trustworthy sources of science information available even if they don't use these themselves

TV (52%), online news (38%) and social media (33%) were considered the best sources for informing people about science, which mapped across to the sources people most commonly used. However, people also thought of science journals (25%), books (21%) and science blogs (16%) as reliable sources, even though these were rarely used in practice.

Science in people's lives (Chapter 5)

Most people recognise the value of science in daily life though this doesn't necessarily translate into active engagement

People overwhelming agreed that science is such a big part of our lives that we should all take an interest (82%) and that it played an important role in helping them to understand the word (77%). However, they were somewhat less likely to agree that it was important to for them personally to know about science in their daily lives (65%) and 32% said that they rarely or never talked about science with friends, family or colleagues.

People are commonly exposed to science though science-related attractions especially as part of a family activity

Most people (72%) had taken part in at last once science-related activity in the past year, most commonly visiting a nature reserve, zoo or science museum. Science-related visits were often family activities, with 41% of people making their last visit with children.

There is significant overlap between engagement in science and other cultural activities

A fifth (22%) felt actively connected with science, while 27% felt the same way about arts/culture and 40% about sports. Most people who actively engaged with science also actively engaged with arts/culture and/or sports (71%) suggesting that science is often part of a wider set of cultural interests. Overall 22% said they felt that science was ‘not for me’. However, 39% of this group felt actively connected to either sports or arts/culture (mainly sports) which indicates a potential to build science capital among some harder to reach groups via their other interests.

Public involvement in science (Chapter 6)

Science communication is seen as important but people feel scientists could do more

There was still a clear desire for government, scientists and regulators to communicate with the public: 83% felt that science regulators need to communicate with the public more and 66% would like to see scientists engaging more about the social and ethical implications of their research. However, a half (49%) felt that scientists put too little effort into informing the public, and 38% saw scientists as being poor communicators.

People feel the public has a right to be involved but they still want experts to drive decision-making

Majorities of people felt the government should act in accordance with public concerns about science (73%) and that scientists should listen more to what ordinary people think (63%). However, seven in ten (69%) felt that experts rather than the public should advise the government on the implications of scientific development suggesting that while they want the public point of view to be considered during the process, they appreciate that final decisions should rest on expert evidence.

There is disconnect between feeling that the public should get involved and people’s own desire to be involved in science. Although most people felt the public should play a role in science decision-making, there was relatively little desire for personal involvement: 28% expressed an interest in involvement, while 69% were happy to leave decision-making to others. In fact, there was evidence that those who supported more public involvement were *less* likely to be interested in being actively involved themselves: 27% of those who agreed that ‘the government should act in accordance with public concerns about science and technology’ were interested in being actively involved in science decision-making compared with 42% who disagreed with this. In the light of this lack of appetite for active involvement, the fact that 67% do not feel empowered to influence science policy is not necessarily a negative finding.

Trust in scientists, regulation and funding (Chapter 7)

Public trust and respect in scientists and engineers remains very high

Levels of trust in scientists remained very high, although the institutional setting in which they work affects the level of trust. Most trusted were scientists and engineers and working for universities, and least trusted were those working in the private sector. Nine in ten agreed that scientists (89%) and engineers (87%) make a valuable contribution to society. Despite this, however, there was also an element of ‘resigned trust’, with 56% feeling that they have no option but to trust scientists.

Although there are some concerns about the effectiveness of science governance

Around half (47%) felt that rules were insufficient to stop scientists doing what they want, while 44% considered scientists to be 'secretive' and 31% that they adjust findings to get the answers they want. Concern about the private sector's role in funding is demonstrated by 74% who feel that the independence of scientists is compromised by the interest of funders.

The public strongly supports government spending on science though remains concerned about the role of the private sector in funding

Eight in ten (79%) think that government should fund 'blue skies' research (scientific research that advances knowledge even if it brings no immediate benefits) while 66% disagree with the suggestion that public funding for science should be cut in favour of other priorities. However, 74% were concerned that the interests of funders compromise the independence of scientists and people's discomfort with the role of the private sector in science is reinforced by the relatively high proportion (58%) who felt that scientists are too dependent on industry.

Perceived benefits and risks in science (Chapter 8)

The public wants risks to be well managed

Three-quarters (75%) believed that government should delay new technologies until scientists are certain of their safety and, encouragingly, 69% felt confident that UK scientists do appropriately consider such risks. However, a third (35%) were concerned that the speed of development limits the extent to which government can properly exert control.

People were more positive than fearful about most technologies asked about

Of the range of scientific applications asked about, vaccination and renewable energy attracted near universal public support, while driverless cars, GM crops, nuclear power, and the use of animals in research were the most contentious. However, on balance, more people felt that the benefits outweighed risks in almost all technology areas asked about. The one clear exception was driverless cars, where more people felt the risks outweighed the benefits: only 23% agreed that driverless car technology will be safer than human drivers. It is notable that support for vaccination remained very strong (only 4% felt that the risks outweigh the benefits) despite prevailing media attention around the 'anti-vaccination' movement.

People associate scientific advancement with widening inequalities

Overall, 30% thought that scientific advances benefit the rich more than the poor. However, there was more concern about inequalities in relation to specific technologies: 77% felt that if robots replace human jobs, people in low-skilled jobs will struggle more, while 67% felt that new medical treatments to extend life expectancy would only be available to the wealthy.

Attitudes towards careers in science & engineering (Chapter 9)

Science and engineering careers are regarded as interesting and future-focussed though engineering is perceived as better paid

Most people viewed both science and engineering jobs as interesting (science 72%, engineering 65%) and future-focussed (68%, 57%) with science careers outscoring engineering careers on these factors. However, engineering was regarded as better career choice in terms of pay (science 50%, engineering 65%).

Science and computer science are regarded as important skills to equip young people for the future and to help drive UK economic growth

Many people viewed computer science (63%) and science (43%) as essential skills for young people, while at least 80% viewed these two subjects as either very important or essential. Nearly all (89%) thought that young people's interest in science is essential for our future prosperity, while 75% agreed that scientific research helps drive economic growth. However, people were relatively more pessimistic about the future with 57% thinking that science and technology will help provide more work opportunities for the next generation.

Ageing society (Chapter 10)

People prioritise quality of life in over longevity

The large majority (84%) would prefer to live only for as long as they can ensure good quality of life, while 15% would choose to live as long as possible even with more limited health. Two-thirds (64%) of people had heard about life extension technologies to slow the ageing process, and 31% would choose this if available. However, people were more negative (62%) than positive (31%) about the impact this would have on society, with people concerned about burden on the NHS and increased taxes for working people.

People are open to some enhancement technologies to assist them in later life

When asked about different enhancement technologies to assist older people in later life, the public was largely in favour of cognitive enhancing drugs (80%) and to a lesser extent robotic clothing to improve mobility (59%). However, there was much less support for more medically invasive technologies such as brain chip implants to improve intelligence and cognition (24%).

Around half of people are open to using robot caregivers to help with practical tasks in later life but there are concerns about loss of human contact

About half (54%) had heard about the idea of robot caregivers to help older people and around half (45%) said that they would use one, either for themselves in later life or for a relative. People felt more comfortable with the idea of a robot helping with household tasks (61%) or healthcare (57%) than providing companionship (29%). Eight in ten (80%) thought that robot caregivers would lead to older people having less human contact.

Artificial intelligence, robots and data (Chapter 11)

Most people have heard about AI applications in use today although depth of knowledge was variable

Between 74% and 92% had heard or read about a range of AI applications in use today. People had more in-depth knowledge about web-based applications such as targeted advertising and speech or facial recognition. People were less well-informed about AI used in more specific contexts such as to sift job applications or diagnose medical symptoms.

Most people are open to the use of AI and robotics in healthcare but only when used to support rather than replace a doctor

A large majority felt comfortable about AI and robots being used to support a human doctor to make a diagnosis or recommend treatment (80%), or in surgery (71%). The opposite was found in relation to technology *replacing* human doctors, where a clear majority felt uncomfortable in both contexts (respectively 81% and 75% felt uncomfortable about technology replacing doctors in diagnosis and surgery). While 58% believed AI and robots used in healthcare will accelerate progress in medicine, only 37% thought that it could surpass the accuracy of human doctors. The chief concern was related to loss of contact, with 68% thinking it likely that doctors would lose their medical skills and 78% that patients would lose the 'human touch' in healthcare.

There is widespread recognition of the potential for people's jobs to be replaced by robots and AI though views about this are mixed

Nine in ten people (90%) had heard about the idea that AI and robots could begin to take over many human jobs, beyond the more routine jobs. Most working people recognised that aspects of their job could be automated in the future: 51% thought that their job could be at least partially automated within the next 5 years, rising to 69% within a 20-year timeframe. Overall, 49% considered this to be a 'good thing' for society and 45% 'a bad thing'. When asked about more specific potential outcomes, people were mostly pessimistic: only 16% thought this would lead to the creation of new and better jobs and almost everyone (87%) believed that this would lead to declining levels of human interaction. However, people were as likely to agree (37%) as disagree (36%) that people would find their jobs more fulfilling if computers took over more routine tasks.

People are happy to share their medical data with the NHS but not private companies

For the purposes of developing healthcare-related AI, the large majority were willing to share their personal health data with the NHS (90%). People were somewhat less willing to share their data with research organisations (73%) and the government (61%), and much less willing to share their data with private companies (35%). This echoes the public's discomfort with the role of the private sector in scientific development noted in Chapter 7.

People are reluctant for companies to use personal data to target online content and do not fully trust UK data protection regulations to keep their data safe

While there was a degree of acceptance that companies could use data to target news articles or develop new products and services, there was widespread disapproval of the use of data to target online adverts and for political campaigning. On balance people were more distrustful (55%) than trustful (44%) about the ability of UK data protection regulations to ensure their data is not shared without permission. Most people favoured the oversight of the safety of AI by an independent regulator rather than by the technology industry.

Genome editing (Chapter 12)

Most people have some awareness of genome editing though few feel well informed

Most people (91%) had heard about genetically modified (GM) plants and 58% had heard about genome editing (58%). However, much lower proportions felt informed about these technologies (32% and 13% respectively said they felt informed). Awareness increased when people were presented with more specific examples. Most people (between 70% and 90%) had heard about genome editing in plants to increase food production, in humans to prevent disease, and in animals to increase food production. However, genome editing in mosquitos to control the spread of malaria was relatively less well-known (49%).

More people support than oppose genome editing applications but only when there is a clear benefit to humans

People were broadly supportive of applications which aimed to improve the health benefits in animal and plant food production, but they were much less supportive of techniques associated with cosmetic benefits or which could be seen as negatively affecting animals. While most people supported gene editing to correct a genetic condition in humans, more people favoured this when the edits can be passed on to future generations (74%) than not passed on (55%).

Micro pollution and plastics (Chapter 13)

Most people are aware of microbeads and microplastics as a cause of pollution

Most people had at least heard about micro-beads in cosmetics (76%) and micro-plastics in clothes (67%) as a cause of micro-pollution, though they were less aware of the use of silver particles in sports clothes and socks as a source of micro-pollution (43% had heard of this).

There is overwhelming support for government bans on micro-pollutants and plastics

At least eight in ten supported a government ban on unrecyclable plastic in supermarkets (90%), plastic straws (82%), cotton buds (81%) and microbeads in cosmetics (81%). When asked to rank, the public felt that government should have most responsibility for reducing micro-pollution (52%), then industry and business (33%), and finally the public (11%).

How do attitudes differ across the population?

As noted above, men, the more educated, and younger people had the highest levels of science capital. Consistent with this, these groups were also more engaged, optimistic and positive about science across a range of attributes. The following general patterns were found by demographic subgroup across the report:

Gender

Women were less likely to feel informed about science; to feel connected to science in their everyday life; to actively engage with science; and were also less likely to hold positive views about science both in general and in relation to specific applications. They were also less trusting of scientists and media reporting of science.

Education

Similar to the gender divide, people with lower levels of education were less likely than people with higher levels of education to feel knowledgeable, trusting, connected, engaged and trusting about science.

Although people with higher levels of education were in general more positive about science, they were also more critical in some areas, being more likely to think that media sensationalises science, and to question the role of science funders in ensuring independence. More educated people were also less likely to value public involvement in science and more likely to value expert-drive decision-making.

Age

In general, older people aged 65 or over were less likely than younger age groups to feel informed about science across a range of areas and applications.

Older people age 65+ were also less likely to consider that science was relevant to their everyday life, and were generally less engaged and connected to science as part of their daily lives. However, despite this, older people 65+ valued more public involvement in science but it was notable that they were less keen to get involved personally and more cynical about science public engagement.

In general, younger people aged 16-34 were more informed about and engaged in science, and more receptive to and supportive of new and emerging technologies. However, younger people aged 16-24 were more negative than older age groups about careers in science and engineering, and were less likely to view computing as an essential skill in the job market. This is possibly because younger people are basing views on their own personal educational choices which will have been made more recently, whereas older people might be basing this on a wider societal perspective.

Older people aged 65+ were much more likely than younger people to get science news from traditional sources such as TV, radio and print newspapers, whereas younger people were much more likely to access science via social media. On the whole, younger people were more trusting of online media as a source of science information.

Ethnicity

The sample base for BAME subgroups was small and therefore it was difficult to detect many statistically significant differences in survey findings between white people compared with BAME people. In the small number of cases where differences were observed, BAME people were generally more positive than white people.

Note on differences by demographic subgroups

It should be noted that the gender, educational and age divides were in part driven by higher levels of ‘don’t know’ and neutral responses among women, older people and among those with no qualifications. This is because people in these groups generally feel less knowledgeable, confident and engaged in science which means that they also have a tendency to feel less able to form an opinion about scientific issues.

Introduction

This report presents the findings from quantitative research, along with four case studies summarising the qualitative work carried out as part of Public Attitudes to Science (PAS) 2019, a study of attitudes among the UK public. The research was conducted by Kantar, on behalf of the Department for Business, Energy and Industrial Strategy (BEIS).

In addition to this report, an evaluative review of the global literature on public attitudes towards science and science in the media (Burchell, 2019) and findings from social media analysis have also been published at Kantar.com/uk-public-attitudes-to-science.

Background and context

The institutions[2] that govern and influence UK science[3] have paid considerable attention to the relationships between science and society, in all their myriad forms, for almost 35 years. This was given greater prominence and impetus by the 1985 Public Understanding of Science (PUS) report (also known as the Bodmer report), which identified a lack of public knowledge about and public support for science as significant threats to UK science, and to UK economic prosperity. Although institutional understandings of the roots of public concerns about science have shifted since 1985, the broad-based concern about public support that is expressed in Bodmer remains, as seen in the House of Lords Science and Technology Committee's report 'Science and Society' (2000)[4], the 2014 UK Charter for Science and Society[5], DIUS (2008), the UKRI Concordat for Engaging the Public with Research (2010, currently under revision)[6]; for more details see Burchell (2015). In addition, what is now often referred to as the 'science and society' agenda has also been the subject of considerable attention from scholars and practitioners. It is notable that activity on this issue in the UK has prompted other countries to follow suit, and that the UK remains a global leader and exemplar in this domain.

In particular, attention has focused on the following key strands in the UK and internationally:

- Understanding public attitudes towards: science, scientists, science policy, and the regulation of science.
- Understanding public attitudes towards education and science careers (e.g. Hamlyn et al (2017), including inequality of access and widening participation.
- Understanding public attitudes towards a range of new and emerging technologies (such as machine learning, AI, genomics, and environmental issues) and how these hopes and concerns can be addressed through the policy-making process.

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[2] Currently these institutions include: the UK government Department for Business, Energy and Industrial Strategy (BEIS), Research Councils UK (from 1 April 2018, UK Research and Innovation), the Royal Society and other learned bodies, and Wellcome Trust.

[3] It is notable that the brief defines 'science' as scholarship and research in: all of the natural sciences, technology, engineering, mathematics, arts, humanities and social sciences. While this is appropriate, it is important to note that work in this domain tends to emphasise the STEM subjects (rather than humanities and social sciences).

[4] https://publications.parliament.uk/pa/ld199900/ldselect/ldsctech/38/3801.htm.

[5] https://scienceandsociety.blog.gov.uk/uk-charter-for-society/

[6] https://www.ukri.org/public-engagement/research-council-partners-and-public-engagement-with-research/embedding-public-engagement/

- Understanding how these attitudes are formed, and therefore how they can be influenced. Understanding the role of the media, and increasingly social media, is a key focus here. Here, debates have moved on from preoccupations with scientific knowledge (or lack of it) alone to broader concerns about public trust, the social impacts of new technologies and the transparency, ethics and responsibility of science.
- Practical action designed to influence public attitudes towards science. Here, broadly speaking, approaches have shifted from the top down education approaches of PUS to the two-way approaches of public engagement with research. Recent research (Hamlyn et al, 2015) suggests that researchers are undertaking more public engagement than ever before and that this trend is likely to continue.
- Tracking trends over time is key to understanding the shift in attitudes over time, and the underlying reasons for these shifts.

In many respects, the social context within which science operates has not changed: novel technologies are emerging (e.g. artificial intelligence and quantum technologies), public engagement activity is likely to increase further, and certain technologies and practices are likely to remain contentious (e.g. genetic technologies, data security, AI and nuclear technologies).

At the same time, it is important to highlight some broader changes in context since Public Attitudes to Science 2014. The first relates to the increasingly-held contention that we are living in a post-truth age, in which emotion plays an enhanced role in establishing 'truth' or 'fact', and – crucially for the PAS survey – the claim that society has an increasing disregard for experts[7]. Related to this, it is widely accepted that the increasing proliferation of social media (beyond what was present in 2014, when the last PAS survey took place) has been a key facilitator of the post-truth era, due to its role in the easy dissemination of 'fake news' (either to encourage clicks in pursuit of advertising revenue or to influence debates), though of course it is also important to note that social media can also promote public engagement with science. Further linked to this, there has also been an increasing focus on the protection of personal data, especially with the advent of GDPR. Of course, recent media coverage around the unauthorised sharing of social media data for profiling and targeting is also highly relevant here.

Finally, one of the two defining moments in the arrival of the post-truth/fake news era is often said to be linked to the campaigning around the UK's EU Membership (the other being the Trump US election victory). Aside from this, Brexit is also potentially important to any major UK survey because of its highly significant implications for the future of science within the UK, with continued question marks around future scientific collaborations with Europe and the wider world, the mobility of scientists, research funding, and regulation of science and novel technologies.

[7] For instance, see: https://theconversation.com/post-truth-politics-and-why-the-antidote-isnt-simply-fact-checking-and-truth-87364;.https://www.theguardian.com/commentisfree/2017/nov/17/were-in-a-post-truth-world-with-eroding-trust-and-accountability-it-cant-end-well

Research objectives

The research had several wide-ranging objectives, covering many aspects of people's attitudes to science, including:

- What people think about science, scientists and UK science policy, and why they think this
- People's confidence in science regulation and policymaking
- How people find out about science, and how the development of social media has impacted on this
- Views on public involvement in decision-making on science issues
- How science is pursued as a leisure or cultural activity
- How attitudes have changed over time

Beyond this, four emerging areas of science and technology – two of which relate to Grand Challenges set out by the Government as part of their Industrial Strategy[8] - were selected for a more detailed examination of public attitudes:

- Ageing society
- Artificial intelligence, robots and data
- Genome editing
- Micro-pollution and plastics

These four topics are covered in their own chapters in this report.

Methodology

PAS 2019 employed a mix of methodologies, including:

- A literature review conducted by Dr Kevin Burchell: the aim of this element was to set the context for the 2019 survey, including an independent review and synthesis of existing literature in this domain, and a mapping of developments over time and primarily since 2010 (Burchell, 2019).
- A face-to-face survey of 1,749 UK adults aged 16+, which was carried out from 17th January to 29th April 2019 using a random probability sampling approach.
- Four waves of online qualitative research using a deliberative digital dialogue process, each covering a different topic. Deliberative dialogue is a research method where the public interact with information, expert stakeholders, and one another to deliberate on

8 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf

policy-relevant issues. It is different to other forms of qualitative research in that it goes beyond exploring people's top of mind views about complex issues, to uncover how they form these views, and to debate issues in more depth using different information sources. Each dialogue involved around 30-35 participants and was active for a week

- Sixteen face-to-face qualitative group discussions, each involving eight participants who were less able to engage in online discussions. Findings from the deliberative dialogues and group discussions are covered as separate case studies in this report, and have also been published separately.

- Four waves of social listening, to track how four different science topics were discussed online (veracity of online information; AI in healthcare; robots in the workplace; ocean plastic pollution)– findings from this strand have been published as four separate topic-specific reports.

Data from the survey are weighted to be representative of the UK adult population profile.

Full details of the quantitative methodology are provided in the technical report.

The full set of publications can be found at Kantar.com/uk-public-attitudes-to-science.

Interpreting the data

It should be remembered that the survey findings are based on a sample of UK adults, rather than the entire population. Therefore, results are subject to sampling tolerances, and not all differences are statistically significant. Throughout this report, only differences that are statistically significant at the 95% level of confidence are commented on.

Unless stated otherwise all figures reported on have an unweighted base of 100 or more. Percentages may not total 100 due to rounding or the exclusion of 'don't know' responses.

Science capital index

In recent years the concept of 'science capital'[9] has been developed to better understand how individuals engage with science and technology in their everyday lives and why some people feel that science either is or isn't 'for me'. Using PAS 2019 data, an index was created to measure the degree of science capital held by survey respondents. This index is used throughout the report to help explain patterns of attitudes towards science.

The index is constructed based on eleven survey items which between them cover the main domains of science capital: science-related qualifications; scientific literacy; science-related contacts; participation in informal science learning; feeling comfortable in scientific environments; and knowledge about the transferability of science in everyday life. Individuals with high science capital score highly across a range of these attributes and feel more connected to science, while individuals with low science capital tend to have lower levels of scientific literacy and feel less connected to science.

More detail is provided in Chapter 1, and technical details on the derivation of the index can be found in the technical report.

[9] https://www.ucl.ac.uk/ioe/departments-and-centres/departments/education-practice-and-society/science-capital-research

Science knowledge quiz

The survey included a science knowledge quiz intended to measure people's basic scientific literacy. This comprised ten true-or-false questions. Respondents were classified into one of three groups based on their score from the knowledge quiz and these subgroups are referred to throughout the report:

- Those who answered five or fewer questions correctly were classified as "low" scoring
- Those who answered six to eight questions correctly were classified as "medium" scoring
- Those answering nine or ten questions correctly were classified as "high" scoring.

This follows the exact same questions and classification approach used in other surveys in the UK and elsewhere, including the Wellcome Monitor[10].

Comparisons to previous studies

To explore changes in attitudes over time, the PAS 2019 survey findings have been compared to the five previous studies in the PAS series.

Although the 2019 survey has been designed to be comparable to previous waves, it is important to acknowledge the various changes to the research design between studies, which may have affected the results.

Most notably the survey methodology has evolved over time, moving from a paper-based survey to computer interviewing. Table 1 summarises the key approach used in each survey year.

[10] https://wellcome.ac.uk/what-we-do/our-work/public-views-science-and-health

Table A.1: Public Attitudes to Science studies: survey design

Survey year	Interviewing organisation	Sampling approach	Survey mode	Achieved sample
2019	Kantar	Probability	Computer-Aided Personal Interviewing (CAPI)	1,749 UK adults (16+)
2014	Ipsos MORI	Probability	CAPI	1,749 UK adults (16+)
2011	Ipsos MORI	Quota	CAPI	2,103 UK adults (16+)
2008	TNS	Quota	CAPI	2,137 UK adults (16+)
2005	MORI (now Ipsos MORI)	Quota	Paper	1,831 UK adults (16+)
2000	Harris Research	Quota	Paper	1,839 British adults (16+)

Structure of report

The report is structured as follows:

- Chapter 1 covers the derivation of the science capital index and how this is distributed across the sample.
- Chapter 2 explores people's awareness and knowledge about science.
- Chapter 3 examines how and where people find out about science.
- Chapter 4 looks at trust in science reporting including what drives trust and distrust in science reporting.
- Chapter 5 focuses on science in people's everyday life including how reflections on science at school shape attitudes, the value people place on science in their everyday life and science-related activities people participate in.
- Chapter 6 covers public involvement in science, focusing on views on public consultation about science, involvement in decision making and whether the public feels the government is consulting the public enough.
- Chapter 7 explores attitudes towards regulation and funding of science including perceptions of scientists and engineers.
- Chapter 8 examines how people feel about the pace of scientific developments, risks and benefits of different technologies and how people's views on religion and ethics shape attitudes towards science.

- Chapter 9 looks at attitudes towards careers in science and engineering.
- Chapter 10 explores awareness of, and attitudes towards technologies aimed at supporting people in older life including: life extension technologies; technologies which aim to enhance cognitive and physical abilities in later life; and robots used in a social care role.
- Chapter 11 examines familiarity with, and support for, the use of Artificial Intelligence (AI), robots and data technology in society. Three main areas are covered: AI in healthcare; AI in the workplace; and the use of personal data to develop AI.
- Chapter 12 looks at familiarity with, and support for, genome editing and its application in different organisms (humans, animals and plants/crops).
- Chapter 13 explores familiarity with different causes of micro-pollution, support for a government ban on their use, and responsibilities for reducing micro-pollution. It also looks at support for a government ban on common sources of plastic waste.

Across the report we will also use a number of acronyms and terms related to science and technology.

Glossary

Throughout this report we use several scientific terms and acronyms. A guide is provided here.

Table A.2: Glossary of terms and acronyms

Glossary of terms and acronyms	
Artificial Intelligence (AI)	Technology that can perform tasks that would otherwise require human intelligence.
BAME groups	Black and minority ethnic groups.
Driverless vehicles	Also referred to as automated vehicles, a vehicle that can move and guide itself without human input.
Genetically modified (GM) foods	Organisms (i.e. plants or animals) in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating and/or natural recombination.
Genome editing	Genome editing is the deliberate alteration of a selected DNA sequence in a living cell. Genome editing techniques can be used to delete sections of DNA or alter how a gene functions: for example, by changing a variant that may give rise to disease to one that functions normally.

Human enhancement technology	A modification aimed at improving human performance and brought about by science-based and/or technology-based interventions in or on the human body.
Life extension technology	Longevity enhancements are interventions, such as new medical treatments and drugs, that have the potential to significantly extend a human's lifetime.
Micro-pollution/ microplastics	Micro-pollution is caused when large plastic products degrade in the environment. These microplastics are tiny pieces of plastic that are present in a variety of products, including cosmetics, synthetic clothing, plastic bags and bottles and can pose threats to animals, aquatic life and ecosystems.
Nanotechnology	Nanotechnology relates to the study and application of extremely small things (1 to 100 nanometres in size). It can be used within a range of scientific and technological fields such as chemistry, biology, physics, materials science, and engineering.
Nuclear power	Electricity generated by power plants that derive their heat from fission in a nuclear reactor.
Public engagement (with science policy)	The National Coordinating Centre for Public Engagement (NCCPE) defines this as: 'the myriad of ways in which the activity and benefits of higher education and research can be shared with the public. Engagement is by definition a two-way process, involving interaction and listening, with the goal of generating mutual benefit.'
Renewable energy	Energy from a resource that is replaced rapidly by a natural process such as power generated from the sun or from the wind.
Robots	Machines that can do a series of complex tasks automatically and by themselves, tasks that humans would otherwise perform.
Science capital	Science capital is a measure of someone's engagement or relationship with science, how much they value it, and whether they feel it is connected with their life.
STEM	Science, Technology, Engineering and Maths
Synthetic biology	The application of engineering principles to the fundamental components of biology, this involves designing and creating forms of life that have never existed in nature.

1. Science capital index

An index of science capital was created for PAS 2019 to help explain patterns of attitudes towards science throughout this report. This chapter provides a background to the concept of science capital, and a brief explanation of how the index was constructed. Further details can be found in the PAS 2019 technical report.

Context

In recent years the concept of 'science capital' has been developed to better understand and measure how individuals engage with science, technology and engineering in their everyday life. Ultimately the concept is an attempt to provide insight into why some people participate in and engage with science, while others do not.

The science capital measure developed by Louise Archer and her team, currently based at UCL Institute of Education[11] comprises several dimensions including: scientific literacy and qualifications; participation in informal science learning; family science connections; talking about science in everyday life; and feeling 'connected' to science. Government policy is to encourage building and enhancing science capital among the general public as a means of upskilling people, to support economic growth, ensure a supportive social context for science and technology, and to widen engagement in science across all social groups.

Previous studies, both in the UK and elsewhere, have consistently found that those from lower socio-economic groups tend to be less positive about, and less engaged with, science and technology. Importantly, this socio-economic 'gap' is also reflected among young people in terms of their science career aspirations. The most common policy response has been to target STEM public engagement activities at lower socio-economic groups. However, Archer et al (2013) argue that a broader social response to tackling social and economic inequality, supported by specific public engagement measures, is the best way to increase science capital in the UK.

Based on eleven survey items, which between them cover the main domains of science capital, an index has been constructed to measure science capital in PAS 2019. This science capital score has been used to help explain patterns of attitudes towards science throughout this report (see below).

Measuring science capital

Building on the work of Archer *et al*[12] a science capital index was constructed based on a number of relevant questionnaire items in PAS 2019. These items broadly (though not precisely) align with similar questions used by Archer's team in their derivation of a science capital index.

[11] www.ucl.ac.uk/ioe-sciencecapital
[12] https://www.ucl.ac.uk/ioe/departments-and-centres/departments/education-practice-and-society/science-capital-research/enterprising-science/publications-enterprising-science-project

Following reliability and validity analyses using principal components analysis, an index was constructed based on a composite score which includes the items displayed in Figure 1.1

Figure 1.1: Components of science capital index

- Which of these statements best describes your relationship with science? *(I feel connected with science – I actively seek out science news, events, activities or entertainment; I'm interested in science but I don't make a special effort to keep informed; Science is not for me)*.

- 'The science I learnt at school has been useful in my everyday life' *(agree/disagree scale)*

- 'It is important to know about science in my daily life' *(agree/disagree scale)*

- 'School put me off science' *(agree/disagree scale)*

- 'I would feel comfortable in places where science is discussed and practised, such as in laboratories, in science centres, in industrial settings' *(agree/disagree scale)*

- 'I have a good understanding of scientific terms, such as hypothesis, theory, experiments and research trials' *(agree/disagree scale)*

- How well informed do you feel, if at all, about science, and scientific research and developments?

- How often did you visit or attend a science talk/ lecture outside of school, college or work in the last 12 months?

- Do you work in a science related job or study a science subject?

- Highest science qualification

- How often do you talk about things to do with science with family, friends or colleagues?

- Do you have any friends or family who work in a job using science, computer science, engineering, or medicine?

Scores were summed across the above questions, after removing all cases where a missing value was recorded on one or more items. The index score was then split into three equal segments, and categorised into high, medium, and low science capital. Individuals with high science capital score highly across a range of these attributes and tend to feel more connected to science. On the other hand, individuals with low science capital tend to have lower levels of scientific literacy and to feel less connected to science.

Based on the SET 2019 categorisation, 18% of people were classified as having low science capital, 60% as medium science capital, and 22% as high science capital.

As displayed in Table 1.2, science capital was highest among men, more educated people, people aged under 55, and people from BAME backgrounds.

Table 1.2: Science capital index bands by key demographics

		Low	Medium	High	Base (n)*
		%	%	%	
	All	18	60	22	(n=1621)
Gender	**Men**	13	57	29	(n=801)
	Women	24	63	14	(n=820)
Highest qualification	**Degree**	5	54	42	(n=541)
	Below degree level	19	68	13	(n=878)
	No qualifications	61	37	1	(n=202)
Age	**16-34**	15	60	25	(n=337)
	35-54	15	58	26	(n=537)
	55-64	15	67	18	(n=278)
	65+	31	57	12	(n=469)
Ethnicity	**White**	19	60	21	(n=1433)
	BAME	13	58	29	(n=183)

* Bases exclude any cases where a missing value was recorded on one or more items.

2. Awareness and knowledge about science

This chapter explores people's instinctive associations with science, how well-informed people feel about science, their knowledge of science funding and regulation in the UK, and objective science knowledge.

Key findings

Most people were confident in their ability to understand science. However, knowledge of more specialised science topics remains low and there are misperceptions about the funding of science. There is a strong association between confidence in understanding science and objective knowledge, as measured by a ten-item science quiz. There have been some positive shifts in the extent to which people feel informed about science since the PAS 2014.

Changes over time

- Since 2014, there have been some positive shifts in the extent to which people feel informed about science. Compared with 2014, people were more likely to feel either very or fairly informed about science (51%, up from 45%), and less likely to say that science and technology are too specialised for most people to understand (47%, down from 55%). In addition, people were slightly more likely than in 2014 to have heard of synthetic biology (70%, up from 61%) and nanotechnology (72%, up from 65%).
- However, compared with 2014, the proportion of people who felt very or fairly well informed has fallen in relation to vaccination of people against diseases (71%, down from 77%), nuclear power (38%, down from 47%), and genetically modified plants (32%, down from 43%).

2019 findings

- People most commonly associated science with specific subjects as taught in schools, namely Biology, Chemistry and Physics.
- Half of people (51%) felt informed about science. Men and degree holders were more likely than other groups to consider themselves so. People who use scientific journals, books and podcasts to learn about science were more likely to feel either very or fairly well informed than those who use more passive sources, such as TV and radio programmes.
- A sizeable minority of people had never heard of genome editing (38%), synthetic biology (27%) and nanotechnology (25%). While awareness of specific science topics differed across different groups, at least nine in ten people had heard of all other topics mentioned.
- People were most likely to feel very or fairly well informed about vaccination of people against diseases (71%) and renewable energy (63%).

- As in 2014, most people (67%) thought that scientific research in the UK is funded by the government/ taxpayer and they under-estimated the role of the private sector in funding research.
- Two thirds of people (67%) thought the government (including devolved governments) sets the rules and regulations for scientists in the UK to follow when they are doing their job. This was, by a wide margin, the most commonly cited response.

Context

The PAS 2014 survey offered a mixed picture about the extent to which people feel informed about science and technology, showing that around half of the public felt informed about science and technology and around half did not feel capable of understanding science and technology (Burchell, 2019).

Research also highlights a number of long-standing challenges that people might experience when trying to become informed about science and technology issues. The first of these is the extent to which people feel or do not feel capable of understanding – or becoming informed about – science and technology. PAS 2014 suggests that there was a significant minority who themselves feel that this is a challenge. For instance, although 54% disagreed that, ‘I don’t think I’m clever enough to understand science and technology, and although this represents an ongoing increase since 2000, still 30% agreed with this statement. Further, 43% agreed that, ‘I cannot follow developments in science and technology because the speed of development is too fast’ (this is broadly consistent since 2000), and 55% agree that, ‘science and technology are too specialised for most people to understand them’; there is broadly a downward trajectory here since 2000 and evidence from PAS 2019 suggests that this downward trend has continued.

Due to its ongoing influence, it makes sense to suppose that people who know more about science will have a range of more supportive and positive attitudes towards it (and vice versa). This idea was elaborated in the UK Public Understanding of Science report (Bodmer, 1985), and has influenced a longstanding and ongoing focus on education-inspired science communication and public understanding of science (PUS) activities across the globe. However, the relatively small associations that are typically noted between knowledge about and attitudes towards science, and the fact that associations are both positive and negative (Sturgis et al., 2010), suggests that this is a very complex issue.

What does science mean to people?

When people were asked what instinctively comes to mind when they think about ‘science’, the strongest association was with specific categories of science, perhaps as result of studying these subjects at school (see Figure 2.1). Biology, chemistry or physics were mentioned by 24% of people, while 12% simply mentioned ‘school’ as the thing that came to mind when thinking about science.[13]

[13] Although a similar question was asked in 2014, the format was changed for 2019. Whereas in 2014, interviewers coded open-ended responses to a pre-defined list, in 2019 respondents were asked a fully open question (‘When I talk about ‘science’, please tell me in your own words what comes to mind?’) and verbatim responses were recorded by the interviewer. This means that findings cannot be reliably compared over time.

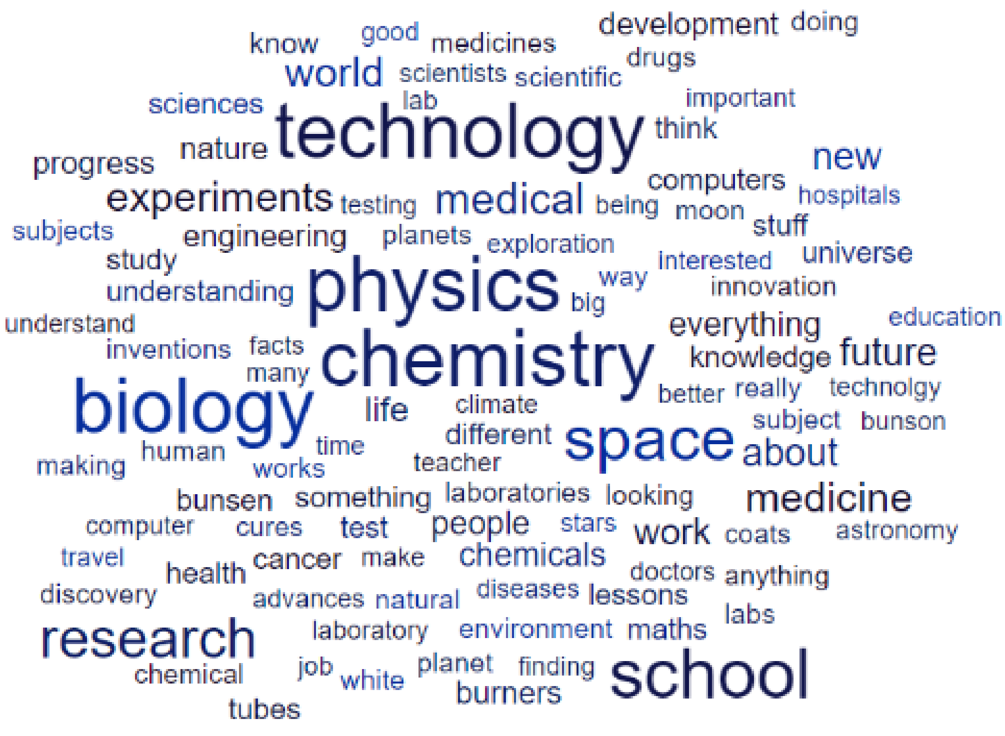
Those who associated science with ‘school’ were more likely than average to feel that they are not well informed about science (74% vs 48%), and to say that science isn’t for them (33% vs 22%). This potentially suggests that, for these people, school was their last point of real engagement with science.

Given the wide range of individual words and phrases that were mentioned it is challenging to group these into obvious easily defined categories. However, other commonly mentioned themes were:

- Health/ drugs/ medicine/ doctors (16%)
- Ideas/ innovation/ invention/ research/ analysis (15%)
- Space/ rockets/ astronomy (15%)
- Technology (13%)

Those with a degree were more likely than those with no qualifications to mention ideas/ innovation/ invention (21% vs 11%) or technology (17% vs 8%).

Figure 2.1: What people associate with science



Q1. When I talk about “science”, please tell me in your own words, what comes to mind?
Base: All respondents (n=1749)

How well-informed do people feel about science?

In terms of how well-informed people felt about science, the population was split almost equally between those who said they felt ‘very’ or ‘fairly’ well informed about science and scientific research and developments (51%) and those who said they felt ‘not very’ well or not at all informed (48%). Compared with PAS 2014 there was an increase in the number of people who felt informed about science (from 45% to 51%).

There were some demographic differences in the proportions of people who felt they were informed about science (defined as feeling very or fairly well informed):

- Men were more likely than women to feel informed (63% vs 39%).
- There was a strong association between education level and feeling informed about science: 65% of degree educated people said they feel informed about science compared with 49% of those educated to below degree level and 25% of those with no qualifications

Not surprisingly the extent to which people said they felt informed about science was closely related to their interest and engagement in it. Among those who said that science is not for them, just 11% felt informed, compared with 90% of those who felt connected to science and 52% of those who are interested but don't make an effort to keep informed.

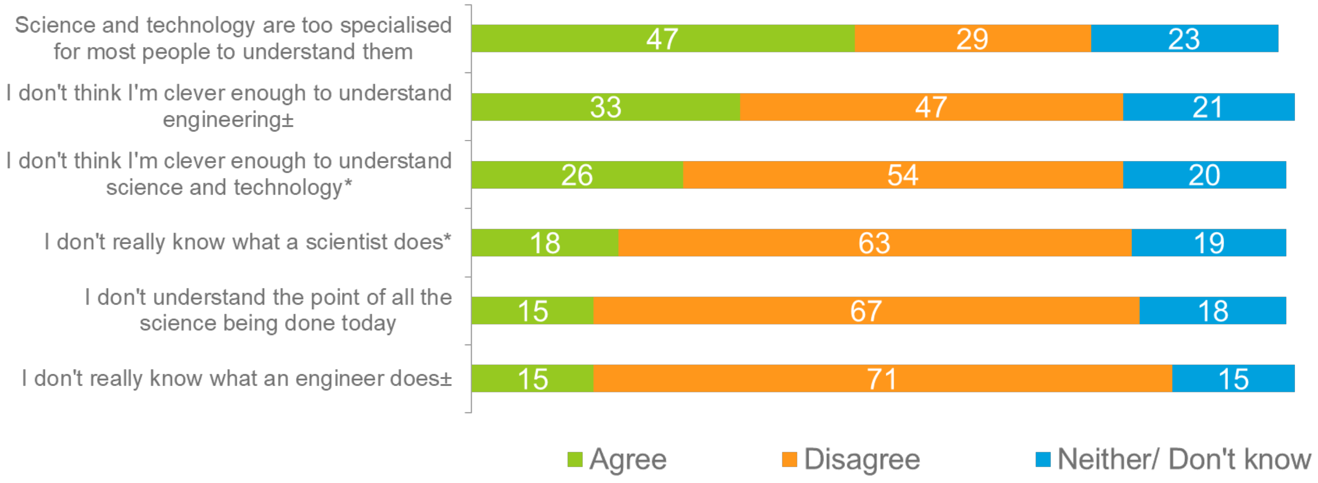
Feeling informed also appears to be associated with the main sources people use to learn about science. Those who get information from scientific journals and work colleagues were the most likely to feel well informed (82% and 77% respectively), followed by books (71%) and podcasts (71%)[14]. It should be noted, however, that 63% of those who said they learn about science through work colleagues either work or study in the field of science.

In general, people were more likely than not to express confidence in their own understanding of science. Only 15% felt they do not understand the point of the science being done today compared with two-thirds (67%) who felt this was not the case. Similar proportions of people felt that they know what a scientist (63%) or an engineer (71%) does and just over half (54%) felt that they are clever enough to understand science and technology (Figure 2.2). Interestingly, people had less confidence that other people can understand science, with almost half (47%) saying that science and technology are too specialised for most people to understand compared to 29% who did not agree with this.

Compared with 2014, people were less likely to say that science and technology are too specialised for most people to understand (47%, compared with 55%).

[14] For the question about main sources used, respondents chose their answers from a showcard and could select as many options as applied.

Figure 2.2: Agreement with statements about knowledge of science



Q15. Here are some statements about science. For each, please could you tell me the extent to which you agree or disagree?
*Base: All respondents (n=1749); *All who were asked the questions about scientists (n=860); ± All who were asked the questions about engineers (n=889)*

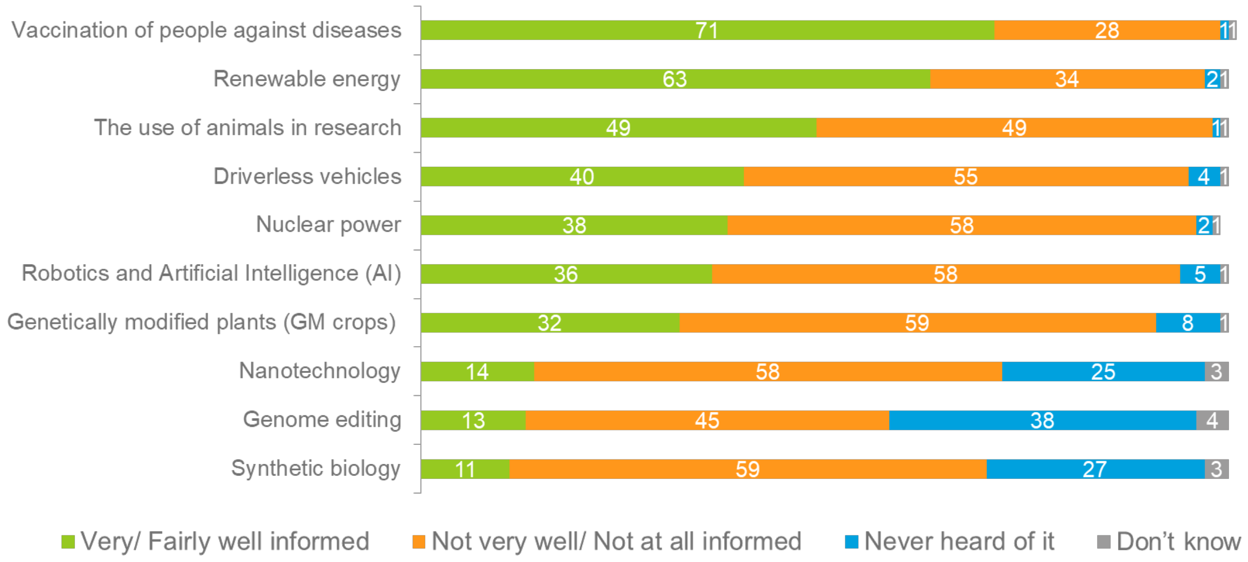
There were some notable differences across different demographic groups:

- Men were more likely than women to feel that they understand the point of science being done today (73% vs 63%); that they know what a scientist does (70% vs 56%); and that they are clever enough to understand science and technology (63% vs 45%).
- People in the oldest age group (65+) had the lowest level of confidence in their ability to understand science. More than four in ten (43%) felt that they are not clever enough to understand science and technology (compared with 21% of those aged under 65); a quarter of the 65+ age group (24%) said they do not understand the point of science being done today (compared with 12% of those aged under 65). Older people were also more likely to feel that science and technology are too specialised for most people to understand (63%, compared with 43% of those aged under 65).
- People with low science capital were less likely than those with high science capital to feel that they are clever enough to understand science and technology (21% vs 91%), and that they understand the point of science being done today (40% vs 90%); and more likely to feel that science and technology are too specialised for most people to understand (70% vs 33%).

How well-informed do people feel about specific science topics?

While there was variation in the extent to which people felt informed about specific science topics, most of those asked about were at least heard of by more than nine in ten people. The topics which people were least likely to have heard of were genome editing (38% had never heard of it); synthetic biology (27%); and nanotechnology (25%). (Figure 2.3)

Figure 2.3: How well-informed people feel about specific science topics



Q7. I’m going to read out a list of topics. Could you tell me, using this card, how well informed you feel, if at all, about each topic?
Base: All respondents (n=1749)

There was, however, evidence that awareness of some of these topics has increased. In 2014, 39% had never heard of synthetic biology (fallen to 27% in 2019) and 35% had never heard of nanotechnology (fallen to 25% in 2019).[15]

Awareness levels on some topics differed by demographic group:

- Men were more likely than women to have heard of nanotechnology (82% vs 67%), synthetic biology (76% vs 70%) and genome editing (69% vs 55%).
- People aged 65+ were less likely than those aged under 65 to have heard of genome editing (55% vs 64%), nanotechnology (62% vs 79%) and synthetic biology (66% vs 75%).
- Those with no qualifications were much less likely than people educated to degree level to have heard of most topics, particularly genome editing (34% vs 81%), nanotechnology (42% vs 89%) and synthetic biology (46% vs 83%).
- Those with high science capital were much more likely than those who had low science capital to have heard of nanotechnology (95% vs 47%), genome editing (90% vs 34%), and synthetic biology (88% vs 50%).

Although most people had heard of the specific science topics, there was considerable variation in how well-informed people felt. The only topics on which the majority of people said they felt well informed were vaccination of people against diseases (71%) and renewable energy (63%). A much lower proportion of people said they felt informed about nuclear power (38%) or genetically modified plants (32%).

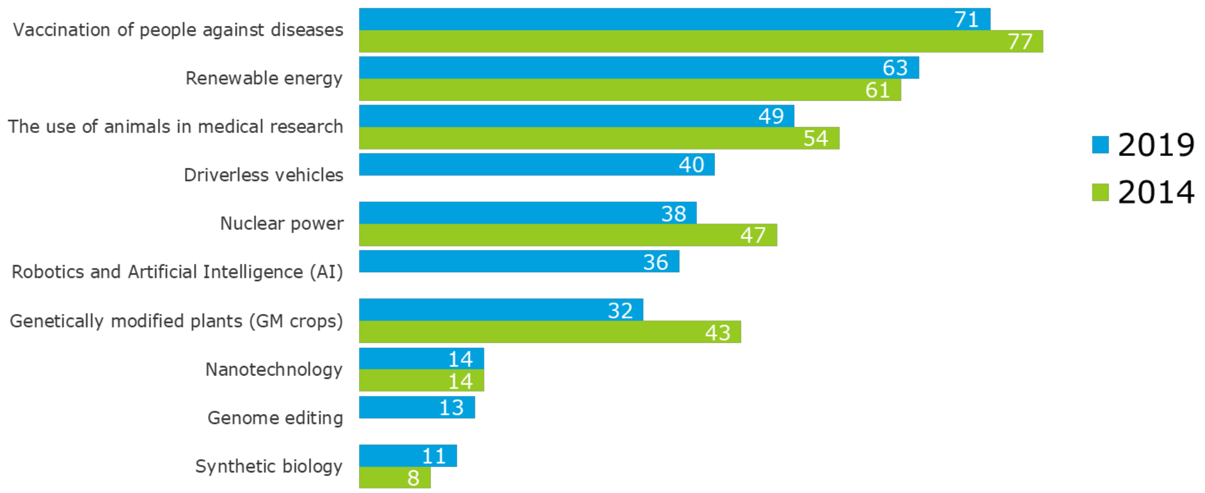
[15] Respondents were not asked about genome editing in 2014. In 2014, respondents were asked about ‘The use of animals in research’, which was amended to ‘The use of animals in medical research’ in the 2019 survey.

For some topics, people were less likely to say they feel well informed compared with 2014 (see Figure 2.4):

- Vaccination of people against diseases (71%, compared with 77% in 2014)
- Nuclear power (38%, compared with 47% in 2014)
- Genetically modified plants (32%, compared with 43% in 2014)

All three topics are areas of science that are regularly debated in the media and it may be that the way in which these topics are covered in the media has contributed to this decline in how well-informed people feel.

Figure 2.4: Proportion feeling very or fairly well informed about specific science topics (comparison with 2014)



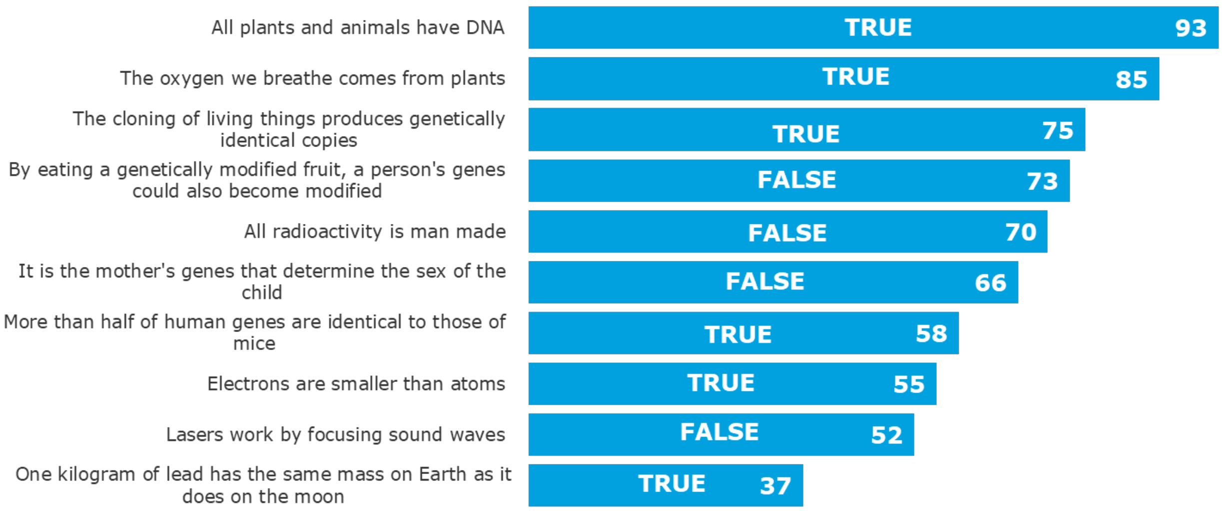
Q7. I'm going to read out a list of topics. Could you tell me, using this card, how well informed you feel, if at all, about each topic?
Base: All respondents (n=1749 in 2019)

Across almost all topics, men were more likely than women to feel that they are well informed. The exception was the use of animals in research, on which knowledgeability was broadly similar among men and women (48% vs 50%).

Objective science knowledge

Nearly all of the questions asked in the survey were based on people's own self-perception of their knowledge about science. To try to obtain a more objective measure of people's basic scientific literacy a science 'quiz' was included comprising of 10 true or false questions[16] (Figure 2.5).

Figure 2.5: Proportion of people correctly answering science quiz questions



Q33. Now for a quick quiz. For each of the following statements, please say whether you think it is definitely true, probably true, probably false or definitely false. If you're not sure, just say so and we'll go on to the next one.
Base: All respondents (n=1749)

Questions related to biology and genetics were most likely to be answered correctly. Nine in ten (93%) knew that all plants and animals have DNA, while more than eight in ten (85%) knew that the oxygen we breathe comes from plants. Conversely, physics questions were least likely to be answered correctly: 55% knew that electrons are smaller than atoms, 52% that lasers do not work by focusing sound waves, and 37% that one kilogram of lead has the same mass on the Earth as on the moon.

Based on their quiz scores, people were split into three groups based on their overall scoring. Those who answered five or fewer questions correctly were classified as having *low* scientific knowledge, those who answered six to eight questions correctly were classified as *medium* scientific knowledge, and those answering nine or ten questions correctly were classified as having *high* scientific knowledge.

Based on this approach just over half of people (53%) were classed as having medium scientific knowledge, around a quarter (27%) had low knowledge, and 20% had high knowledge. The mean score was 6.6.

As might be hoped, there was a close association between this objective measure of scientific knowledge and people's own perception. People with a high level of scientific knowledge were

[16] Respondents were not told afterwards whether their answers were right or wrong

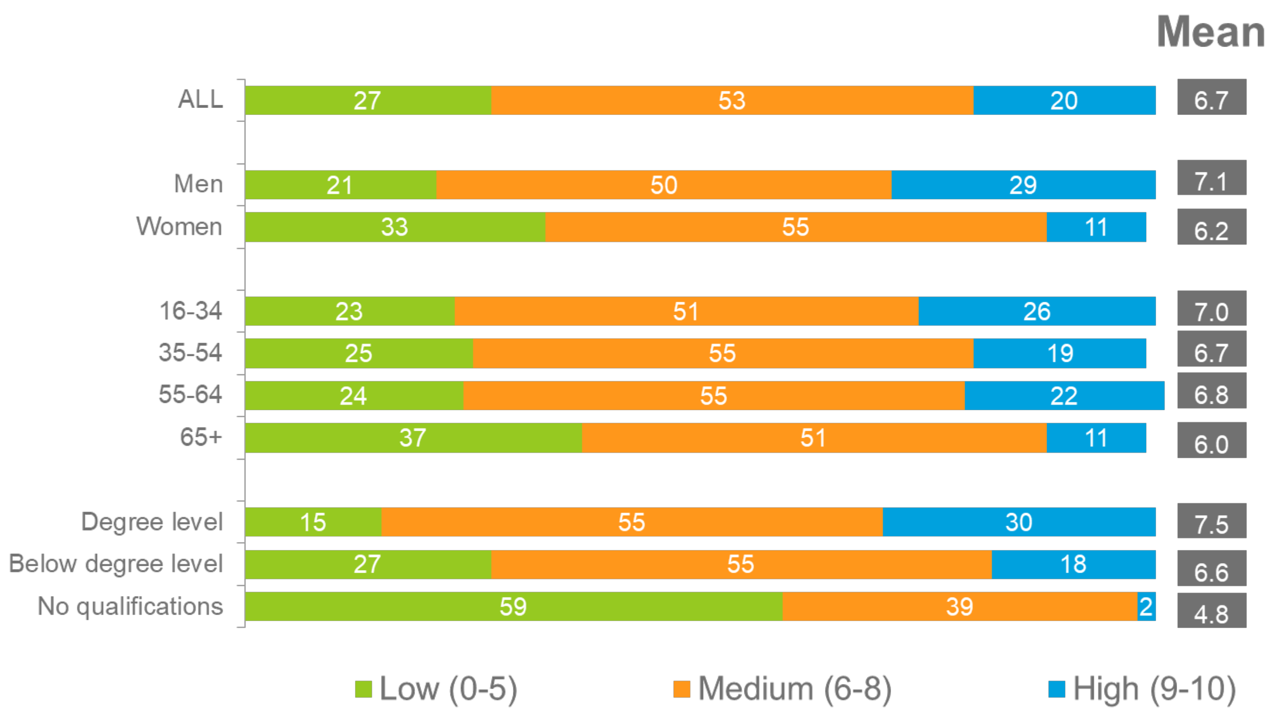
more likely to feel informed about science than not (73% informed vs 27% not informed), while people with a low level of scientific knowledge were more likely to not feel informed (35% informed vs 64% not informed). People with a medium level of knowledge were equally split between feeling informed and not informed (51% vs 48%).

Further evidence of a correlation between self-perception and objective knowledge was illustrated as follows:

- People who felt very or fairly well informed about science had a higher mean score than those who did not feel well informed (7.2 vs 6.1).
- People who said they have a good understanding of science had a higher mean score than those who did not (7.5 vs 5.4).
- People who considered themselves clever enough to understand science and technology had a higher mean score than those who did not (7.4 vs 5.5).
- People who believed that science and technology are too specialised for most people to understand had a higher mean score than those who did not (7.3 vs 6.3)

Objective knowledge about science also varied by group (Figure 2.6):

Figure 2.6: Science quiz scores by group



Q33. Now for a quick quiz. For each of the following statements, please say whether you think it is definitely true, probably true, probably false or definitely false. If you're not sure, just say so and we'll go on to the next one.
Base: All respondents (n=1749); Men (n=842); Women (n=907); 16-34 (n=350); 35-54 (n=572); 55-64 (n=301); 65+ (n=526); Degree level (n=558); Below degree level (n=935); No qualifications (n=249)

- Men had a higher mean score than women (7.1 vs 6.2).
- The mean score for those aged 65+ was 6.0, compared with 7.0 aged 16-34, 6.7 aged 35-54 and 6.8 aged 55-64.
- There was a strong association between education level and objective levels of scientific knowledge. The mean score for those who were degree educated was 7.5 compared with 6.6 for those with below degree qualifications and 4.8 for those with no qualifications.
- People with high science capital had a higher mean score than those with low science capital (8.3 vs 5.3).

Who do people think funds UK scientific research?

People were asked who they thought funds scientific research in the UK: they were not prompted with any specific sources and were able to give as many answers as they wanted (Figure 2.7).

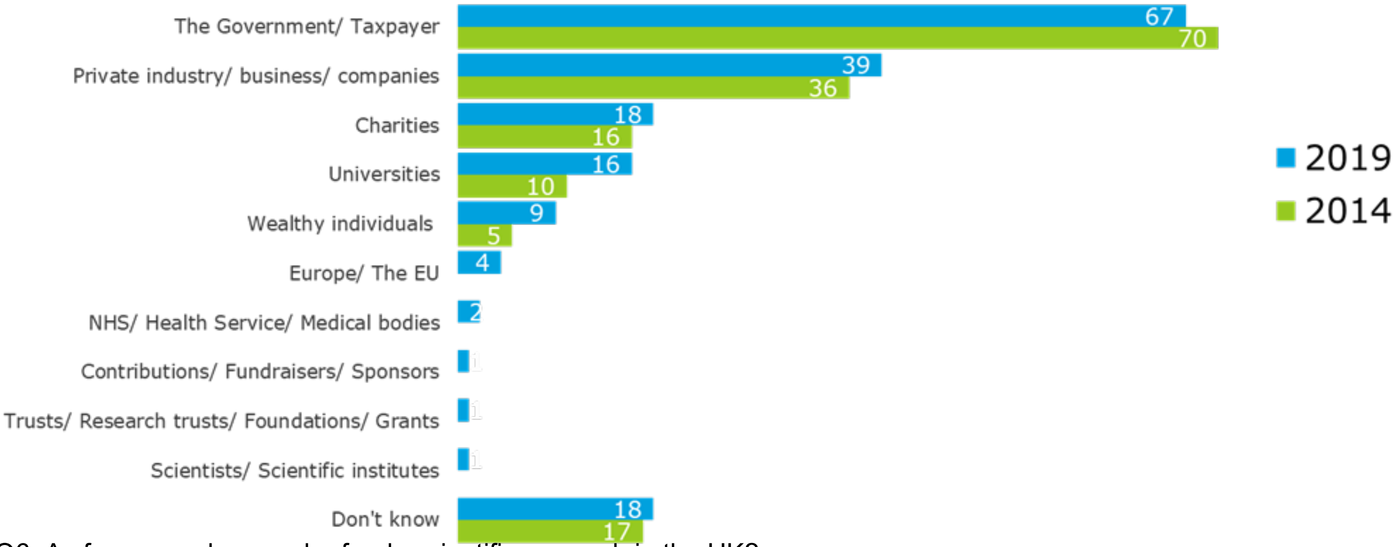
Two-thirds of people (67%) mentioned the government as the funder of scientific research in the UK. The next most commonly mentioned sources were private businesses (39%), charities (18%), and universities (16%). Almost two in ten (18%) people said they did not know who funded science in the UK.

These findings were similar to previous PAS surveys.

Although there is no precise definition of ‘scientific research’, ONS publish annual figures on the UK gross domestic expenditure on research and development which probably represents a close proxy for scientific research. In 2017, this showed that private businesses accounted for 68% of research and development expenditure; higher education accounted for 23%; government for 6%; and private non-profit organisations for 2%[17]. This suggests that while the public do broadly know the main funding sources for science, they underestimate the role that private businesses in the UK play in funding scientific research, while overstating the importance of other sectors (such as charities).

17 https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/bulletins/ukgrossdomesticexpenditureonresearchanddevelopment/2017

Figure 2.7: Who people think funds scientific research in the UK



Q6. As far as you know, who funds scientific research in the UK?
Base: All respondents (n=1749 in 2019)

Perceptions about who funds science varied greatly across different groups:

- Men were more likely than women to mention at least one organisation or body as a source of science funding: 86% of men mentioned at least one source of funding compared with 78% of women.
- Nine in ten people educated to degree level (92%) mentioned at least one source of funding, compared with six in ten of those with no qualifications (62%).
- People aged 25+ were more likely than 16-24 year-olds to mention at least one organisation or body as a source of science funding: 84% of those aged 25+ mentioned at least one source of funding compared with 70% of 16-24 year-olds.
- Those with high science capital were more likely than those with low science capital to mention at least one source of funding (93% vs 71%).

As illustrated above, the proportion of people saying they did not know who funds science varies across different groups. Excluding these people from the analysis reveals some interesting differences in relation to specific sources of funding. Among those who mentioned at least one source of funding, men were more likely than women (55% vs 40%) and people educated to degree level were more likely than those with no qualifications (61% vs 23%) to mention private industry as a source of funding.

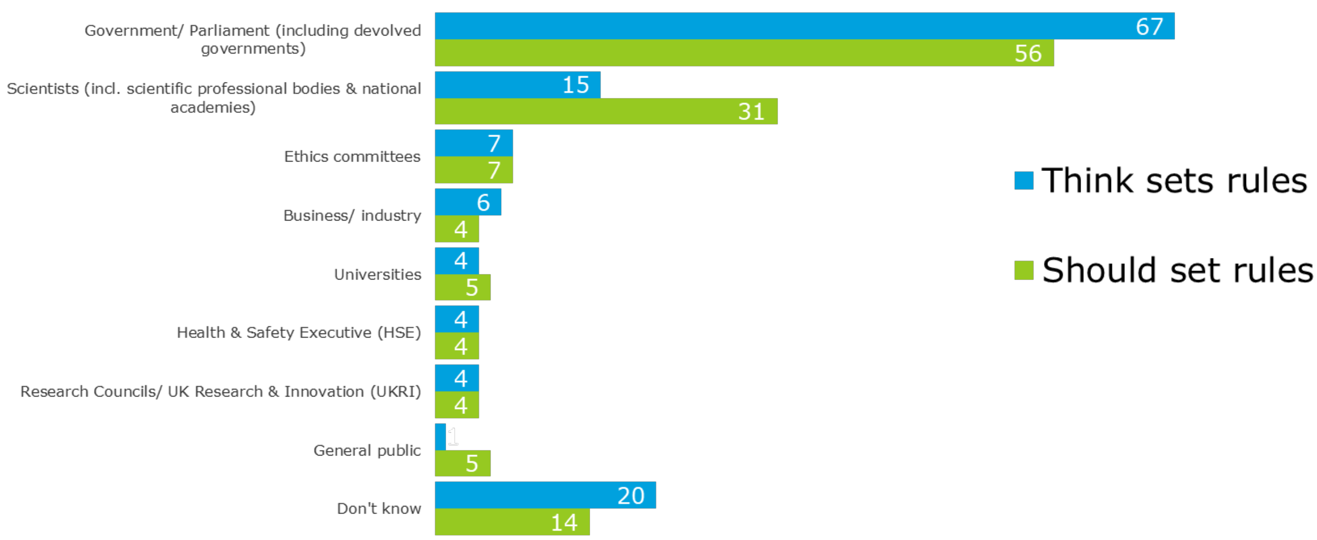
Further information about attitudes towards science funding can be found in Chapter 7.

How much do people know about science regulation in the UK?

People were asked who they thought regulates scientific research in the UK: they were not prompted with any specific sources and were able to give as many answers as they wanted (Figure 2.8).

Two thirds of people (67%) thought the government (including devolved governments) sets the rules and regulations for scientists in the UK to follow when they are doing their job. This was, by a wide margin, the most commonly cited response. The only other source of regulation mentioned by more than one in ten people (15%) was scientists themselves, either individually or through their professional bodies and national academies. One in five people (20%) said they did not know who regulated science.

Figure 2.8: Who people think sets/ should set the rules and regulations for scientist in the UK to follow when they are doing their job



Q10. As far as you know, who, if anyone, sets the rules and regulations for scientists in the UK to follow when they are doing their job? / Q11. Who, if anyone, do you think should set the rules and regulations for scientists in the UK to follow when they are doing their job?
Base: All respondents (n=1749)

Awareness of regulation varied across different groups:

- Men were more likely than women to mention at least one organisation or body which regulates science: 86% of men mentioned at least one regulator compared with 75% of women.
- People educated to degree level were more likely than those with no qualifications to mentioned at least one regulator (83% vs 61%).
- Awareness of who regulates science is lowest among the very old and the very young. More than eight in ten of those aged 25-74 (83%) mentioned at least one regulator, compared with 74% of those aged 75+ and 71% of those aged 16-24.
- Those with low science capital were more likely than those with high science capital to say they did not know who regulates science (32% vs 9%). Those with high science capital were more likely than those with low science capital to mention at least one regulator (91% vs 68%).

Among those who mentioned at least one organisation or body which regulates science, there were some differences across groups regarding who was thought to act as a regulator. People educated to degree level were more likely than those with no qualifications to mention the European Union (15% vs 1%) or Ethics Committees (14% vs 3%) as regulators. People aged under 65 or more likely than those aged 65+ to mention the European Union as a regulator (10% vs 5%).

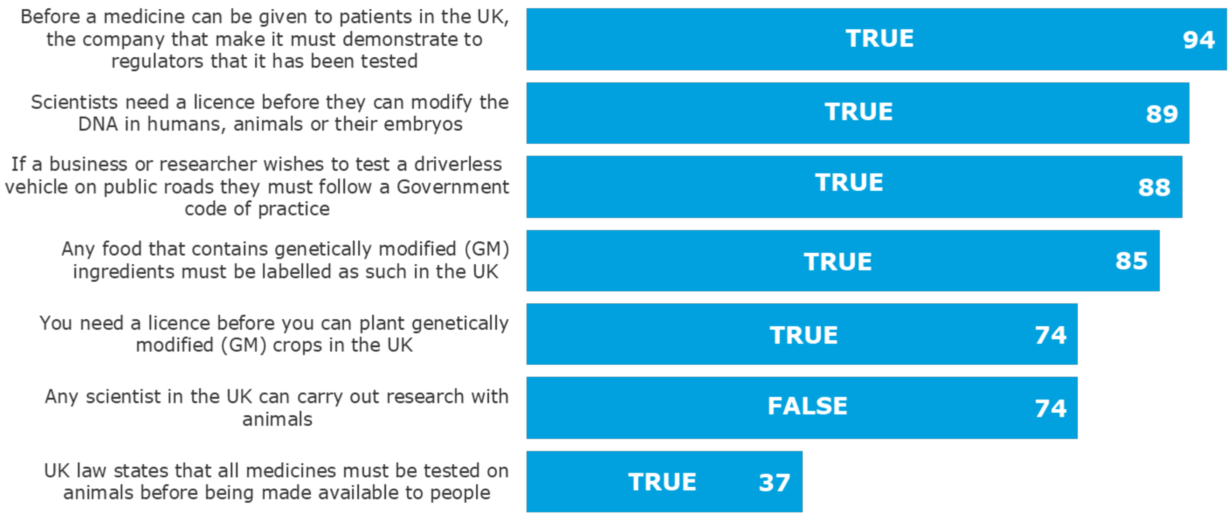
However, of those people who mentioned the government as regulators, not all agreed that this should be the case. Just over half of all people (56%) said they thought science should be regulated by the government. There was a sense among some people that scientists should have a larger role in regulating science. Three in ten (31%) thought that scientists or scientific professional bodies should set rules and regulations compared with 15% who believed they currently do.

Further information about who people feel should regulate science is provided in Chapter 7.

In order to further gauge people's understanding of science regulation in the UK, respondents were shown a series of statements in relation to regulation and asked to state whether they were true or false. The findings remain aligned with 2014 though the statements about regulation for DNA modification in humans and animals, and about driverless vehicles, were new in 2019.

As shown in Figure 2.9, most people answered correctly in relation to all statements, with the exception of 'UK law states that all medicines must be tested on animals before being made available to people'. Just under four in ten people (37%) correctly identified this statement as being true, with half (49%) believing it to be false.

Figure 2.9: Proportion of people correctly answering questions about science regulation



Q20. I am going to read out a number of statements. For each one, I would like you to tell me whether you think it is true or false.
Base: All respondents (n=1749)

Wave 1: Engaging the public with science

The first digital dialogue (28 participants) and focus groups (30 digitally excluded people) explored engagement with and levels of trust in science. Participants understood science in different ways but were more engaged and felt more involved when it was relevant to their lives. They felt particularly involved with science during medical episodes, such as when a loved one was ill or during pregnancy.

"Science to me is people working in a lab finding new medicines to help fight off illness or creating cures. I also think of science from when I was at school and doing test with the Bunsen burners and test tubes." *(Digital Dialogue, Female)*

"Blue Planet' is a fascinating, captivating and totally enthralling series which makes me feel in total awe of the wonders of our fabulous planet and sheds light in areas we would never have imagined could be captured on camera." *(Digital Dialogue, Female)*

Science was seen as a broad and ill-defined topic synonymous with technological advancement. Participants held one of two main conceptions of science. In line with the survey, some participants held a narrow view focused on schools, and experiments in labs, while a broader vision acknowledged the involvement of science in everything in the world and society. Those who did not see science as particularly important tended to be from lower socio-economic groups and said they rarely thought about it. Although there was wide interest and curiosity in science, participants felt confused and overwhelmed by the processes and terminology involved in scientific research.

"Yes, when my father was taken ill with cancer. Without the untold research analysis etc done he may have died. This allowed me to have a father in my life which I'm truly thankful for!" *(Digital Dialogue, Male)*

While the two categorisations differed significantly, participants could move from a narrow to a broader approach when prompted to consider the role of science in society and their own lives.

"It's full of terminology I don't understand. I also think it requires a capacity of thinking in abstract ways and I'm just not very good at that." *(Digital Dialogue, Female)*

Personal relevance was key to engagement. There was broad agreement that science plays an important role in the highly personal area of healthcare. Participants also liked to engage with science for their own enjoyment at a time and place of their choosing – with TV programmes about nature and space, listening to podcasts and attending museums with families all being popular. These brought science to life and catalysed curiosity.
This suggests that appealing to personal experiences of medical science and showcasing the natural world are effective ways of increasing public engagement with science. Key to this, however, is showing the science in an accessible and vivid way, as is exemplified by nature documentaries.

3. Finding out about science

This chapter explores whether people feel they get enough information about science and the main sources used to obtain information about new scientific research findings. Where relevant, findings have been tracked since 2014.

Key findings

People continued to display an appetite for information about science and to get their information from television and newspapers, but there was a shift over time from print to online newspapers, and an increased reliance on online sources, particularly social media.

Changes over time

- There was an increase in the proportion of people citing online sources as their main source of information about new scientific research findings. In particular, social media was cited by 6% of people in 2014 compared with one in five (20%) in 2019. This was primarily driven by the growth of Facebook as a main source of information (from 4% in 2014 to 15% in 2019).
- There was a shift from print newspapers to online newspapers and news channels as a main source of information. In 2014 28% mentioned print newspapers but this declined to 13% in 2019. In contrast mentions of online newspapers and news websites grew from 15% in 2014 to 28% in 2019.

2019 findings

- As in previous years, there was an appetite for more information about science. Only 5% of respondents said they hear or see too much information about science these days compared with almost half (47%) who said they hear or see too little information about science.
- The most commonly used sources of information about new scientific research findings were television (46%) and newspapers (40%). Few people mentioned scientific journals (5%) and online science blogs (1%).
- In contrast to findings in other chapters, gender does not appear to be associated with where people hear or read about scientific findings most often (outside of any formal science lessons or classes) and whether or not people feel they hear or see far too much or too little information about science. People’s age and education level were the most influential demographics.

Context

Most people do not hear or see about science and scientific developments through direct engagement with scientists, specialised scientific journals and papers, or public engagement activities. Instead, the majority of the public obtain information about science through traditional and online media.

After individuals finish their formal education, media becomes the most available and often sole source of information about scientific discoveries (Brossard & Nisbet, 2007). Given that media consumption patterns have been changing rapidly over the last decade (Ofcom, 2018, Newman et al, 2019) this is likely to have affected the way the public consume science news over time. In particular, data from Ofcom shows that:

- Although almost all households still have access to television (95%), the average number of hours watched per week has been falling and the way in which television is consumed has changed with the growth of streaming services and on-demand TV.
- 9 in 10 people watched TV every day in 2017, although the average time spent went down by 9 minutes compared to 2016, and those aged 55+ accounted for more than half (51%) of all viewing in the UK.
- Over nine in ten adults (90%) use the internet, with usage almost universal among those aged under 65. The average time spent on the internet has been increasing, with 86% of adults using the internet daily.
- More than three-quarters (77%) of internet users have a profile or account on a social media or messaging site. Facebook remains the most popular social media site, although the number of visitors to the site has been declining.
- The proportion of people obtaining their news from print newspapers has declined from 59% in 2013 to 36% in 2019, as more people switch to reading digital newspapers.

These changes in general media consumption were clearly reflected in PAS 2019, in terms of where people report hearing or reading about new scientific research findings, and how these sources have changed since PAS 2014.

This is important because the changing ways in which people consume media more generally and the different channels and platforms they use may change the information people see or read about science in the future, which will, in turn, help shape their attitudes. This is especially important in the current era of 'fake news'.

The PAS 2014 report and the PAS 2019 literature review (Burchell, 2019) noted that most people were likely to acquire information about science in an 'incidental' manner, as part of their general media consumption, rather than actively seeking it out. It was suggested that those using traditional media sources, such as television or radio, were even more likely to acquire information about science incidentally, while those using online sources were more likely to be actively seeking out information about science.

Some evidence for this was found by a Wellcome survey (Ipsos Mori, 2016), which indicated that 67% of people passively encountered information about medical research compared with 42% of people who actively sought out information. Supporting this, the Wellcome Monitor (2016) also found that the majority of the public would prefer to hear from scientists via passive means, such as television, radio, newspapers and websites, rather than through direct interaction.

This same study also found that, among those who actively sought out information, 90% said they used the internet to do this. However, this assumption is based largely on people using search engines to deliberately search for science-related information online. Increasingly, with the growth of online newspapers and the increasing popularity of social media platforms, it is likely that people will also obtain information about science online in an incidental or passive manner, similar to that in traditional media, as well as actively searching for it.

For example, social media platforms rely heavily on algorithms to provide appropriate suggested content for the user and this is largely based on what the user has searched for before. This means that a single interaction with scientific content online, whether initiated through searching for content or exposure through online advertising, has the potential to expose someone to similar content, which could result in increased incidental exposure within their social media feed(s).

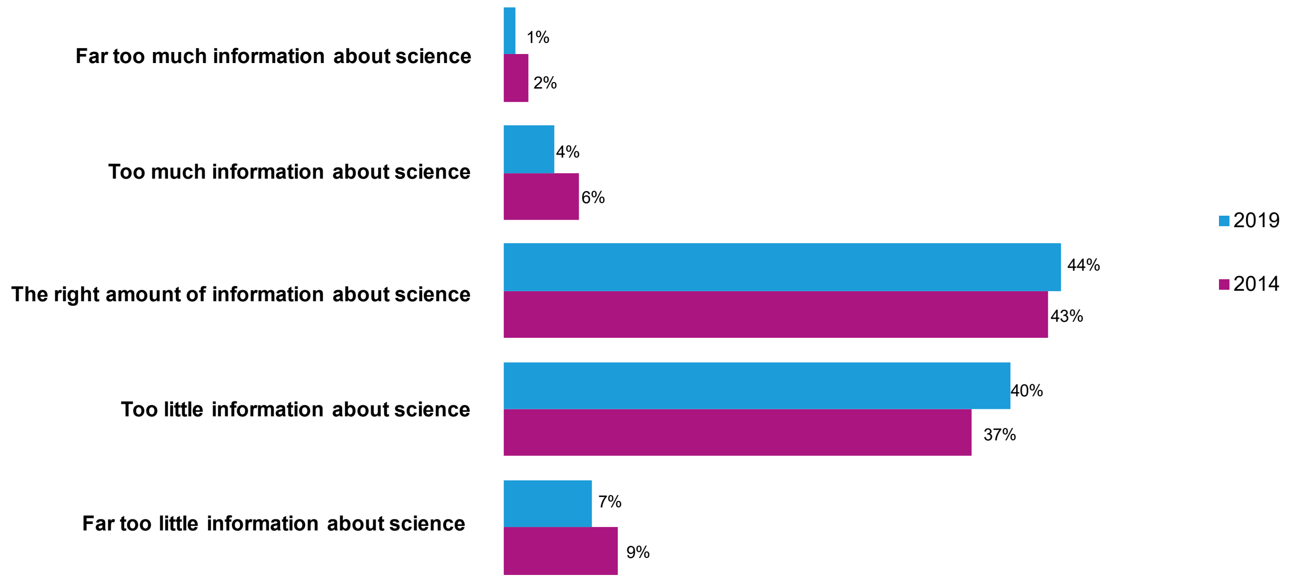
Herein lies one of the critiques of social media, that users get caught within their user ‘bubble’, only exposed to content that is similar to what they have engaged with before, further reflecting their interests, opinions and biases. However, it would only take a limited amount of interaction with scientific content for a social media user to increase their potential for incidental scientific research exposure. There is the risk that those who do not engage with scientific content through their social media are missing out.

Whilst this is something to bear in mind, it also means there is a new opportunity to communicate with populations through social media advertising who might have previously been ‘hard to reach’. Using targeted ads, a single interaction with this ad would increase the scientific content fed onto the user’s social media feed.

What do people think about the amount of information they hear or see about science?

Survey respondents were asked whether they feel they hear and see too much or too little about science these days. Almost half (47%) felt that they hear or see too little information about science, compared with only 5% who felt they hear or see too much (Figure 3.1). A further 44% of people felt that they receive about the right amount of information about science. These findings are very similar to the findings from PAS 2014.

Figure 3.1: How much information about science people hear or see these days



Q3. Which of the following statements on this card do you most agree with? These days I hear and see …
Base: All respondents (n=1749 in 2019, n=1749 in 2014)

There were only a few differences among different sub-groups of the population. While no one group was more or less likely to feel they hear or read too much about science, some were more likely to feel that they hear or read too little:

- Younger people aged 16-34 were more likely than those aged 65 or over to feel they received too little information about science (59% vs 31%).
- Those educated to degree level or above were more likely than those with no qualifications to feel they received too little information about science (50% vs 33%).

Where do people find out about new scientific research findings?

Few people had any direct contact or involvement with scientific research in their day-to-day lives, with only 17% of people reporting that they were studying science or working in a science-related job at the time of the survey. As a result, the media through which people get their information about science and scientific developments are integral to shaping their broader attitudes and beliefs about science, regulation and science policy.

Over the last decade people’s sources of science information and news have changed, with the proliferation of digital platforms and channels displacing more traditional media channels. Moreover, traditional channels have themselves diversified and changed in response to this digital growth: for example, newspapers have developed both print and digital channels, while traditional news and information organisations such as the BBC have become multi-channel news platforms.

Survey respondents were asked which one or two sources they used most often to hear or read about new scientific research findings, excluding any formal science lessons or classes they may have taken. Television was the source reported most frequently, with 46% of the public choosing this as one of their main sources of scientific research findings. Other common sources were newspapers (40%), social media (20%), and radio (15%). Few people reported using specialised science sources, with only 5% choosing scientific journals and 1% choosing online science blogs (Figure 3.2). As might be expected those who worked in or studied science were more likely than those who did neither to report scientific journals as one of their most used sources of information (17% vs 2%).

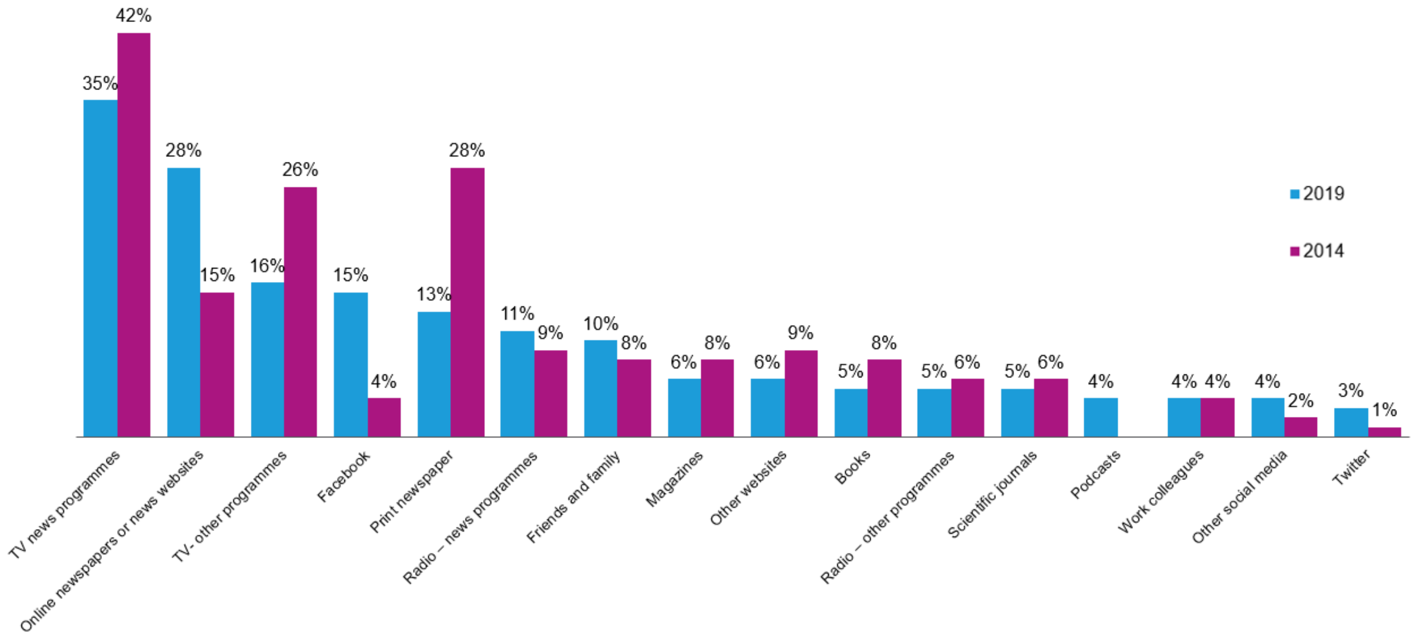
Each main type of channel was further broken down into different categories. Television news programmes specifically were reported as a main source used to hear or read about scientific research findings (35%), while 16% selected ‘other’ television programmes[18]. A similar pattern was seen for radio, with radio news (11%) being a more common source than other radio programmes (5%). Almost three in ten (28%) reported online newspapers or news websites as one of their main sources used to hear or read about new scientific research, while 13% chose print newspapers.

The most popular social media source was Facebook, which was selected by 15% of people. It is worth noting that despite Facebook more than trebling since 2014, scientific content consumed on Facebook is most likely shared content (in the form of articles, short films, memes) from other sources, rather than Facebook-generated content. This might include an individual seeing new scientific content on the BBC news Facebook page. There were some notable changes between PAS 2014 and PAS 2019:

- While television remains the single most commonly reported source used to hear or read about new scientific research findings, the proportion of people selecting it declined from 59% in PAS 2014 to 46% in PAS 2019.
- The use of newspapers as a source was broadly similar in 2014 and 2019. However, the split between online and print channels changed significantly between the two surveys. In PAS 2014, 28% reported print newspapers as a main source of information, but this declined to 13% in 2019. In contrast the proportion of people selecting online newspapers and news websites grew from 15% in 2014 to 28% in 2019.
- Social media as a main source increased from 6% in 2014 to 20% in 2019. This was primarily driven by the growth of Facebook from 4% in 2014 to 15% in 2019 but there was also growth in the reported use of Twitter and other social media sites. The growth of Facebook as a main source of science findings may be related to the nature of social media algorithms, as outlined earlier.
- Although a less frequently reported main source, radio was equally prevalent in 2019 (15%) compared with 2014 (14%) suggesting there is still a place for more traditional sources, although radio programmes can also be accessed online.

[18] Percentage figures add to more than the total for television because people could have given both TV news and other TV programme as a response

Figure 3.2: Where people hear or read about scientific research findings most often



Q4. Outside of any formal science lessons or classes you may take, from which one or two of these, if any, do you hear or read about new scientific research findings most often?
Base: All respondents (n=1749 in 2019, n=1749 in 2014)

More detailed analysis of the PAS 2019 data reveals that age and education level were the primary discriminators. Differences by age are almost certainly a reflection of more general differences in media channel usage by age group.

- Older people were more likely than younger people to report using traditional media channels as a main source of information about new scientific research findings. Those aged 65 and over were almost twice as likely as those aged 16-34 to select television (61% and 32% respectively). Similarly, those aged 65 and over were more likely to choose radio (21%) than those aged 16-34 (10%).

- In contrast younger people were more likely to report social media as a main source of information. More than a third (36%) of 16-34 year olds selected this compared with 7% of 55-64 year olds and only 2% of those aged 65 and over.

- Newspapers as a whole were equally likely to be reported as a main source by young and old (38% of both 16-34 year olds and 65+) but the type of newspaper channels used differed. Those aged 16-34 reported using online newspapers and news websites almost exclusively as a main source (34%) with few reporting using print newspapers (4%). For those aged 65 and over the reverse was true, with print newspapers (27%) being a more common source than online newspapers or news websites (11%).

The main sources used to obtain information about new scientific research developments also differed by level of education:

- People with no qualifications were more likely than those educated to degree level or above to report using television (56% and 37% respectively).

- All other sources of information were reported more often by those educated to degree level or above compared with those with no qualifications, particularly newspapers and social media.
- Newspapers were reported as a main source by half (50%) of those educated to degree level or above compared with 28% of those with no qualifications. This difference was largely due to a difference in using online newspapers and news websites (39% and 10% respectively) rather than print newspapers.
- Social media was reported as a main source of information by 18% by those educated to degree level or above, twice the proportion of those with no qualifications (9%).

There were also similar differences by science capital. People with high science capital were more likely than those with low science capital to mainly access science information through online news sites (40% vs 10%) and science journals (16% vs 2%) but less likely to access to use TV news as a main source of science information (20% vs 42%).

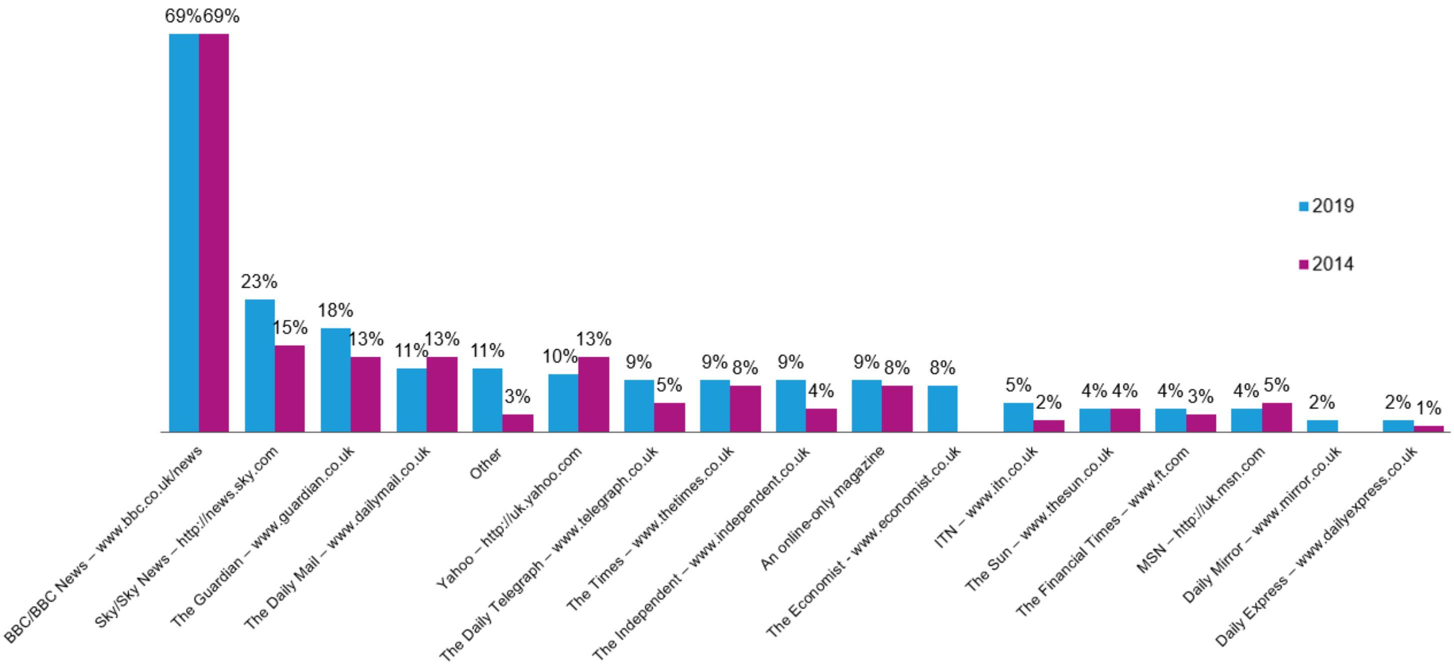
Which online newspapers or news websites do people use most to find out about new scientific research findings?

Survey respondents who reported using online newspapers or news websites as one of their main sources of information about new scientific research findings, were asked which specific sites they used.

Overall, traditional news media outlets were the most commonly reported sources, with BBC/ BBC News chosen by 69% of those using online sources (Figure 3.3). Sky/ Sky News was the next most frequently reported source of online news (23%).

People were more likely to report the online sites of broadsheet newspapers (33%) as a source of information compared with tabloid newspapers (18%). The most commonly reported sites were The Guardian (18%), The Daily Mail (11%) and The Times (9%). It seems unlikely that people use these sites specifically as a source of information about science but rather that their choice is driven by the newspaper they read for all their news.

Figure 3.3: Where people find out about new scientific research findings from online newspapers or news websites



Q5. You said you get information about new scientific research findings from online newspapers or news websites. From this card, which of these, if any, do you use?
Base: Finds about new scientific research findings from online newspapers or news websites (n=486 in 2019, n=336 in 2014)

There were few differences between PAS 2014 and PAS 2019 in terms of the main online sources used, with the well-known news 'brands' remaining the most popular sites reported.

The online news sources most commonly reported as a source of science information showed some differences by level of education but little difference by age. Among those who reported using online news sites, those educated to degree level or above were more likely than those with no qualifications to choose the BBC/BBC News as a source of information (80% and 43% respectively) and to choose the websites of broadsheet newspapers (47% and 10% respectively).

4. Trust in science reporting

This chapter explores the different dimensions of trust in science reporting, covering people's views on media coverage of science, the role of journalists in science reporting, and the sources of information people use when learning about science.

Key findings

Traditional media is more trusted than online-only media. People are still confused about the reliability of science news reporting although there is evidence that trust has increased since PAS 2014.

Changes over time

- Compared with 2014, people were more positive about science reporting in the media. A belief that the media sensationalises science fell from 71% in 2014 to 61% in 2019 and people were less likely to say that politicians are too easily swayed by the media's reaction to scientific issues (62% in 2019 vs 70% in 2014) and that there is so much conflicting information about science it is difficult to know what to believe (65% vs 70%).
- A third of people (32%) thought it was always or mostly true that journalists check the reliability of scientific research findings before they write about them. This represents a slight improvement from 2014, when less than three in ten (28%) thought this was always or mostly true.

2019 findings

- Opinion was split as to whether information heard about science is generally true. Half of respondents agreed that this is the case, while a tenth disagreed and one third said that they neither agree nor disagree.
- Those who agreed that information about science is generally true typically felt this way because they have no reason to doubt the information. Those who disagreed most commonly explained their scepticism as being due to a lack of evidence for the information they come across.
- People clearly had more trust in traditional media (such as newspapers, magazines, television news, radio news, and associated websites) than online-only media (i.e. online news sites and blogs which do not have an offline version). However, a fifth of people would trust neither traditional nor online media to provide accurate information about science.
- In relation to online information about science, people were much more likely to trust the accuracy of information they have searched for themselves, compared to information that is presented to them via a third party (i.e. friends, celebrities, or promoted content). However, compared with other groups, those with no qualifications had less confidence in information they have searched for themselves.
- When asked to identify the sources that are best for informing people about science, many people selected sources that they do not use themselves.

Context

Many surveys, including previous PAS surveys, have shown that almost all people obtain information about science and technology through various forms of media, and not through more direct routes such as engagement with scientists, scientific papers or public engagement with science activities. Although the online-only sources are an increasingly important source of information about science and technology, TV and newspapers still appear to be more important (see Chapter 3).

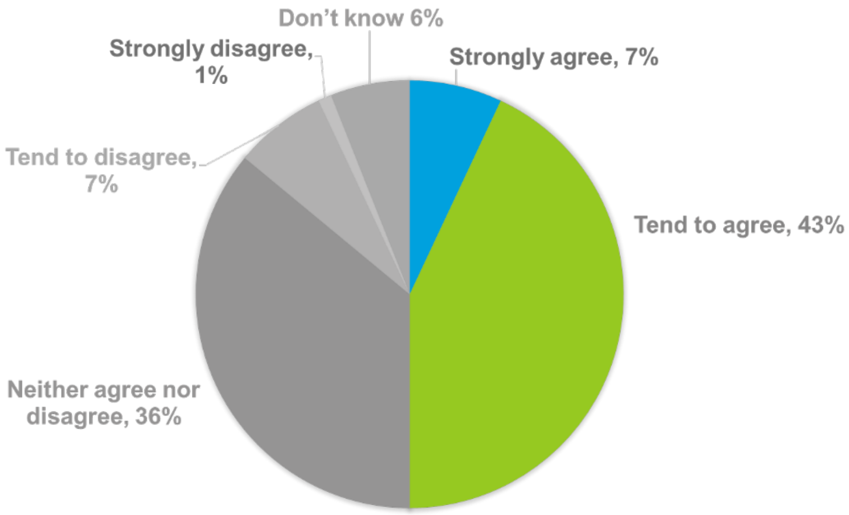
In keeping with broader public attitudes to the media, surveys on public attitudes to science in the media suggest that the public is not trusting of journalists or the media. For instance, in the studies that ask about trust across a range of different professional groups, journalists score very poorly in terms of public trust compared with most other professions (Ipsos MORI, 2011; 2014; Wellcome Trust, 2016; Ipsos MORI, 2017, Ipsos Mori, 2018). Reuters (2019) shows that in the UK, trust in the news has fallen over 11 percentage points since 2015 and in 2019 70% of UK respondents agreed that "I am concerned about what is real and what is fake on the internet", up 12% in a year. However, there is some evidence (backed up by the findings in this chapter) that, bucking this trend, trust in science media is increasing. Burchell, 2019 comments that this may imply that ‘post-truth’ concerns are positively affecting trust in scientists (see also Bauer, 2017). For instance, it might be the case that scientists are understood as a beacon of trustworthiness within a broader untrustworthy context.

In the context of controversial scientific technologies, research has shown a relationship between public attitudes to certain scientific subjects and the amount of media coverage of the controversy, although the direction of the relationship is difficult to establish. For instance, based on surveys tracking media coverage and public attitudes with respect to GM food, from 2003-2012, Marques et al. (2015) reported a significant increase in support for GM food when there was less media coverage, with support being at its lowest in those years where media reports were at their highest (Burchell, 2019).

How much do people trust information about science?

People were five times more likely than not to believe that the information they hear about science is generally true: 50% said they feel the information they hear about science is generally true compared with 9% who did not think this was the case. This was broadly in line with results from previous years (in 2014, 52% thought science information was generally true). (Figure 4.1).

Figure 4.1: Extent to which people agree or disagree that 'the information I hear about science is generally true'



Q29. Here are some statements about how science is communicated and discussed. For each, please could you tell me the extent to which you agree or disagree?
Base: All respondents (n=1749)

Key differences by subgroups were:

- Men were more likely than women to believe the information they hear about science is generally true: 57% of men agreed with this statement compared with 44% of women.
- Those with either degree level or sub-degree level qualifications were more likely to agree than those without qualifications: 54% of degree-educated people agreed science information was generally true compared with 41% of those with no qualifications.
- Those with high science capital were more likely than those with low science capital to feel the information they hear about science is generally true (65% vs 39%).

One of the reasons that people may not feel the information they hear about science is generally true is the multiple sources and channels of information people have access to, which have greatly expanded in the digital age. Two thirds of people (65%) said they feel that the amount of conflicting information about science makes it difficult to know what to believe (down from 70% in 2014).

When asked, unprompted, why they either agreed or disagreed that the information they hear about science is generally true, the most common responses given by both groups suggest a general inability to clearly articulate distinct reasons for their views. Instead, attitudes appear to be derived from a general feeling or instinct that people have, which was driven more by their general outlook on society and people in general (i.e. whether or not they are a naturally trusting person) rather than with specific reference to science.

Among those who felt the information they hear about science is generally true, the most common response (reported by 30%) was that they have 'no reason to doubt it', followed by 16% who said there was no particular reason for their view, it was 'just what they believed'. This suggests a somewhat passive attitude towards science information among some people whereby the default position is to trust information unless there is a clear reason to question it.

To the extent that people could articulate more clearly why they felt information about science was generally true, there was faith in the integrity of scientists themselves and in regulation, with 15% saying that information is checked by other scientists (peer review), and a similar proportion saying that information comes directly from scientists (13%).

The role of scientists in quality assuring their own work was seen in the fact that 61% of all people felt that it was always or mostly true that before scientific research is published it is checked by other qualified scientists.

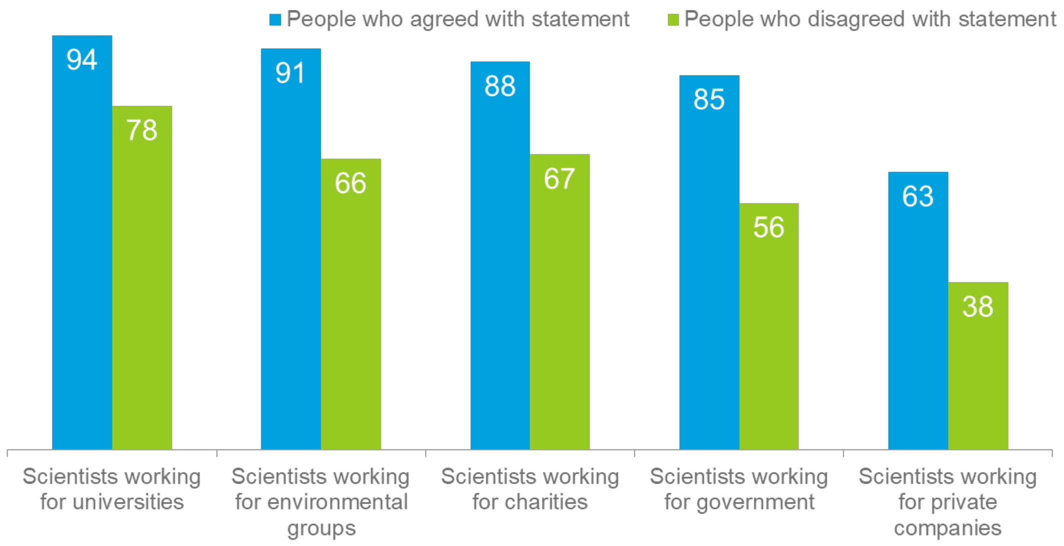
On the other hand, among those who did not feel the information they hear about science is true (only 9% of people), 22% said there was 'no proof or evidence provided' while 20% said that there was no particular reason for their view, it was 'just what they believed'. This suggests the same passive attitude among this group but in the opposite direction; their default is not to trust information unless some evidence is provided.

To the extent that people could articulate more clearly reasons for not trusting science information the only notable reason given was to do with not trusting the media and the way in which the media sensationalises issues – reported by 18% of those who did not feel science information was generally true.

Those who felt information about science is generally not true were less likely to express trust in scientists (Figure 4.2).

Figure 4.2: Extent to which trust scientists to follow rules and regulations which apply to their profession, by agreement with statement 'The information I hear about science is generally true'

% Great deal/ Fair Amount



Q29. Here are some statements about how science is communicated and discussed. For each, please could you tell me the extent to which you agree or disagree?
Base: All respondents: Agreed with statement (n=894); Disagreed with statement (n=146)

How much do people trust media reporting of science?

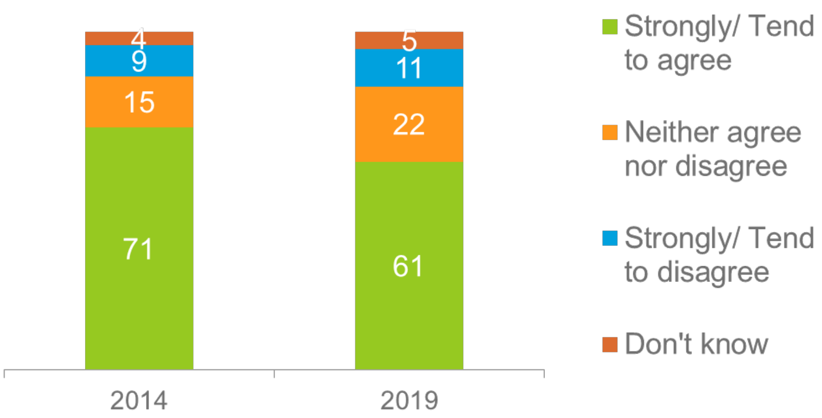
There was a large degree of support for the idea that the media sensationalises science, with six in ten (61%) agreeing that this is the case, compared with just one in ten (11%) who disagreed. In addition, 65% felt that 'there is so much conflicting information about science it is difficult to know what to believe. However, the proportion of people feeling that the media sensationalises science has fallen since 2014, when seven in ten (71%) agreed that this was the case (Figure 4.3). There was a similar level of agreement (62%) with the notion that politicians are too easily swayed by the media's reaction to scientific issues (down from 70% in 2014). These results taken together suggest that, at least in the minds of the public, media sensationalisation can have an important (and potentially detrimental) impact on decisions that are made about science.

By subgroup:

- In terms of educational attainment, the key difference was between those with a degree level qualification and those with lower/ no qualifications. Those with a degree level qualification were not only more likely than other people to agree that the media sensationalises science (73%), but were also more likely to offer an opinion on this issue. Just over half of those with qualifications below degree level (56%) and those with no qualifications (53%) agreed with this statement.

- Those with high science capital were more likely than those with low science capital to feel that the media sensationalises science (74% vs 47%).

Figure 4.3: Agreement with statement: 'The media sensationalises science'



Q29. Here are some statements about how science is communicated and discussed. For each, please could you tell me the extent to which you agree or disagree?
Base: All respondents (n=1,749)

There is further evidence that people have doubts about the robustness of science reporting by the media. Only a third of people (32%) thought it was always or mostly true that journalists check the reliability of scientific research findings before they write about them, compared with 62% who thought this was occasionally or never true. This represented a slight improvement from 2014, when less than three in ten (28%) thought this was always or mostly true.

Only two in ten (18%) thought it was always or mostly true that journalists who write stories about science have a science degree or similar qualification, compared with seven in ten

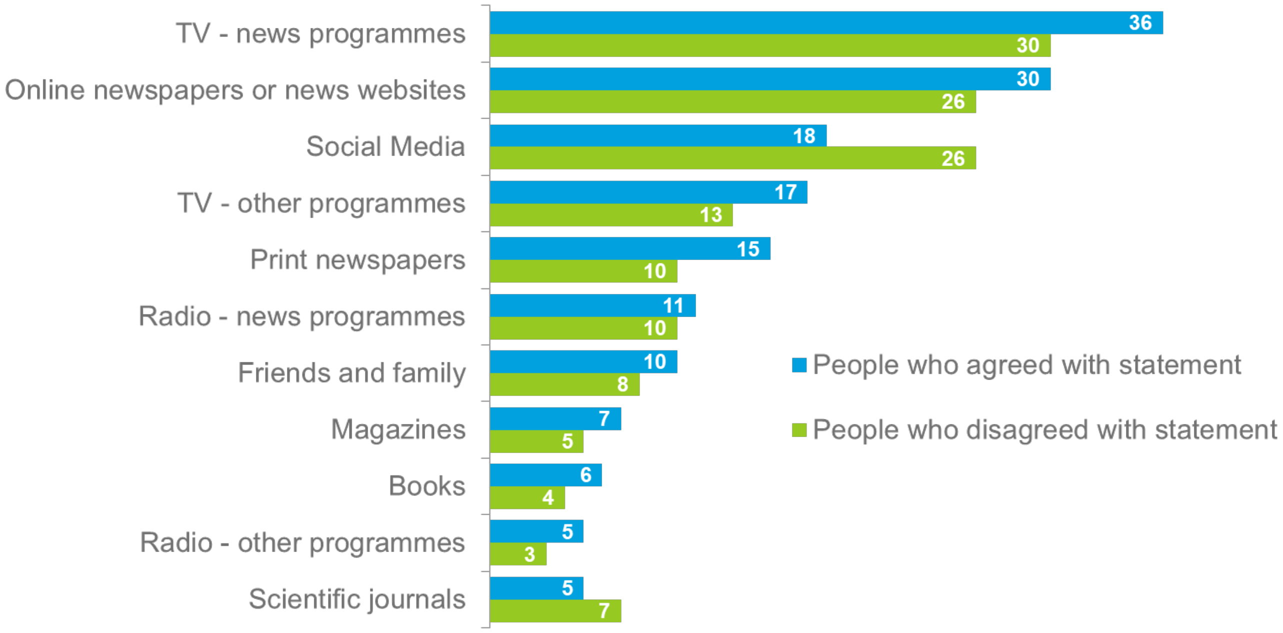
(71%) who felt that it was only occasionally or never the case that they had a science qualification.

How does the source of information affect trust?

As outlined in Chapter 3, people get their information about science from a wide variety of sources; both traditional sources (TV, radio, books and magazines/ newspapers) as well as newer sources such as social media, blogs and podcasts.

There was some evidence that opinions about the truthfulness of scientific information may have been influenced by the different sources of information people typically use to learn about new scientific research findings (Figure 4.4). Those who agreed with the statement 'The information I hear about science is generally true' were more likely than those who disagreed to learn about science most often through TV news programmes (36% vs 30%), online newspapers or news websites (30% vs 26%) or print newspapers (15% vs 10%), and less likely to get such information from social media websites such as Facebook or Twitter (18% vs 26%).

Figure 4.4: Source of information most often used to hear or read about new scientific research, by agreement with statement 'The information I hear about science is generally true'



Q4. Outside of any formal science lessons or classes you may take, from which one or two of these, if any, do you hear or read about new scientific research findings most often?
Base: All respondents: Agree with statement (n=894); Disagree with statement (n=146)

There was a clear relationship between feeling well informed about science and trusting that information heard about science is generally true. Six in ten (59%) of those who felt well informed felt that the information they hear is generally true, compared with four in ten (41%) of those who did not feel well informed about science. Similar results were in evidence in 2014.

People were asked how much they trusted traditional media[19] to provide accurate science information compared with online-only media.

Responses showed that the public had more trust in the accuracy of science information found in traditional media (such as newspapers, magazines, television news, radio news, and associated websites) compared with online-only media (i.e. online news sites and blogs which do not have an offline version). Seven in ten people (71%) said that they would trust traditional media to provide accurate information about science, while fewer than half (45%) said they would trust the accuracy of information from online-only media[20]. In fact, slightly more people mistrusted online-only media to provide accurate information than trusted it (47% v 45%).

While trust in traditional media was broadly the same across all age groups, there was, perhaps unsurprisingly, some difference in relation to online-only media. Those aged 16-34 were more than those aged 65+ to say that they trust online-only media (56% vs 28%).

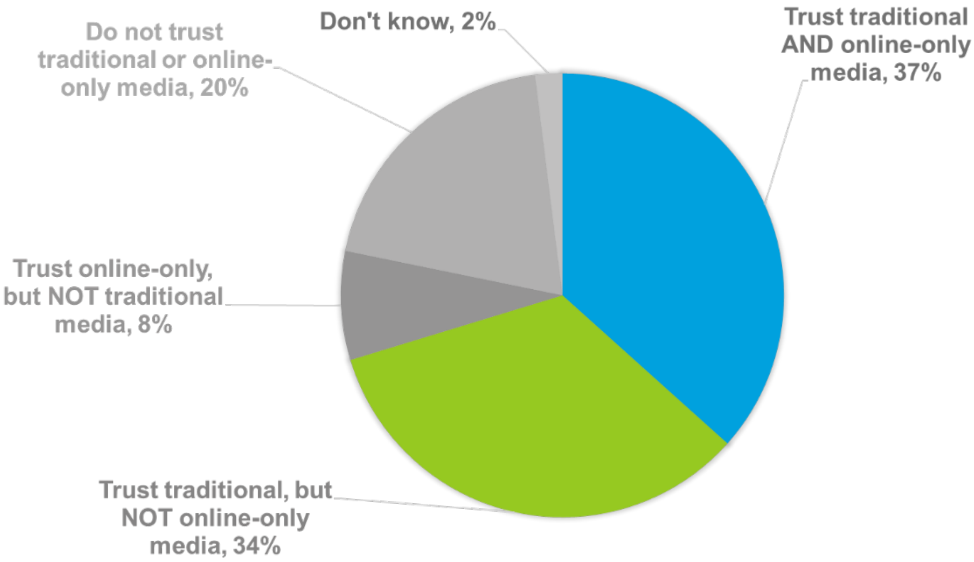
Overall just under three in ten (37%) said that they would trust both traditional and online-only media to provide accurate information about science, with a third (34%) saying they would trust traditional media but not online-only media and one in ten (8%) saying they would trust online-only media but not traditional media (Figure 4.5). A sizeable minority of people (20%) said that they would not trust either traditional or online-only media to provide accurate information about science. This view was most prevalent among those with no qualifications, three in ten of whom (29%) said that they would not trust either source, compared with less than two in ten (15%) of those with a degree or higher.

These findings are supported by wider research (Reuters, 2019) which indicates that while 40% of UK adults trust ‘most news’, this falls to 22% for news in search engines and 10% for news in social media.

[19] Traditional media was defined as newspapers, magazines, television news, radio news and websites associated with these

[20] Percentages represent those saying they would trust each source either ‘a great deal’ or ‘a fair amount’.

Figure 4.5: Whether people would trust traditional and online-only media to provide accurate information about science



Q5b1. To what extent would you trust that online information about science is accurate when it is…?
Traditional media such as newspapers, magazines, TV or radio news, or websites associated with these;
Online-only media such as online news sites and blogs which do not have an offline version, such as Huffington Post, Buzzfeed
*Base: All who use the internet (n=1,571); *and use social media (n=1,110)*

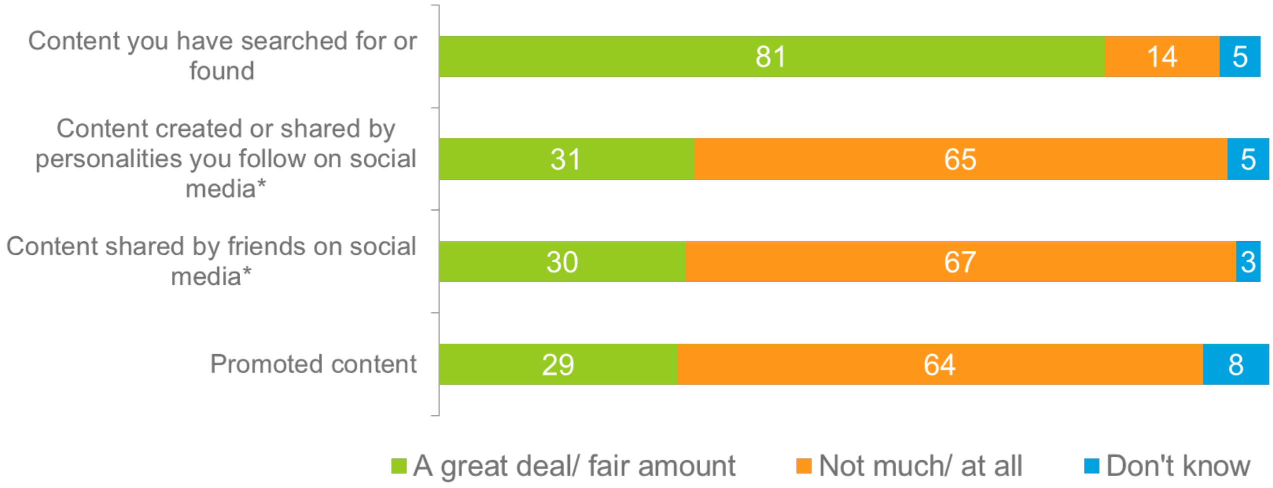
Given that digital media incorporates a wide range of potential sources, people who use the internet were asked how much they trust the accuracy of science information that comes from different online sources. Overwhelmingly, people had most trust in online content they have searched for or found themselves, with eight in ten (81%) saying they would trust this information either a great deal or a fair amount (Figure 4.6). Reuters (2019) also finds that UK adults have more trust in the 'news I use' (51%) than news found on social media (20%) or search engines (10%) which suggests that people are selective in the news the choose to trust.

Those with no qualifications had less confidence in the accuracy of science information they have searched for themselves. Six in ten (61%) said they would trust content they have searched for or found themselves, compared with almost nine in ten (88%) of those with a degree or higher.

By comparison, levels of trust in the accuracy of science information obtained online via other routes were lower, with three in ten saying they would trust the accuracy of content created or shared by personalities they follow on social media (31%), contact shared by friends on social media (30%) and promoted content (29%).

Social media users aged 16-34 were more likely to trust content created of shared by personalities (38%) than content shared by their friends (31%).

Figure 4.6: Extent to which trust that online information about science is accurate



Q5b. How much would you trust each of the following sources to provide accurate information about science?
Base: All respondents (n=1749)

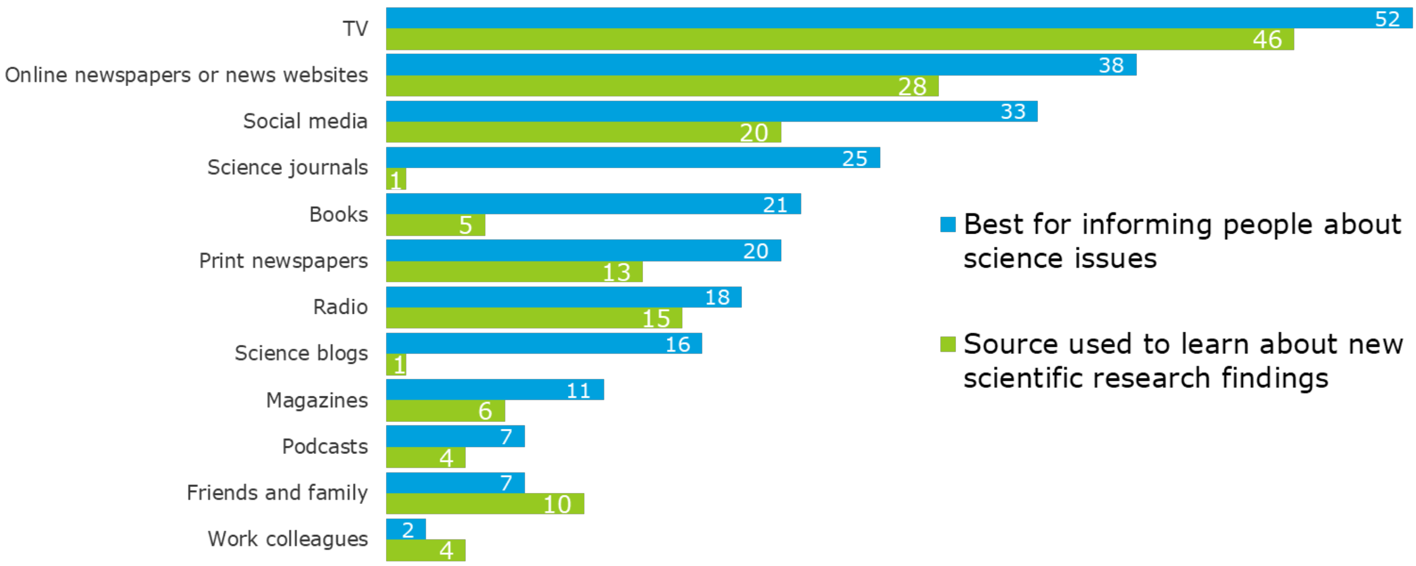
Which methods are best for informing people about science?

As shown in Figure 4.7, TV was widely considered to be the best method for informing people about science, selected by around half of people (52%). Other methods that people reported as being good for informing people about science were online newspaper or news websites (38%) and social media (33%).

There were some notable differences here by age group and education.

- Less than two in ten people aged 16-34 (15%) reported print newspapers as the best way to inform people about science, compared with a third of people aged 65+ (33%). Conversely, 16-34 year olds were much more likely to select social media (46%) compared with those aged 65+ (15%).
- People with different levels of education also expressed different views. Degree holders were more likely to select online newspapers (45%) compared with people who have a lower qualification (38%) or no qualifications (23%), and more likely select radio (23%) when compared with the other two groups (17% and 14% respectively).

Figure 4.7: Sources considered to be the best for informing people about science issues, against sources actually used to learn about science



Q28c. Which, if any, of these sources do you think are the best for informing people about science issues? Please pick one, two, or three sources. / Q4. Outside of any formal science lessons or classes you may take, from which one or two of these, if any, do you hear or read about new scientific research findings most often?
Base: All respondents (n=1749)

There was something of a disconnect between the sources people thought were best for informing people about science and the sources actually being used to learn about science. This was most apparent in relation to science journals. While a quarter of people (25%) identified science journals as being a good way to inform people about science, only 5% said that they get information about science from science journals. Similarly, 16% of people identified science blogs as a good way to inform people about science, but only 1% of people reported using science blogs. These results suggest that people generally have a sense of where information about science can be found even if they do not use those sources themselves.

Wave 1 Social Media Analysis: Attitudes to the veracity of information online

The first wave of social media analysis aimed to explore trust in the veracity of scientific information online through a case study exploring trust in alcohol research and guidance. The content of the conversational landscape was qualitatively explored to identify key themes, trends and patterns of interaction across online communities.

While there is a lot of conversation online about drinking alcohol more generally, only a small proportion of this is discussion around research and findings related to alcohol. Conversations about alcohol-related research tended to be clustered among professionals and institutions.

Analysis of the conversation landscape found that health sector professionals and institutions constituted the largest community for this topic, however they were primarily clustering, communicating, and building networks amongst themselves. A key trend identified within the discussions on news outlet posts, was positivity towards new scientific evidence that reinforced users' own views and behaviour regarding alcohol consumption.

There were also two news outlets, The Independent & Daily Mail, that were able to generate discussion amongst the public in their posts about alcohol-related research.

In contrast, social media users expressed confusion, scepticism and became dismissive in their responses when they saw scientific evidence as contradictory. The communication of what appears to be contradictory advice and evidence about alcohol intake can reduce trust in science and scientific research on the topic and health advice more widely.

5. Science in people's lives

This chapter considers the role of science in people's lives including how much people value science, the role of school in shaping attitudes to science, and people's participation in informal science learning. This chapter also considers the intersections between science and other cultural pursuits. Where relevant changes since 2014 have been tracked.

Key findings

Most people understand the value of science in their everyday life and many people feel comfortable in science-related environments. Furthermore, most people engage with science in informal learning settings such as science museums. Despite this engagement, only a minority feel actively 'connected' to science in their everyday lives. There is a great deal of cross-over in terms of science and arts participation and engagement. This suggests that, for many people, science fits into a broader range of interests across different cultural domains.

Changes over time

- Compared with 2014, people were less positive about the value of science in everyday life, being less likely to think science will make our lives easier (from 81% to 74%), and that it is important to know about science in their daily life (from 72% to 65%).
- Compared with 2014, a smaller proportion of people thought that the science and maths they learnt in school was useful.
- Between 2014 and 2019, there was an increase in annual attendance rates at a range of science-related attractions including science museums, nature reserves, science and discovery centres and working laboratories.

2019 findings

- Science was valued by the public, with majorities of people agreeing that science is such a big part of our lives that we should all take an interest in it (82%), that science will make our lives easier (74%) and that it is important to know about science in daily life (65%).
- Almost eight in ten people felt that science played an important role in helping them to understand the world; a third said they talked about things to do with science with family/friends/colleagues at least once a week; and just over half of people agreed that they would feel 'at home' in in science-related spaces such as laboratories and science centres.
- A majority (67%) felt that the maths they learnt at school was useful in their daily life, though a smaller proportion thought the same about science (43%). Men and those educated to at least degree level were most positive about their school experiences.

- Seven in ten people had taken part in at least one science-related activity in the past year, most commonly nature reserves, zoos/aquariums and science museums. Men were more likely than women to mention visits to laboratories/scientific sites and science festivals. Participation was also more common among young people, those with children at home, and people educated to degree level or above.

- These findings suggest a broad acceptance of the value of science in daily life. However, despite this, just two in ten (22%) described themselves as feeling actively connected to science, slightly lower than the proportion feeling this way about arts/culture (27%) and much lower than the proportion feeling this way about sport (40%).

- There is a great deal of crossover between engagement in science and engagement in other cultural domains such as the arts and sport. For example, there is a strong correlation between those who visit science-related and arts-related attractions; and most people who feel actively to connected to science also feel actively connected to either arts/culture and/or sports. Two in five of those who feel that ‘science is not for me’ feel actively connected to either arts or sports which suggests a possible alternative route to reach those who are less engaged in science.

Context

Many of the survey measures discussed in this chapter form the ‘building blocks’ of science capital index. The background to the concept of science capital, and the derivation of this index, are described in more detail in Chapter 1.

In addition to the increasing focus on science capital, intersections between art and science (‘STEAM’) have gained increasing attention in recent years and there are calls for a greater collaboration between science and other sectors – such as business, politics, sport and the arts – such that science starts to be embedded as part of someone’s cultural identity in the same way as these other fields[21].

Against this backdrop, this chapter explores people’s past experiences of STEM subjects at school; the value they place on science; how they engage with science as a leisure or cultural activity; and comparisons between science and other activities such as arts and sport. It also considers some specific elements of science capital, introduced for the first time to PAS in 2019, namely levels of personal connection to science; the role of science in people’s lives; and how often people have conversations about science in their everyday life.

How much value do people place on science in their lives?

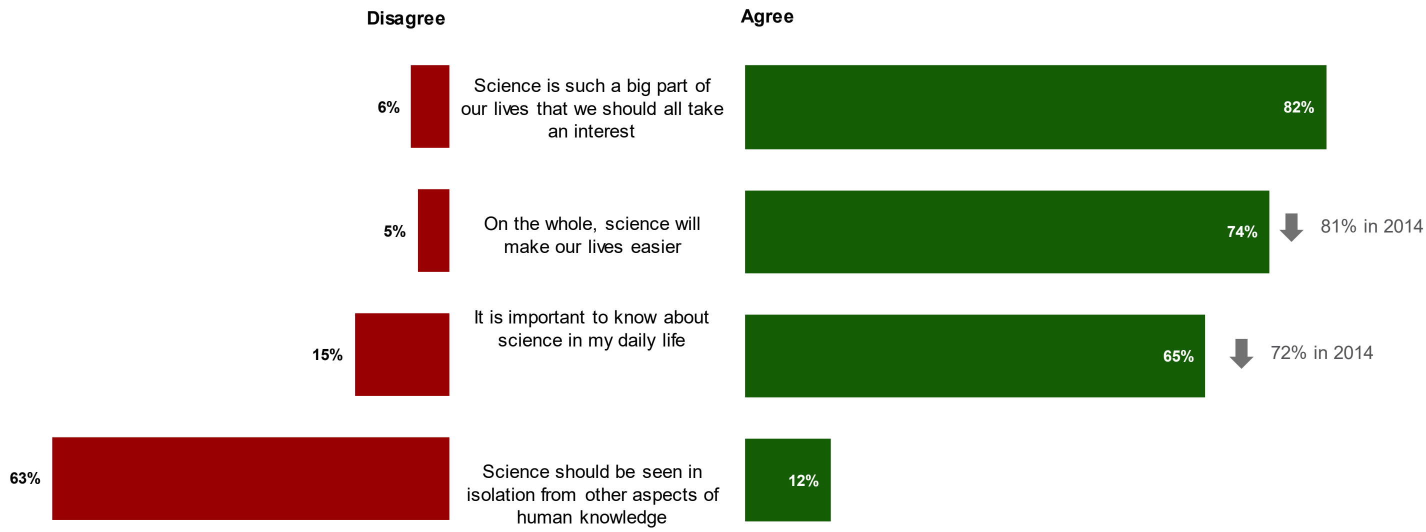
As shown in Figure 5.1, science in general was valued by the public and seen as relevant to everyday life. Eight in ten people (82%) agreed that science is such a big part of our lives that we should all take an interest in it, while 74% felt that on the whole science will make our lives easier. Around two-thirds (65%) of people felt that it was important to know about science in their daily life. The importance of science as integral to everyday life was also illustrated by the

[21] See for example https://www.britishscienceassociation.org/news/science-is-not-just-for-scientists

fact that only 12% of people felt science should be seen in isolation from other aspects of human knowledge.

Compared with PAS 2014, people were less positive about the impact of science on their daily lives. In 2019, people were less likely to think it important to know about science in their daily life (65% in 2019 vs 72% in 2014) and that science will make people's lives easier (74% in 2019 vs 81% in 2014).

Figure 5.1: Perceptions of the value of science in everyday life



Q15. Here are some statements about science. For each, please could you tell me the extent to which you agree or disagree?
Base: All respondents (n=1749)

More detailed analysis of the PAS 2019 data revealed that:

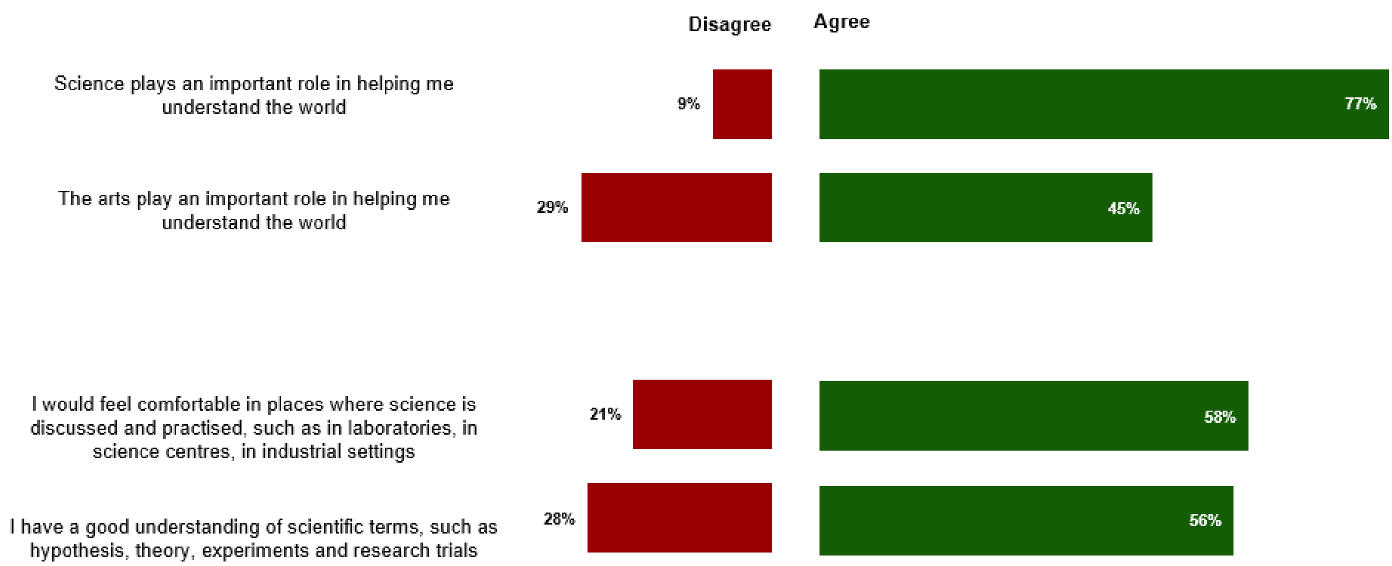
- Men were more likely than women to view the value of science in daily life in positive terms: for example, 81% of men felt that science will make our lives easier compared with 68% of women.
- People educated to degree level were more likely than those with lower educational levels to place value on science in everyday life: for example, 78% of people educated to degree level or above felt it was important for them to know about science in their daily life compared with 43% of those with no qualifications.
- While not consistent across all measures, there was some evidence that older people did not feel science was as important in their everyday life compared with younger age groups. Those aged 65 or over were less likely than younger people to feel that science is such a big part of our lives that we should all take an interest (78% vs 85%) and that it is important to know about science in their daily life (56% vs 70%).

The role of science in people's everyday lives

As shown in Figure 5.2, most people saw science as an important aspect of their life. More than three-quarters of people felt that science played an important role in helping them understand the world (77%), more than the proportion who felt that the arts played an important role in helping them understand the world (45%).

A little over half of people felt comfortable about engaging with scientific settings and concepts. Almost six in ten (58%) people said that they would feel comfortable in places where science is discussed and practised. Similarly, 56% felt they had a good understanding of scientific terms, such as hypothesis, theory, experiments and research trials. All these measures were new for PAS 2019 so no tracking data were available.

Figure 5.2: Perceptions of science in everyday life



Q35. For each of the following, please could you tell me the extent to which you agree or disagree?
Base: All respondents (n=1749)

More detailed analysis of the PAS 2019 data revealed that:

- Men tended to be more comfortable with science than women: 82% of men vs. 71% of women felt it played an important role in helping them understand the world; 67% of men vs. 49% of women felt at home in places where science is discussed; and 64% of men vs. 48% of women felt they had a good understanding of scientific terms. As a point of contrast, similar proportions of men and women felt that the arts play an important role in helping them understand the world.

- People educated to degree level had the highest levels of agreement with all four statements. For example, 69% felt comfortable in places where science is discussed compared with 34% of those with no qualifications. In the case of the arts, 59% of people educated to degree level or above felt that the arts helped them understand the world, compared with 32% of those with no qualifications.

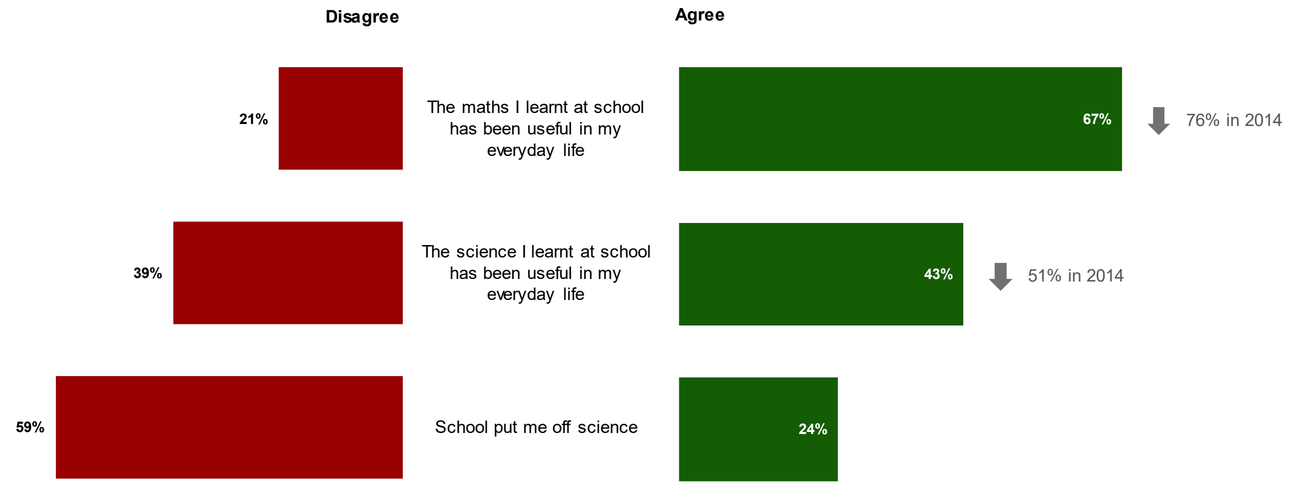
- Younger people were more likely to feel they understood scientific terms (66% of 16 to 34 year olds vs 42% of those aged 65 or over) and were also more likely to feel comfortable in places where science is discussed (61% vs 50%).

How do reflections on school science shape attitudes?

Most people (67%) thought the maths they learned at school had been useful in their everyday life, while around two in five (43%) thought this about science. Overall a quarter had a negative perception of science at school, with 24% saying that school had put them off science (Figure 5.3).

The proportion of people who felt that school had a negative impact on their perceptions of science in later life was the same as in previous surveys. However, people were less positive about the usefulness of both science and maths in their everyday life compared with previous surveys: in 2014 51% of people thought school science was useful (now 43%), while 76% thought school maths was useful to them (now 67%). Moreover, this fall was observed among all age groups.

Figure 5.3: Impact of school on attitudes towards science and maths



Q15. Here are some statements about science. For each, please could you tell me the extent to which you agree or disagree?/ Q26. Here are some statements about studying and working in science. For each, please could you tell me the extent to which you agree or disagree?
Base: All respondents (n=1749)

More detailed analysis of the PAS 2019 data revealed that:

- Women were less positive than men about the impact of school science and maths on their life, being more likely to say school had put them off science (29% vs 18%) and less likely to feel that that science (37% vs 50%) and maths (63% vs 71%) had been useful in their everyday life.

- Those educated to degree level were more positive than those without qualifications about the impact of science and maths at school on all three measures, For example, 60% of those educated to degree level or above felt that the science they learned at school was useful compared with 23% of those with no qualifications.

What science-related activities do people participate in?

Frequency of visiting science-related attractions

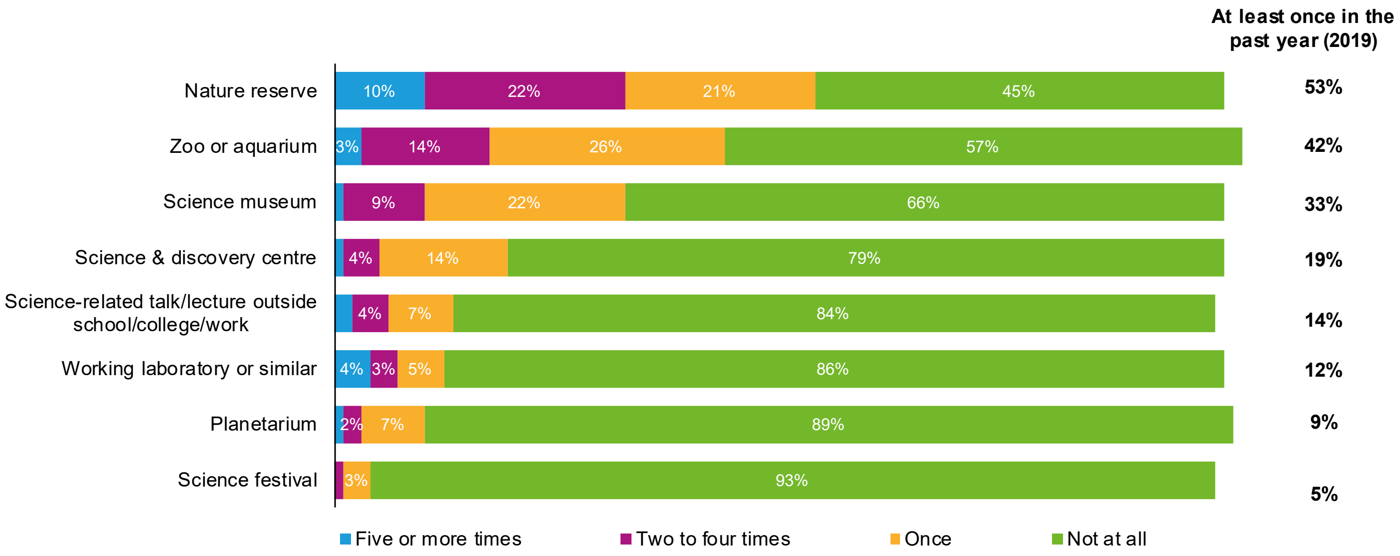
Taking part in informal science learning such as visits to museums, nature reserves, or zoos is an important way of building people's wider science knowledge outside of educational settings.

People were asked about visits in the last 12 months to a number of different types of science-related attractions or events, as shown in Figure 5.4. For comparison purposes, they were also asked about visits to various cultural and artistic events or attractions in the last 12 months.

Compared with PAS 2014 a slightly higher proportion of the public had engaged with at least one science related attraction or event in 2019 (72% in 2019 vs 67% in 2014[22]). At a more detailed level, there have also been increases between 2014 and 2019 in visits to nature reserves (from 40% to 53%), science museums (from 23% to 33%), science and discovery centres (from 13% to 19%), and working laboratories (from 7% to 12%).

In 2019, for the first time, people were also asked how often they had visited these attractions. For most attractions, the majority of people had attended only once in the past year. However more frequent visits were made to nature reserves (33% had visited at least a twice), zoos and aquariums (16% had made two or more visits) and science museums (10% had made two or more visits).

Figure 5.4: How often have you visited science-related attractions in the past year



Q13. How often, if at all, have you visited or attended each of the following in the last 12 months?
Base: All respondents (n=1749)

[22] In PAS 2019, most of the options remained the same as in 2014, although one extra option was added in 2019 'A science-related talk or lecture outside of school, college or work'. However, the overall participation rate in 2019 remained at 72% even when this measure was removed from the overall figure.

In 2019 similar proportions of men and women had attended at least one science attraction or event in the past 12 months although men were twice as likely as women to mention having visited a working laboratory or similar scientific site (16% vs. 8%).

Focussing on the overall participation measure, that is the proportion who had visited at least one science-related event or attraction in the past 12 months, visits were more common among:

- Younger people: 79% of those aged 16 to 34 compared with 57% of those aged 65 or over.
- Those with children aged under 16 at home: 82% of those with children at home compared with 68% of those with no children at home.
- Those with a higher level of education: 88% of those educated to degree level or above compared with 38% of those with no qualifications.

Frequency of attending non-science attractions

Attendance in the last 12 months at science-related attractions or events (72%) was higher than attendance at arts-related attractions (58%), based on the measures included in the survey: art galleries, non-science museums and literature festivals.

As with science attractions and events, attendance at arts events also appear to have increased since 2014: 45% of people had visited a non-science related museum in the last 12 months (compared with 30% in 2014), 43% had visited an art gallery (compared with 32% in 2014), and 7% had visited a literature festival (no change since 2014).

As found in previous PAS surveys, those who visited science-related activities appear to participate more in non-science related cultural activities too. Thus, those who had undertaken a science-related activity in the previous 12 months were also more likely to have visited an art gallery (54% vs 15% of those who have not done a science-related activity), another non-science related museum (58% vs.10%) and a literature festival (9% vs. less than 1%).

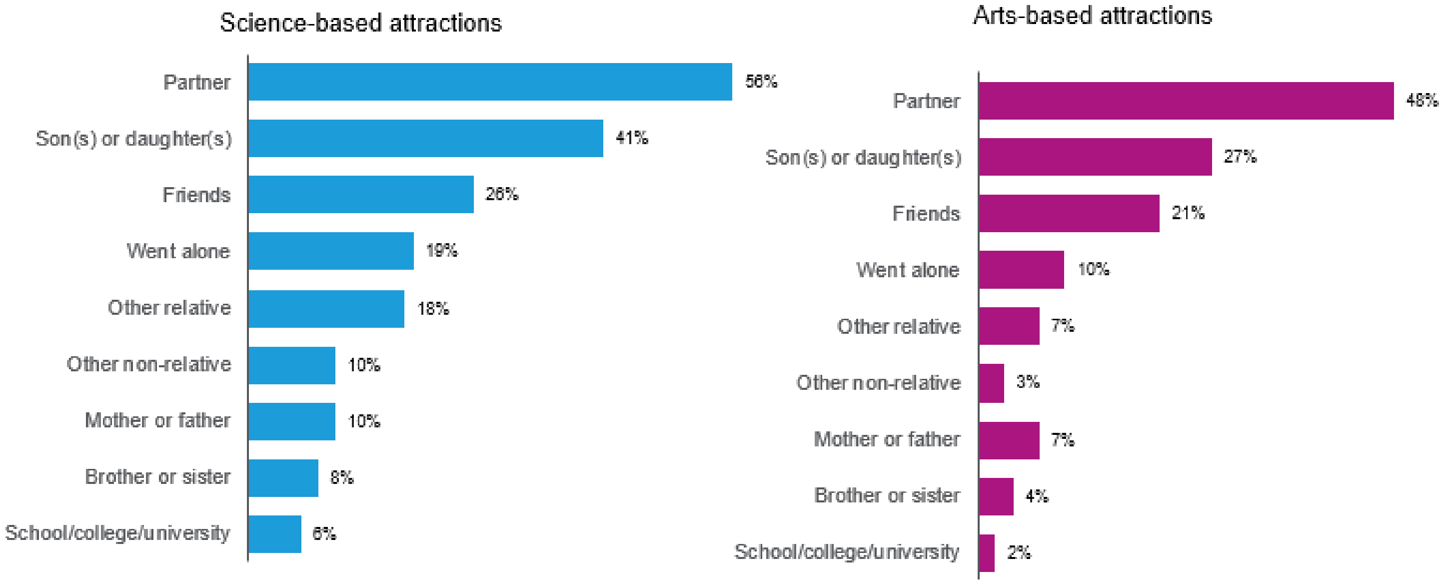
Who people attended attractions with

People who had visited any science-related attraction in the last year were also asked who they had gone with. The figures in Figure 5.5 represent the proportion of people who had attended at least one attraction with this person, based on all visiting any science-related attraction. The equivalent figures for arts-based events are shown alongside.

Generally, people tended to go to science-related activities or events with others rather than on their own. A fifth (19%) of people had gone to at least one event or attraction on their own. People were more likely to go to a science-related talk or lecture (31%) or visit a working lab or similar scientific site (26%) on their own and less likely to go to a nature reserve (9%), science museum (7%) or zoo (2%) on their own.

People were most likely to have gone to any event or attraction with their partner (56%), children (41%), or friends (26%). Compared with arts attractions, science attractions were more often visited with children (41% compared with 27% of arts events) or attended alone (19% compared with 10%). This suggests that science attractions are seen as more of a family activity compared with arts events.

Figure 5.5: Who people went to science-related and arts-related activities with



Q14. And on your last visit, who, if anyone, did you go to the [ATTRACTION TYPE] with?
Base: All respondents who have been to any science attraction/event (n=1224); All respondents who have been to any arts attraction/event (n=1008)

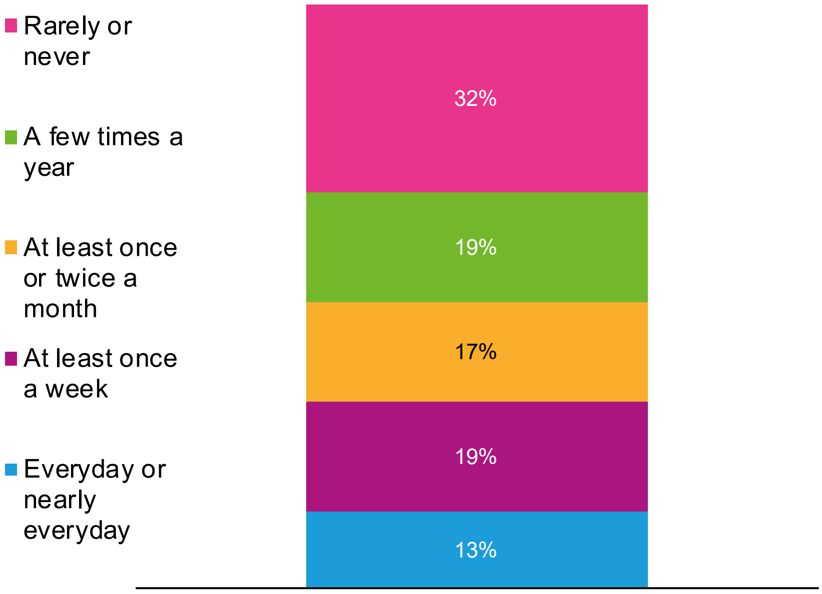
By gender, men were more likely than women to attend science events alone (24% vs 14%), or with a partner (61% vs 52%). As in the 2014 survey, women on the other hand were more likely than men to have gone with their children (48% vs. 35%) suggesting that mothers are an important route for introducing children to informal learning in science.

Conversations about science

Another dimension of science capital is the frequency with which people talk about science with family, friends or colleagues in their daily lives (Figure 5.6). This question was asked for the first time in 2019.

One in three people (32%) said they talked about science-related things at least once a week, with 13% doing so every day, or nearly every day. A half (49%) said they had conversations of this nature at least once a month. A third of people (32%) said that they rarely or never talked about science with family, friends or colleagues.

Figure 5.6: Frequency of conversations about science with family, friends or colleagues



Q34. How often do you talk about things to do with science with family, friends or colleagues?
Base: All respondents (n=1749)

People most likely to talk about things to do with science at least once a week were:

- Men: 39% of men compared with 25% of women.
- People under the age of 55: 38% of those aged under 55 compared with 17% of those aged 65 or over.
- People educated to degree level or above: 46% compared with 30% of those with below degree level qualifications and 6% of those with no qualifications.

How engagement with science intersects with arts and sports

As noted above, there was a strong correlation between those who attended science-related activities and non-science related cultural activities which suggests that, for many people, science fits into a broader set of interests across a range of sectors. This can be seen as a function of cultural capital, which refers to the forms of knowledge and skills that people acquire by being part of a particular social class (Bourdieu, 1984).

The British Science Association[23] has called for greater collaboration between science and other sectors – such as sport and the arts - to ensure that science is seen as part of our overall culture. In this context, it is of interest to look at how connected people feel across these different domains and the extent to which these connections intersect.

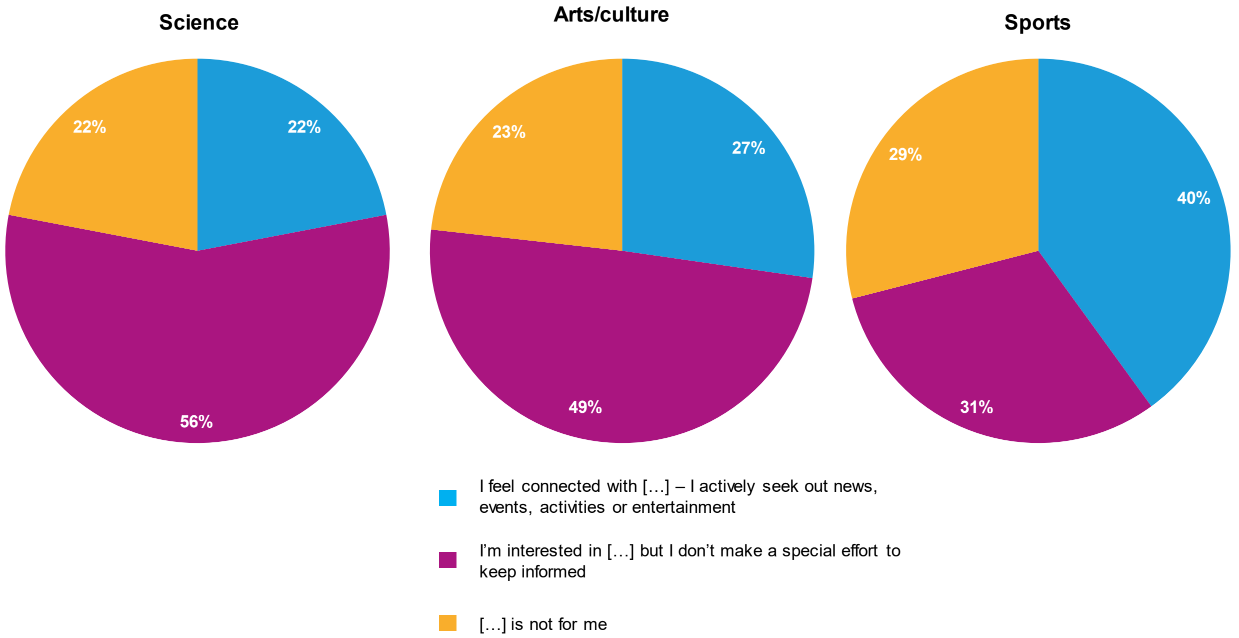
[23] https://www.britishscienceassociation.org/news/science-is-not-just-for-scientists

Feelings of connection with science, arts and sport

Two in ten (22%) people described themselves as feeling connected to science, whereby they actively sought out news, events, and activities related to science. A similar proportion (22%) felt unconnected to science, feeling that it was 'not for me'. However, most people (56%) were somewhere in the middle, describing themselves as being interested in science but without having any strong connection. These findings broadly align with a similar measure in the Kings College Culture Tracker (2016)[24] where 25% considered that 'science is not for me'.

The public's connection with art and culture broadly mirrored that of science. However, sport was more polarising. While a higher proportion of people (40%) felt connected to sport than to either science or arts/culture it was also the case that a higher proportion of people felt unconnected to sport (29%) compared with both science and arts/culture. See Figure 5.7.

Figure 5.7: How connected people feel to science, arts and sport



Q2b Which of these statements best describes your relationship with science? /Q2d. Which of these statements best describes your relationship with art and culture? By this we mean things like art galleries, films, theatre and so on /Q2e. Which of these statements best describes your relationship with sport?
Base: All respondents (n=1749)

Focussing on the proportion who felt unconnected to each of these, that is feeling that science, arts, or sports, is 'not for me', further analysis found that:

- Women were more likely than men to feel unconnected to science (30% vs 14%) and sports (38% vs 19%) while men were more likely to feel unconnected to arts (27% vs 19%)
- Older people aged 65+ were more likely than those aged 16 to 34 to feel unconnected to science (30% vs 17%), while there were no differences with respect to other cultural disciplines

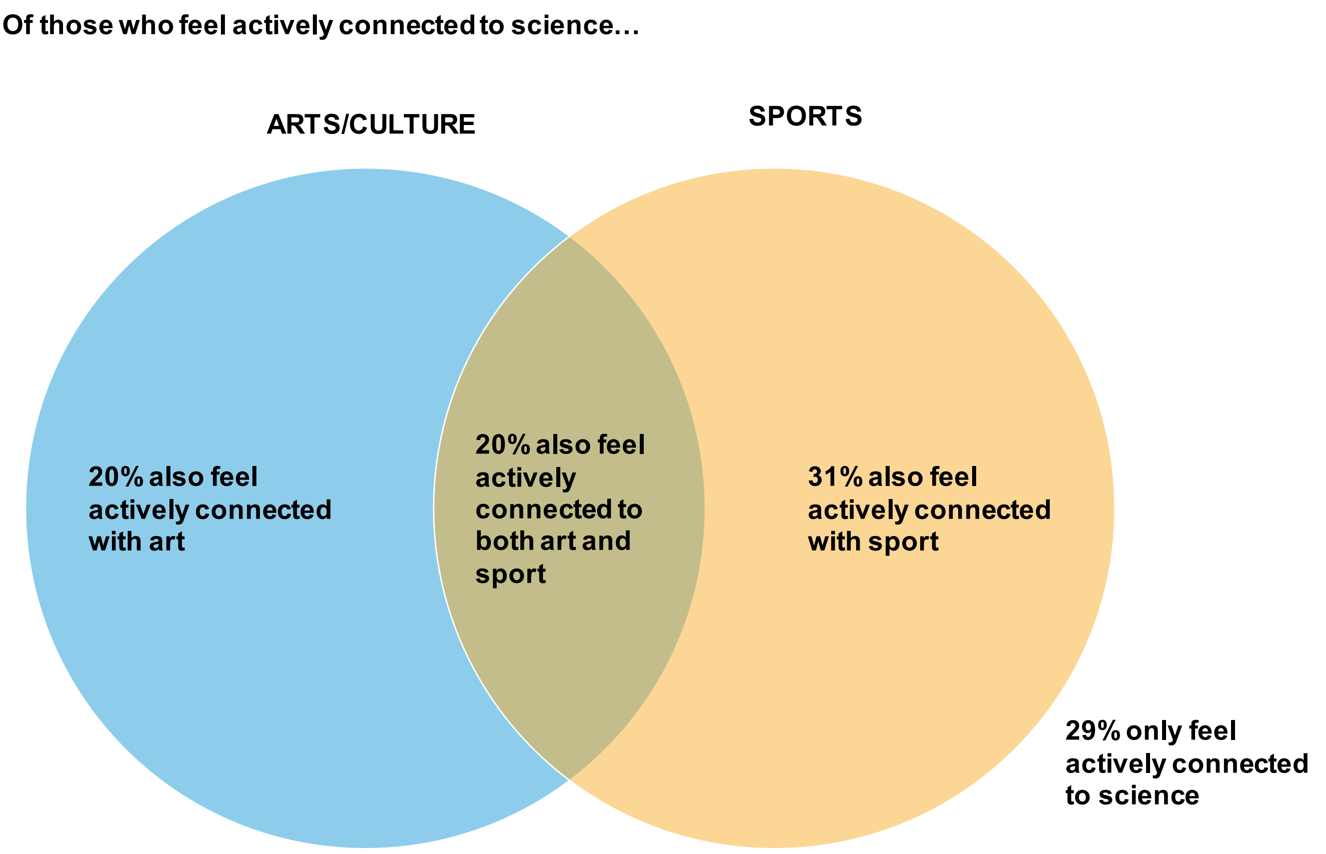
[24] https://www.britishscienceassociation.org/Blog/the-brexit-chasm-our-research-into-science-and-the-referendum

- People with no qualifications were more likely than those with a degree to feel unconnected to all three domains, although the educational gap was widest for science and narrowest for sports (science: 52% vs 8%; arts: 41% vs 14%; sports: 37% vs 27%).
- It is also interesting to note that people who agreed that science had put them off school were three times more likely than those who disagreed with this to feel that science is 'not for me' (37% vs 12%).

What is the crossover between people who feel connected to science, arts and sports?

As shown in Figure 5.8, most people who felt actively connected to science (71%) also felt actively connected to either arts and/or sports. One of three of this subgroup (31%) felt actively connected to science and sport, while one in five (20%) felt actively connected to science and the arts. A further 20% felt actively connected across all three domains.

Figure 5.8: People who feel actively connected to science: proportion of this group who also feel actively connected to arts and/or sports



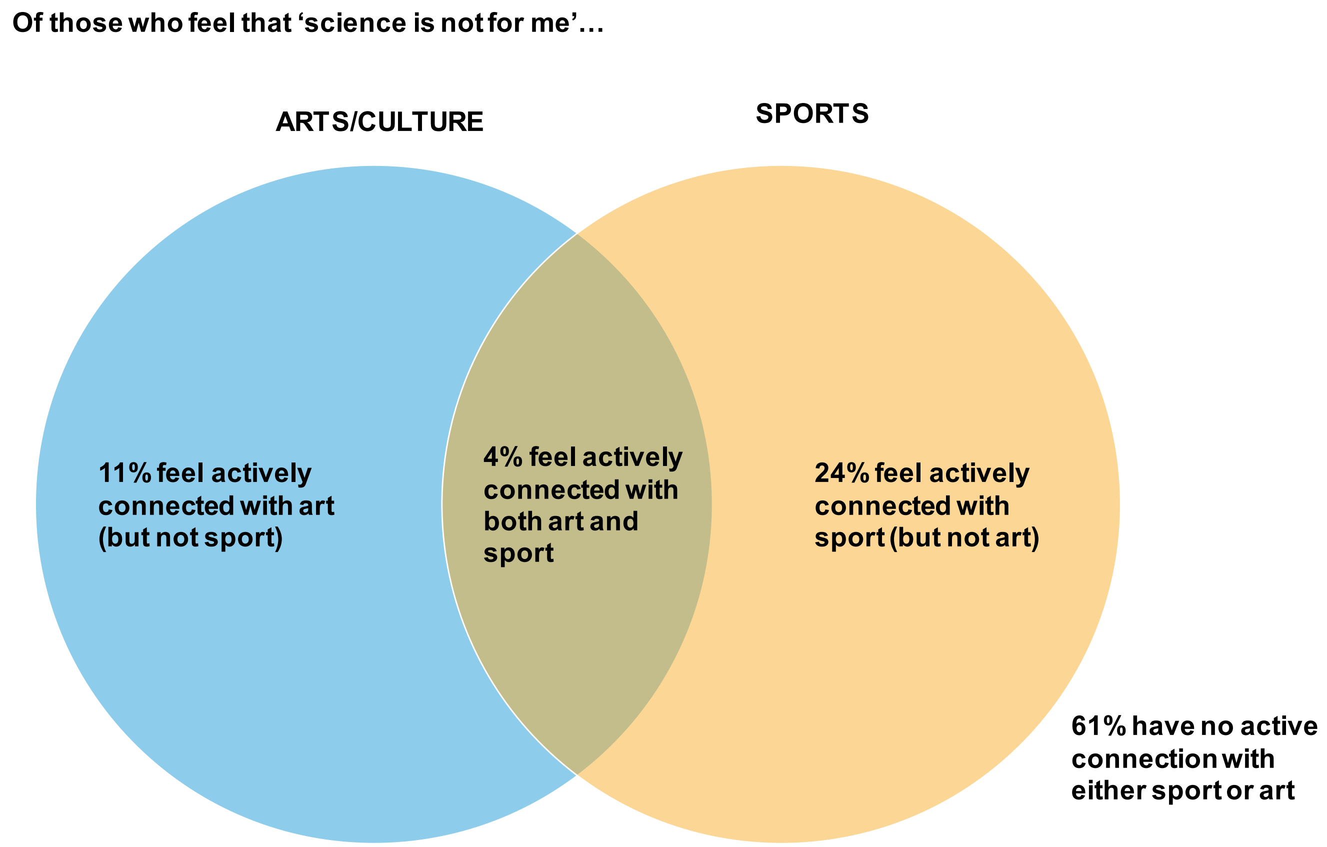
Q2b. Which of these statements best describes your relationship with science?
Q2d. Which of these statements best describes your relationship with art and culture? By this we mean things like art galleries, films, theatre and so on
Q2e. Which of these statements best describes your relationship with sport?
Base: All respondents who feel actively connected with science (n=376)

Do people who feel unconnected to science feel connected to arts and/or sports?

As noted above, greater collaboration between different sectors of society may provide more innovative ways of embedding science in different contexts and broadening access to it. To this end, the PAS 2019 findings have been also explored in terms of the crossover between those who feel unconnected to science but who expressed an active interest or connection with the arts/culture and/or sport. Such crossover might provide an opportunity to consider the potential for building science capital among some harder to reach groups via arts and/or sports spaces (Figure 5.9).

Of those who felt most unconnected to science - that is, they felt that science was 'not for me' - the majority (61%) were also not actively connected to either arts/culture or sport. However, almost four in ten (39%) of this group did have an active connection with another sector: 24% were actively connected with sport; 11% were actively connected with arts or culture; and 4% were actively connected with both. This suggests that there could be some potential to reach people who are unconnected with science through their active involvement with either arts/culture or sport (Figure 5.11).

Figure 5.9: People who feel that 'science is not for me': proportion of this group who feel connected to arts and/or sports



Q2b. Which of these statements best describes your relationship with science?
Q2d. Which of these statements best describes your relationship with art and culture? By this we mean things like art galleries, films, theatre and so on
Q2e. Which of these statements best describes your relationship with sport?
Base: All who say that 'science is not for me' (n=394)

6. Public involvement in science

This chapter explores people's perceptions of different aspects of public engagement with science and the extent to which people feel government puts sufficient effort into consulting the public about science. It also considers how much people would like to be involved in decisions about science policy and the type of involvement they would like. Where relevant, findings have been tracked since 2014 and over the longer-term.

Key findings

People continued to express a desire to be more informed about and involved in developments in science, though they remained critical about the government's efforts to consult people and about their own ability to influence change. However, despite this, most people did not personally want to get involved, and were happy that experts mainly drive decision-making in science. There were some small positive shifts over time in opinions about efforts made by scientists and government to engage the public.

Changes over time

- Compared with 2014, people were more positive about efforts being made to involve the public in science. In 2019, people were less likely to consider that scientists are putting too little effort into informing people about their work, and that the public is insufficiently involved in science decision-making. There was also less cynicism surrounding public consultation events.
- While most people felt that scientists should listen more to what ordinary people think, there has been a general decline in the proportion who report this since 2008, with the proportion at its lowest level (63%) since tracking of this measure began. Over the longer-term, since 2005, there has been a decline in the proportion who feel that the public should be involved in decision-making and an increase in the proportion who feel that key decisions should be made by experts rather than the public.

2019 findings

- Broadly, people stated that they want the public to be both *informed* about and *involved* in decision-making about developments in science. Majorities of people wanted scientists, regulators, and the government to engage the public in discussions and decisions about science.
- However, the government was judged as failing to make sufficient effort to involve the public in science decision-making and most people felt that they couldn't influence science policy, even if they wanted to. Compared with older adults, young people were less critical of scientists and the government and more positive about their personal agency in this area.
- Although people felt that the government should take more account of public views when making decisions, there was clear endorsement for the role of experts (rather than the public) in advising government on the implications of scientific developments.

People with high levels of education and science capital were less in favour of public involvement and more in favour of expert-driven decision-making.

- As seen in earlier waves of PAS, there was a disconnect between feeling that the wider public should get involved and people's own desire to get involved: most people did not want to be personally involved in decision-making. Nonetheless around a quarter of people did want to engage (more likely among men, younger adults, better educated people and those with high science capital), and the most common preferences for this were via a poll or survey, taking part in a public consultation or citizen science activities.

Context

The PAS 2019 literature review (Burchell, 2019) provides commentary on the social context in which the 2019 survey was conducted, referring to the increasingly held belief that we are living in a post-truth age, with less regard for experts. However, the literature review also hypothesises that scientists are increasingly understood as a beacon of trustworthiness within a post-truth world. Indeed, the findings reported in Chapter 7 of this report indicate that trust in scientists remains reassuringly high in 2019.

Research also suggests that trust is in part brought about through emotional involvement, by taking part and engaging in a dialogue (Engdahl and Lidskog, 2014). In this context it is important to understand the extent to which the public feels they are sufficiently informed and involved in scientific and technological developments.

Public engagement with science has been the subject of increasing attention by UK research funders over recent years, although the nature of what is understood as engagement has evolved over time. As noted in a literature review conducted on behalf of Wellcome and other UK research funders (Burchell, 2015), public engagement has increasingly moved beyond science communication (a one-way communication flow from scientists to the public) to a more interactive two-way dialogue, where both parties can learn from each other.

There is also evidence pointing to an increasing 'tolerance of technocracy' (Bauer et al, 2016) among the UK public, whereby people become less demanding over time of the government and scientists in terms of their public engagement. This has been used to explain a fall between PAS 2011 and PAS 2014 in the proportion of people who feel that the public's views should be taken into account in decision-making; and there is some evidence within this chapter that this trend has continued.

There has also long been an acknowledgement that while people want there to be opportunities for the public to be involved in decisions relating to policy, they are less interested in actively engaging at a personal level. To this end, the ongoing challenge for policy makers in the science sector (and more widely) is to understand the public appetite for involvement and find ways to overcome public inertia to take an active role in decision making. The PAS 2019 literature review offers some suggestions in this area including increasing science public engagement at a local and community level, for example through local citizen science projects and other community-based projects.

How much does the public want to be informed about science?

PAS 2019 shows that there was a desire among the public to know what is happening in science. People believed that both scientists and the government should inform and involve the public in science and scientific developments. As their respective roles in this regard are slightly different, the findings for scientists and the government are discussed in turn.

Role of scientists in informing the public

People felt that scientists should do more to keep the public informed about their work. Two in three people (66%) felt that scientists should spend more time discussing the social and ethical implications of their work with the public, while around half (53%) thought that scientists should be rewarded for communicating their research to the public, underlining how important this part of their role is judged to be.

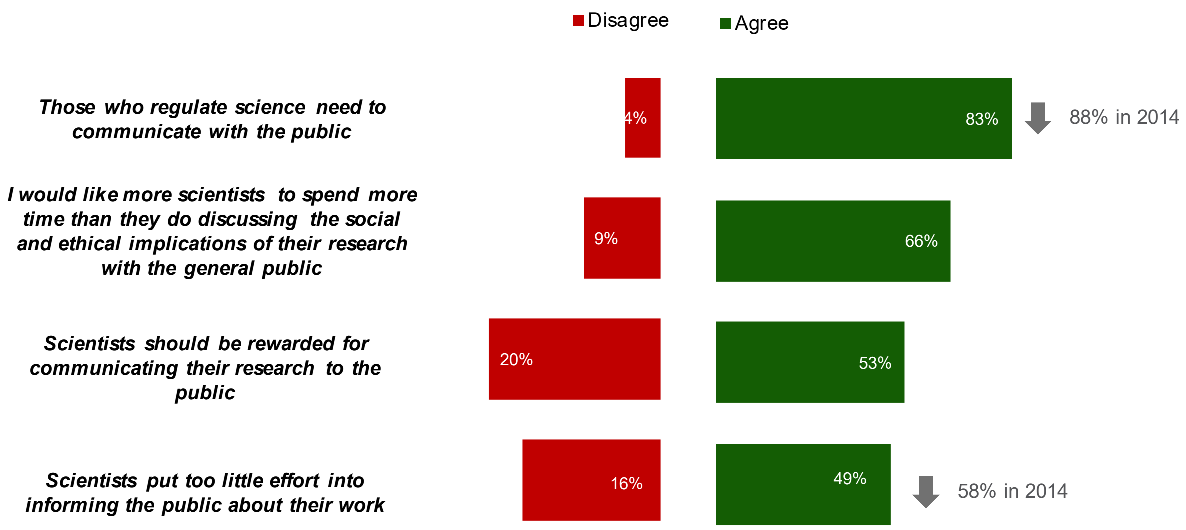
There was, however, a sense that scientists are not currently fulfilling this role as best they might: 49% of people thought scientists put too little effort into informing the public about science. This supports the findings noted in Chapter 7, where significant minorities of people considered scientists to be secretive (rather than open) and poor (rather than good) communicators.

In comparison with PAS 2014, people in 2019 were more positive in their attitudes towards public engagement. The proportion of people who felt that scientists put insufficient effort into informing people about their work fell from 58% to 49%.

Role of government in informing with the public

The role of government extends beyond individual scientific developments and covers the general direction of science policy, regulation, and public involvement in decision-making about science. The government was seen as having an important role to play in keeping the public informed, with 83% of people feeling that those who regulate science need to communicate with the public (Figure 6.1). This represents a slight decrease compared with 2014 (88%).

Figure 6.1: Are scientists and the government communicating with the public enough?



Q29. Here are some statements about how science is communicated and discussed. For each, please could you tell me the extent to which you agree or disagree? *Base: All respondents (n=1749)*

More detailed analysis of the PAS 2019 data reveals that:

- Men were more likely than women to think that scientists should be rewarded for communicating their research to the public (59% vs 48%)
- Degree-educated people were more likely than those who lacked qualifications to feel that scientists should discuss the social and ethical implications of their work with the public (72% vs 59%), should be rewarded for communicating with the public (58% vs 45%) and that science regulators should communicate with the public (87% vs 77%).
- Those with high science capital were more likely to value the importance of scientists and government communicating with the public: they were more likely to want to see scientists discussing the social and ethical implications of their work (73% vs 59% of people with low science capital), to agree that scientists should be rewarded for communicating their research (64% vs 43%), and that science regulators should communicate with the public (88% vs 80%)
- Those aged 65+ were more likely than those aged 16-34 to think that scientists put too little effort into informing the public about their work (59% vs 46%) and that the science regulators should communicate with the public (89% vs 79%).
- Those from a BAME background were more likely to think that scientists should be rewarded for communicating their research to the public (67% vs 51% of white people).

How much should the public get involved in decision-making about science?

Do people think scientists should take account of the public's views?

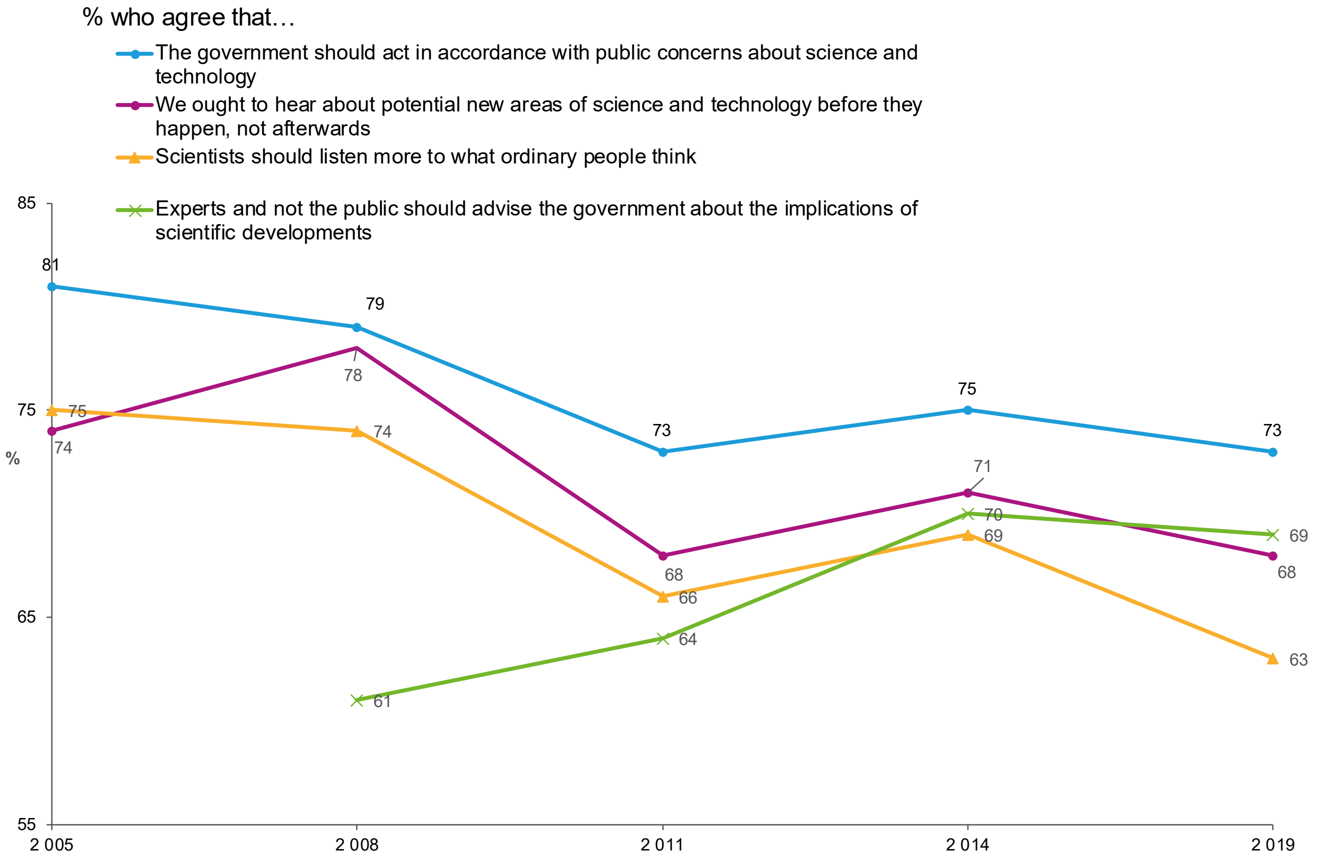
The findings above clearly show that many people want to be more informed about developments in science (*science communication*). However, PAS 2019 also indicates a desire for the public to be more actively involved in decision-making (*public engagement with science*).

People felt that the public has a right to be involved in science: 73% thought the government should act in accordance with public concerns about science, and 68% wanted to hear about new areas of science and technology before they happen (rather than afterwards, by which time it is too late for the public to have a say). Moreover, 63% felt that scientists should listen more to what ordinary people think.

However, despite this desire for more public involvement, 69% of people felt that experts and not the public should advise the government on the implications of scientific developments. The findings suggested that people appreciate the limitations of public involvement in science decision-making: they want the public point of view to be considered during the process but appreciate that final decisions will rest on expert evidence.

Broadly, the results were in line with PAS 2014, although there was a decline in the proportion of people who feel that scientists should listen more to what ordinary people think (from 69% to 63% between 2014 and 2019). Over the longer-term, however, there has been a gradual decline in the proportion supporting public involvement and a gradual increase in the proportion supporting expert-driven decision-making (Figure 6.2).

Figure 6.2 To what extent should the public be involved in decision-making about science?



Q29. Here are some statements about how science is communicated and discussed. For each, please could you tell me the extent to which you agree or disagree?
Base: All respondents (n=1749)

In general, younger people and those with higher levels of education and science capital were less likely to favour public involvement in decision-making, while men and those with higher levels of education and science capital were more likely to favour expert involvement in decision-making.

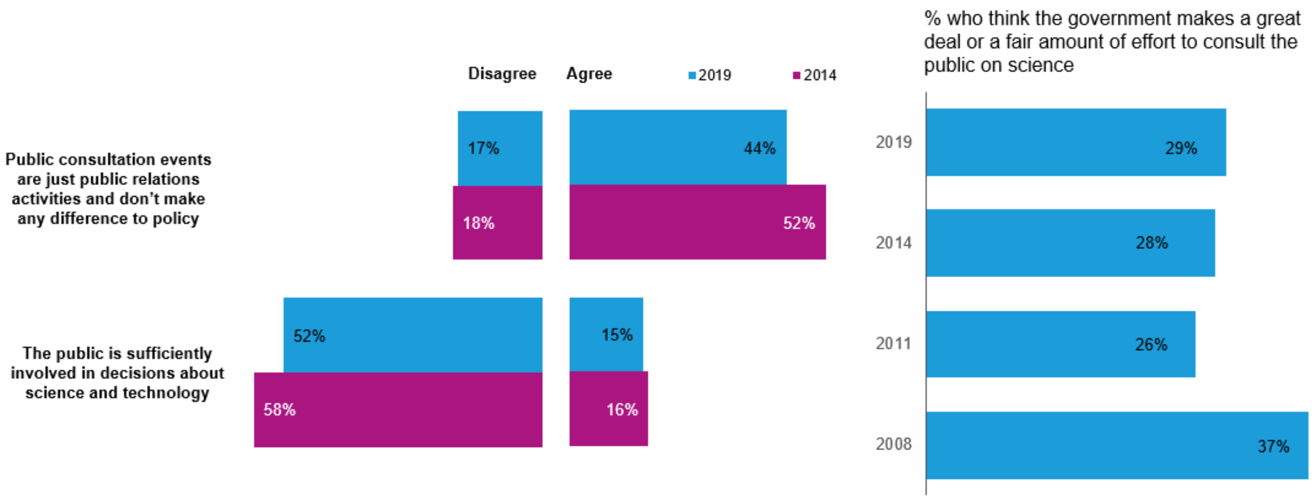
- People aged 65+ were more likely than those aged 16-34 to feel that scientists should listen more to what ordinary people think (74% vs 59%) and that the government should act in accordance with public concerns (77% vs 69%).
- People educated to at least degree level were less likely than those without qualifications to feel that the public should be listened to more (53% vs 77%) and more likely to say that experts rather than the public should advise the government about the implications of scientific developments (72% vs 63%).
- Those with high science capital were less likely than people with low science capital to feel that scientists should listen to the public more (47% vs 75%), and more likely to feel that experts should advise the government (77% vs 67%).
- Men were more likely to think that experts, rather than the public, should advise the government (73% vs 65% of women).

Do scientists and the government sufficiently inform and involve the public?

As mentioned previously, people felt that scientists could be doing more to communicate and engage with the public about their work. Following on from this, there was also clear evidence that people feel the government is not doing enough to involve the public: 52% did not feel the public is sufficiently involved in decisions about science (only 15% felt that they are) and 64% thought the government makes little or no effort to consult the public about science (compared with 29% who felt it makes at least a fair amount of effort). In addition, there was a degree of scepticism about the consultation that does happen, with 44% of people feeling that public consultation events are just PR exercises, without any influence on policy (Figure 6.3).

Comparing these findings with PAS 2014, there have been some positive shifts. In 2019 people were less likely to disagree that the public is sufficiently involved in science decision-making, and a smaller proportion felt that public consultation events are merely PR exercises. However, in terms of the efforts made to consult people, the findings have been stable since 2011 when the proportion of people who thought the government was making at least a fair amount of effort dropped markedly to 26% (from 37% in 2008).

Figure 6.3: Perceptions of public involvement in science decision-making



Q29. Here are some statements about how science is communicated and discussed. For each, please could you tell me the extent to which you agree or disagree?
Q27. How much effort do you think the Government is making to consult the public on science?
Base: All respondents (n=1749)

In general, younger people, those educated to degree level, and those with higher science capital were most positive about efforts made by the government and scientists to involve the public:

- Older people were more likely to feel that public consultation events have little impact on policy (53% of those aged 65+ agree vs 36% of 16-34 year olds).
- Those educated to degree level were less likely than those with no qualifications to agree that the public are sufficiently involved in decisions around science (11% vs 20%).

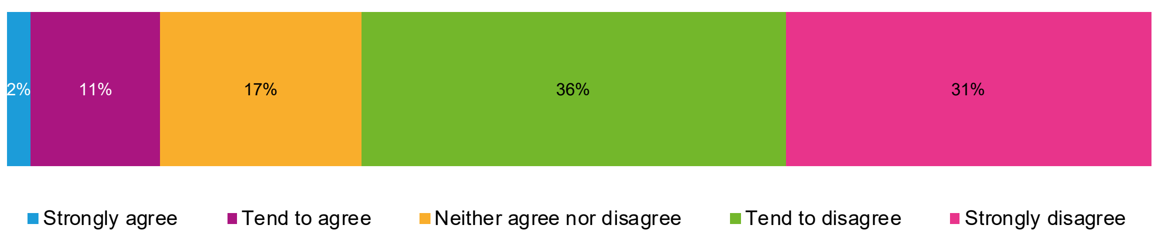
- People with high science capital were more likely than those with low science capital to feel that the government is making at least a fair amount of effort to consult the public (31% vs 18%) and to disagree that public consultation events have little impact on policy (23% vs 11% respectively).
- People from a BAME background were less likely to think the government is making not very much/no effort at all to consult the public on science (51% vs 66% of white people).

Do people personally want to be involved in decisions about science policy?

Do people feel they can influence science policy?

As shown in Figure 6.4, while there is a view that the public should be involved in science decision-making, only 13% of people felt they could influence government policy on science if they wanted to (the majority, 67%, felt they couldn't influence it), and this is similar to the findings of PAS 2014. This may reflect a feeling of powerlessness (as indicated by the finding above that many see consultation as simply a PR exercise), or it may reflect a distinction in people's mind between the general public playing a role in science decision-making and their own individual role.

Figure 6.4: Extent of agreement that 'I feel I could influence Government policy on science if I wanted to'



Q29. Here are some statements about how science is communicated and discussed. For each, please could you tell me the extent to which you agree or disagree?
Base: All respondents (n=1749)

More detailed analysis of the PAS 2019 data reveals that:

- Older people were less likely than younger people to think they could influence policy if they wanted to (75% of those aged 65+ felt they could not influence policy vs 61% of those aged 16-34)
- People with high science capital were more likely than those with low science capital to feel that they could influence policy if they wanted to (20% vs 9%).
- Those from a BAME background were markedly more likely than white people to agree that they could influence government policy in this area if they wanted to (27% vs 11% respectively).

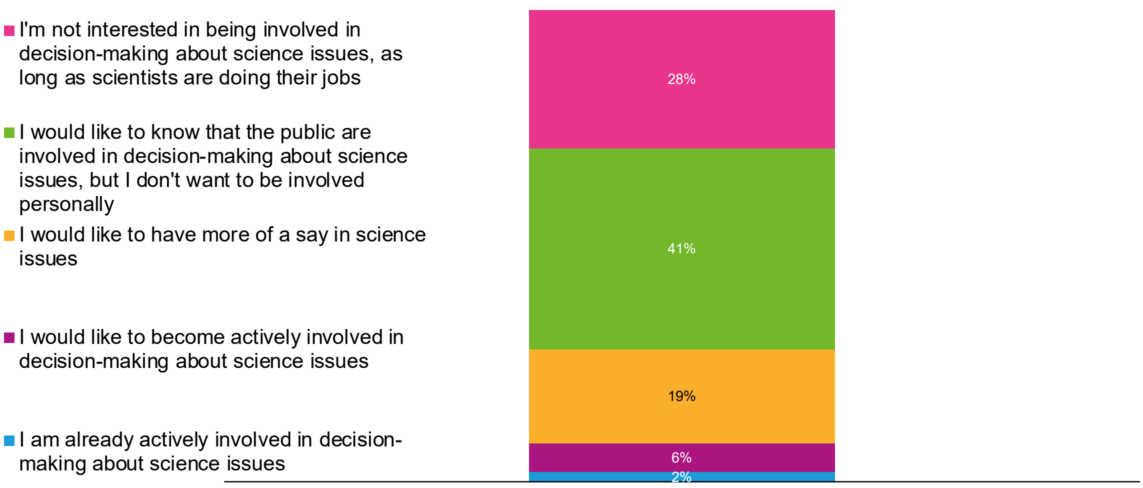
How much do people want to get involved?

When asked how the public should be involved in science decision-making, 28% of people felt that the public shouldn't be involved at all, while 41% thought the public should be involved, but they were not personally interested (Figure 6.5). So, despite a stated desire for public involvement, seven in ten people did not wish to get personally involved in the decision-making process. These findings tie in with those from the 2016 Wellcome Monitor, which found that while the majority of the UK public said they were interested in hearing from scientists they would prefer to hear from them via passive means, such as television, radio, newspapers, and websites, rather than interacting with them directly (Ipsos Mori, 2016).

In terms of those who did want to have some personal involvement, 19% said they would like more of a say (i.e. low-level involvement), while 6% would like to be actively involved, and a further 2% reported having already been actively involved in some way. There have been no changes on this measure since 2014.

Unpicking the relationship between attitudes and intentions further it is interesting to note that there was no positive correlation between those who feel that the public *should* be more involved and the proportion who *want* to be more involved. In fact, there is evidence that the opposite is true: those who agreed that 'the government should act in accordance with public concerns about science and technology' were *less* likely to want more active involvement or already be involved (27%) than those who disagreed (42%). There was no relationship between thinking that 'scientists should listen more to what ordinary people think' and wanting to become more actively involved.

Figure 6.5: Whether people want personal involvement in science decision-making



Q28. Which of these statements, if any, comes closest to your own attitudes to decision-making about science issues?
Base: All respondents (1749)

Overall, 28% stated some desire for active involvement[25]. Focussing on this summary measure:

- Men were more likely than women to want active involvement (34% vs 24%).
- Older people were less interested in active involvement than younger people, with 34% of those aged 16-34 wanting some active involvement compared with 17% of those aged 65+.
- Degree-educated people were much more likely to want some involvement than those without qualifications (42% vs 8%). Conversely, people with no qualifications were markedly more likely to take a totally 'hands off' position: 58% of this group were not interested in being involved in decision-making as long as scientists are doing their jobs, compared with the average of 28%.
- It is of little surprise that those with high science capital were considerably more likely to want some active involvement than those with low science capital (56% vs 6%) In contrast, people with low science capital were much more likely to say they want no involvement as long as scientists are doing their jobs (59% vs 13% of those with high science capital).

How do people want to get involved in decision-making about science?

People who were already involved in science-decision-making[26] were asked how they have been involved, while people who were either already involved in science-decision-making or who expressed a wish for this were asked about their preferences for doing so. These questions were asked for the first time in PAS 2019.

The responses for these questions were combined (Figure 6.6)[27]. The most common preferences for getting involved were to provide opinions via a poll or survey (70%), taking part in a public consultation (47%) and participating in citizen science activities (47%). Smaller proportions of people would choose focus groups (40%) or taking part in a public dialogue event about science (30%).

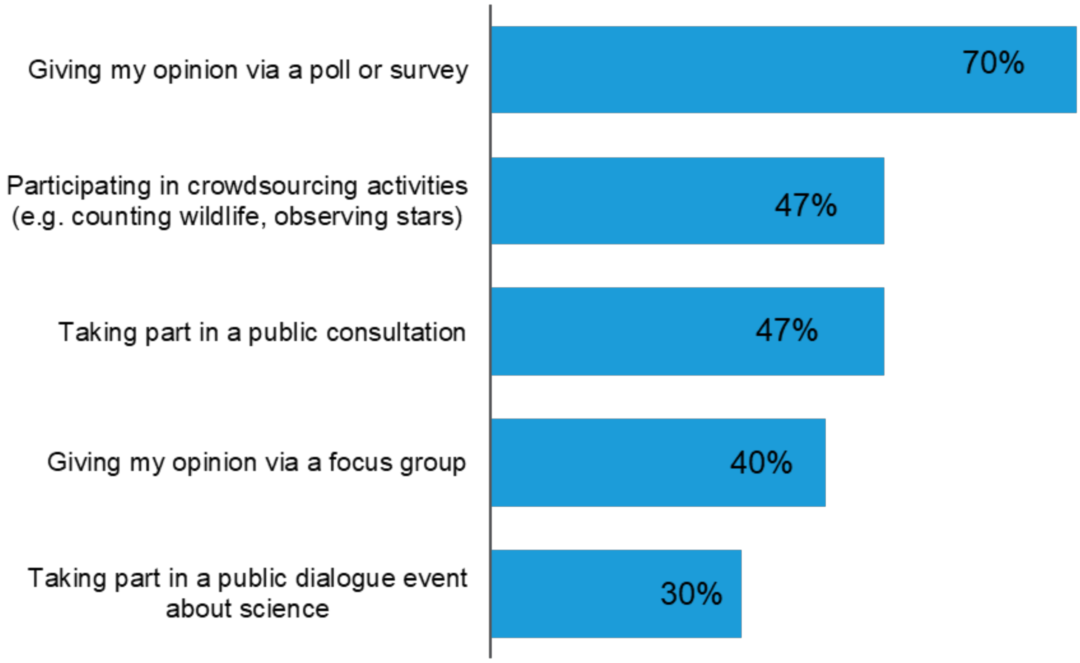
Due to a reduced sample size at these questions, analysis is limited to gender differences. This shows that the views of men and women were similar apart from in relation to taking part in a public dialogue event: men were more likely than women to favour this option (34% vs 25% respectively).

[25] This summary measure combines those who are either already actively involved, would like to be more actively involved, or would like to have more of a say

[26] n=41 cases

[27] As above, this group includes those who wanted more say, those who wanted to become actively involved, and those already actively involved (n= 468)

Figure 6.6: Preferences for involvement in decision-making about science issues



Q28b. Would you like to be involved in decision-making about science issues that matter to you in any of these ways?/Q28c Are you involved in decision-making about science issues in any of these ways?
Base: All who have some desire for further involvement in science decision-making (already actively involved, would like to be actively involved, would like more of a say) (n=468)

7. Trust in scientists and the regulation and funding of science

This chapter investigates levels of trust in scientists; how much people value the work of scientists; which traits are most valued in scientists; whether people trust scientists to carry out their role with integrity and transparency; attitudes towards government regulation of science; opinions about how science is funded; and key trends in attitudes since 2014 and over the longer-term.

Key findings

Public trust in scientists and engineers, and recognition of their contribution to society, remained very high. However, the public continued to have concerns about the effectiveness of governance and funding, especially in relation to the role of the private sector. While results remained mostly stable since 2014, there were a small number of positive shifts in trust over time.

Changes over time

- Public trust in scientists and engineers remained broadly stable since 2014. However, there was a continuing increase in trust among scientists working for environmental groups and a small decline in the proportion trusting charity-based scientists; this latter finding could be linked to declining trust in the charity sector more generally over this period (Populus, 2018).
- Since 2014, there were some positive shifts in people’s attitudes towards scientists and governance frameworks, with slightly lower proportions in 2019 agreeing that scientists adjust their findings to get the answers they want, that rules won’t stop scientists doing what they want behind closed doors, and that the speed of scientific development is affecting the government’s ability to provide adequate control.
- Between 2005 and 2014, there was an increasing trend towards people having a sense of ‘resigned trust’: that is feeling they have ‘no option but to trust those governing science’. However, this trend was reversed in 2019 (a drop from 67% in 2014 to 56% in 2019) which could be linked to the increased levels of confidence in the effectiveness of regulation.

2019 findings

- The public continued to feel that the government (56%) is best placed to set regulations for scientists, followed by scientists and their professional bodies (31%).
- Level of trust in scientists was linked to where they worked. Scientists, engineers and researchers working for universities were most trusted by the public (around 90%); then those working at charities and environmental groups (around 80%); then those working for the government (around 75%); and finally, those working in the private sector (57% of scientists, 66% of engineers).

- However, despite these mostly high levels of trust, people had concerns about how effective current regulation is in terms of ensuring scientists work with integrity. For example, around half felt that rules will not stop scientists doing that they want behind closed doors, and a third felt that the pace of scientific development is too fast to allow adequate government control.
- The traits that people most value in scientists were being ethical, honest and open-minded. While most people agreed that scientists uphold these traits, there continued to be concerns around scientists' ability to communicate and to be transparent about their work.
- Linked to this, people valued independence and transparency in the funding of scientific research. Three in four (74%) were concerned that the interests of funders compromise the independence of scientists, and over half (58%) felt that scientists are too dependent on industry. However, people were much more supportive of government funding for science, with only a small minority (10%) feeling that government should cut science funding in favour of other priorities.
- In general men, the more affluent, the more educated, and those with high science capital had most trust in scientists and science regulation.

Context

The PAS surveys, backed up by other data sources, have shown that trust in scientists remain at an all-time high, and that scientists and engineers are among the most trusted professions in the UK and other technologically advanced countries (Burchell, 2019).

However, unpicking the different drivers of trust in science and scientists is complex. Scientists work within 'expert systems' by which we refer to the networks of institutions and regulatory processes that people rely on to manage science and technology. A key finding of the PAS 2019 literature review (Burchell, 2019) was that while levels of public trust in scientists is high, people are more questioning about the effectiveness of governance and funding frameworks. The literature review cites evidence of public scepticism of these 'expert systems' and their ability to: put public interest ahead of commercial interests; ensure that the benefits and risks of science are equitable; and robustly ensure accountability when things go wrong (Burchell, 2019).

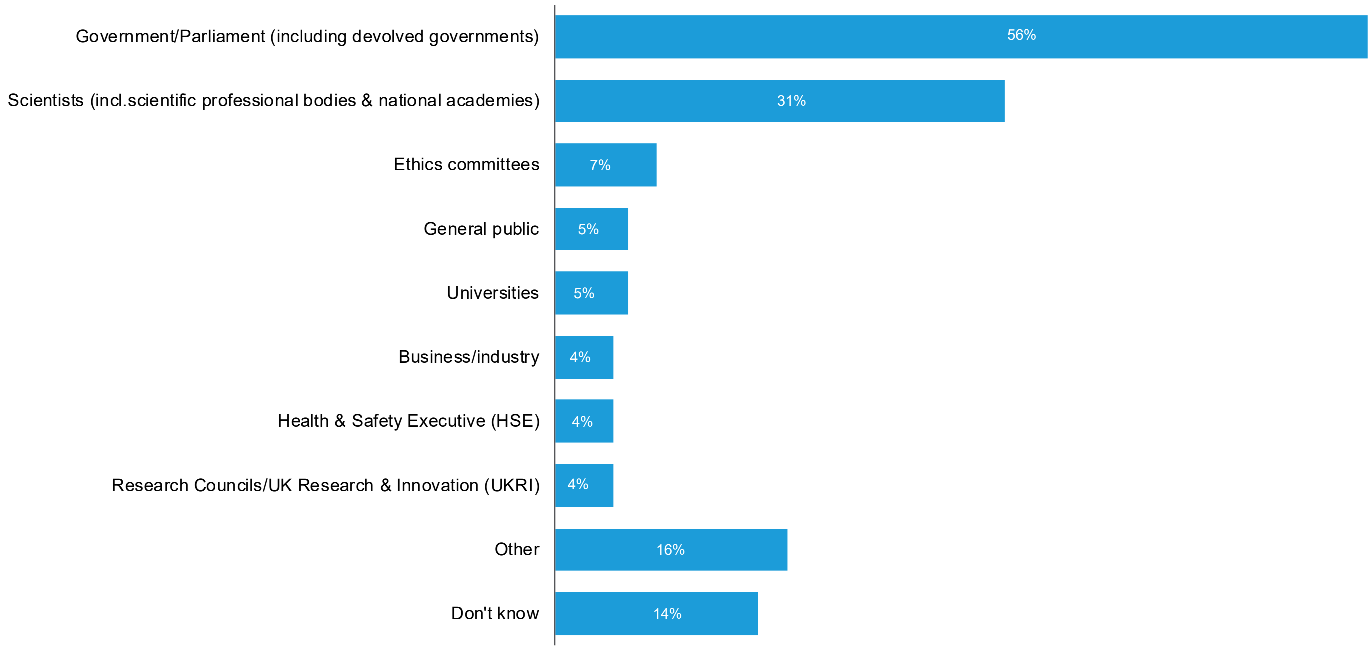
It is important therefore to track public opinion on trust in scientists and the expert systems which manage and fund the work of scientists, to explore the extent to which their work is perceived as open and transparent, and reflective of public interests and values.

Who do people feel should regulate scientific research?

When asked unprompted who they think should set the rules and regulations for scientists in the UK to follow, most people felt that this role should be taken on by government (56%) or by scientists, either themselves or via a professional scientific body or academy (31%). Smaller proportions felt this role should be (at least partly) taken on by the business community, the general public, and other institutions such as universities, research councils, and ethics committees (Figure 7.1).

Broadly, the results are in line with PAS 2014, though a slightly lower proportion in PAS 2019 thought science should be regulated by scientists (31% compared with 36% in 2014).

Figure 7.1: Who people think should set the rules and regulations for UK scientists



Q11. Who, if anyone, do you think should set the rules and regulations for scientists in the UK to follow when they are doing their job?
Base: All respondents (n=1749)

Overall, 14% did not know who should regulate scientists, and this level was particularly high among those with no educational qualifications (30%), the least affluent DE group (23%) and women (19%).

How much do people trust scientists and engineers?

Trust in scientists, researchers and engineers to follow rules and regulations which apply to their professions remained high. However, the institutional setting in which scientists and engineers work can affect the level of trust (Figure7.2). Scientists, engineers, and researchers working for universities were most trusted by the public (around 90%); then those working at charities and environmental groups (around 80%); then those working for the government (around 75%); and finally, those working in the private sector (57% to 66%).

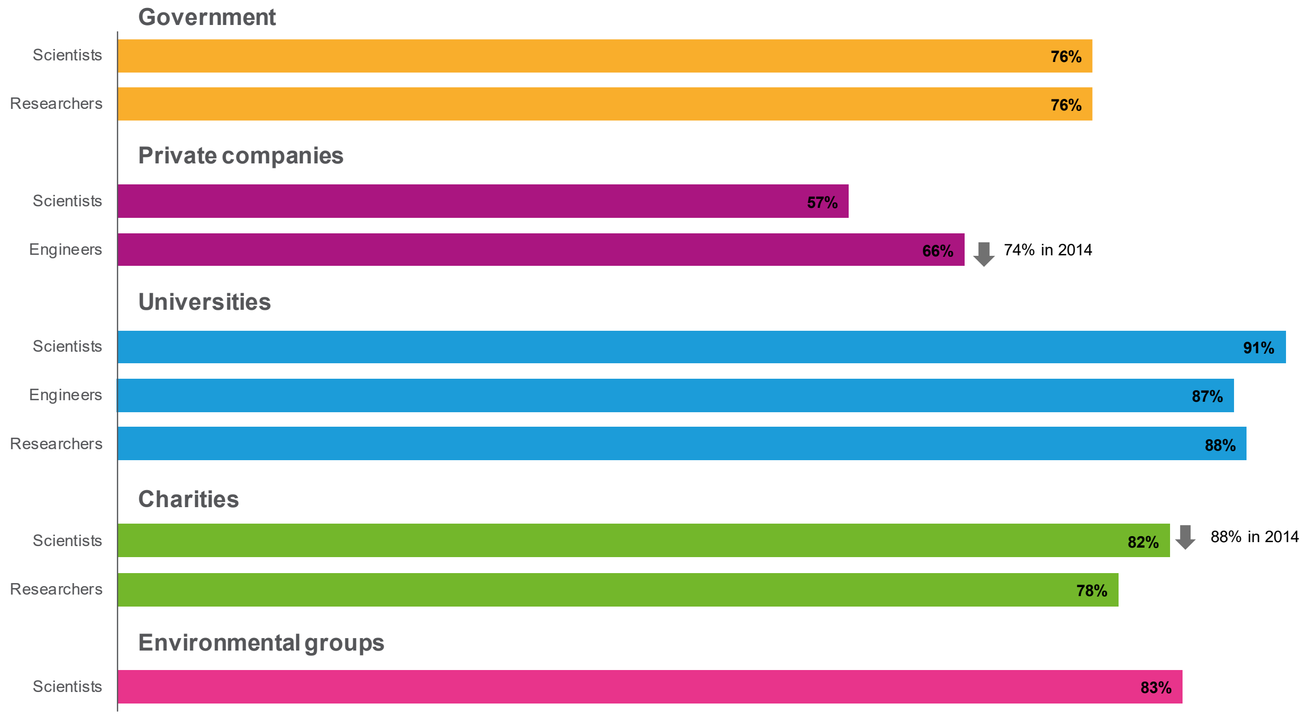
These trends reflect wider literature on trust. For example, the Ipsos Veracity Index (Ipsos Mori, 2018) found that engineers, professors, and scientists were among the most trusted professionals in the UK, while the BEIS Public Attitudes Tracker (BEIS, 2019) found that scientists working for universities and scientific organisations were the most trusted to provide accurate information about climate change, ahead of the charity/environmental campaign group sector, and then government.

The gap between trust in university versus commercial sector scientists was also found in the 2018 British Social Attitudes study (Curtice et al, 2019) which found that 85% of people trusted university scientists to do their work with the intention of benefitting the public, while only 67% trusted commercial scientists to do this.

While trust remained high, and largely unchanged since 2014, there were some dips between 2014 and 2019 in levels of trust of engineers working for private companies and of scientists working for charities. Conversely there was an increase in trust of scientists working for environmental groups which has also been observed over a longer period (72% in 2011; 79% in 2014; 83% in 2019). Other BEIS data (BEIS 2019) reports a rise in the proportion of the public thinking that climate change is caused entirely or mainly by human activity from a low of 35% in 2014 to a high of 48% in 2019. With more people now believing the scientific evidence on climate change, this may help explain why trust in environmental scientists has risen.

The dip in trust of scientists working for charities may be linked to a more general decline in trust among charities over this period (Populus, 2018) rather than to charity-based scientists specifically.

Figure 7.2: How much do people trust scientists and engineers to follow professional rules & regulations



Q21. How much, if at all, do you trust each of these groups to follow any rules and regulations which apply to their profession?
Base: All respondents, half sample (n=860)

Focussing on the proportions of people who distrusted scientists and other professionals (that is, said they trusted them ‘not very much’ or ‘not at all’), the following demographic differences were observed:

- Women were more likely than men to distrust university engineers (12% vs 3%)
- The less affluent (DEs) were more distrusting than the most affluent (ABs) about most professions asked about.
- People with no qualifications were more distrusting than those educated to at least degree-level, again for most professions asked about.
- People with low science capital were more distrusting than those with high science capital for almost all of these professions.

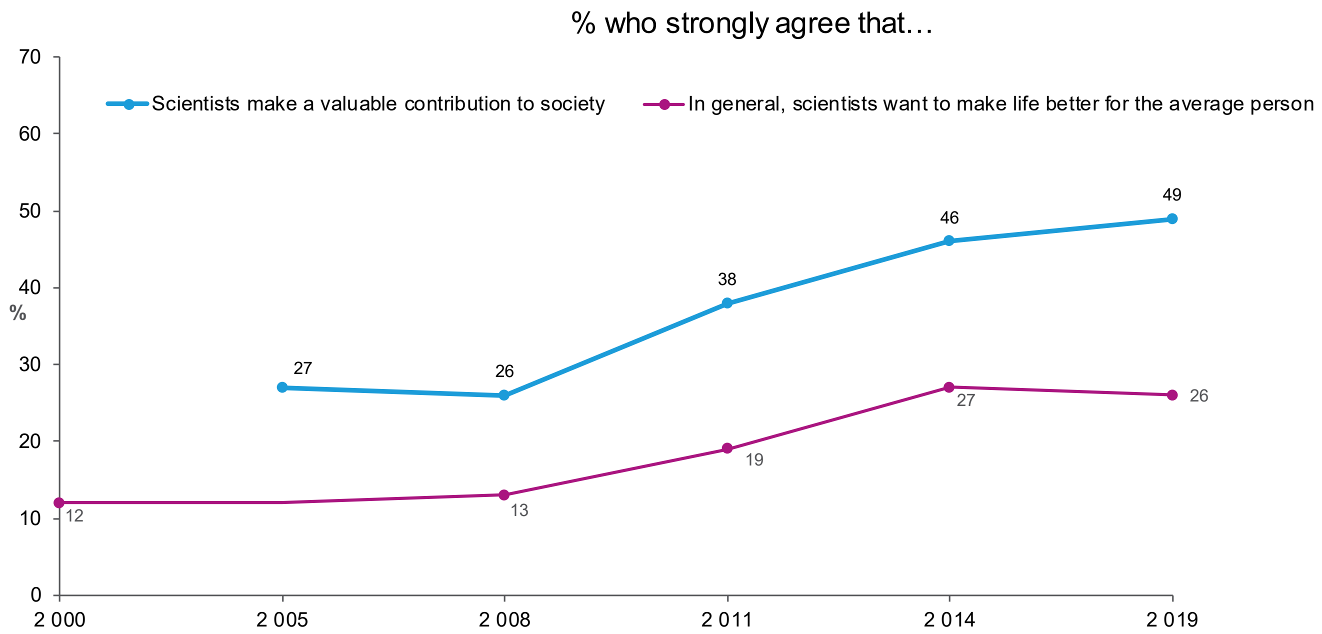
How do people view scientists and engineers?

Do people value scientists and engineers?

As in 2014, the public's overall perception of scientists and engineers is overwhelmingly positive. Around nine in ten agreed that scientists (89%) and engineers (87%) make a valuable contribution to society, while eight in ten (82%) agreed that scientists want to make life better for the average person.

Focussing in on the proportion who agree strongly with these statements, there was a continuing upward trend in relation to the proportion who feel that scientists make a valuable contribution to society (Figure 7.3). This trend corroborates the findings of the 2018 British Social Attitudes (Curtice et al, 2019) which also found that between 2000 and 2018, the public has become less likely to agree that 'modern science does more harm than good', and more likely to disagree.

Figure 7.3: How much people value the contribution of scientists over time



Q23. Here are some statements about working in science. For each, please could you tell me the extent to which you agree or disagree?
Base: All respondents, half sample (Scientists n=860; Engineers n=889)

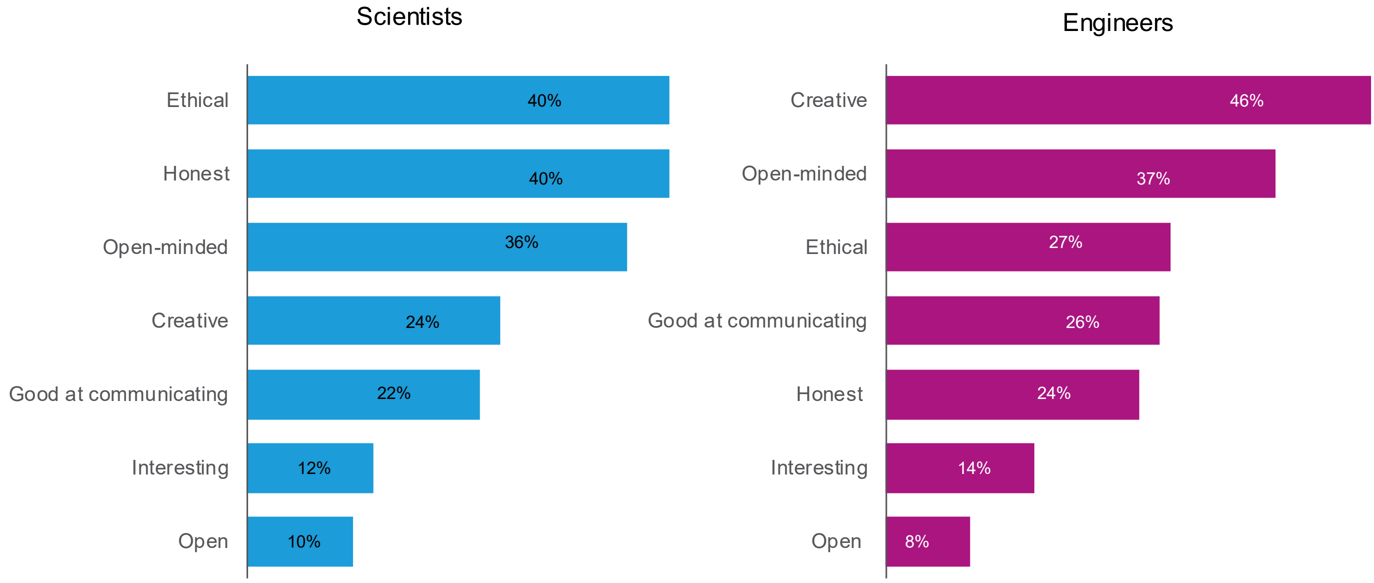
Which professional traits in scientists and engineers are most important?

When asked to pick their top one or two from a list, the traits which people considered most important for scientists were being ethical (chosen by 40%), honest (40%) and open-minded (36%: Figure 7.4).

The key traits for engineers, on the other hand, were creativity (46%), being open-minded (37%) and being ethical (27%). The PAS 2019 findings were almost identical to those observed in PAS 2014. However, in 2019, people were less likely to prioritise honesty in engineers (24% down from 33%).

Although good communication skills and openness were not as highly valued in engineers and scientists as other traits such as being ethical, open-minded or creative, it is clear from findings reported elsewhere (see Chapter 6) that there was overwhelming support for public engagement about science. It is likely, therefore, that the lower ranking of these latter traits does not indicate that they are unimportant to people, but more that they value scientists finding ethical and creative solutions to problems over their willingness and ability to communicate these with the public.

Figure 7.4: Top one or two traits considered most important for scientists and engineers



Q19. And looking at these words or phrases, which one or two, if any, do you think it is most important for scientists or engineers to be?
Base: All respondents, half sample (n=860)

The perceived need for scientists to be open-minded and creative was further underlined by the very high proportion who agreed that 'Scientists are always learning' (94% agree, 55% strongly agree) and that 'it is normal for scientists to disagree with each other'[28] (87% agreed, 44% strongly agreed).

More educated people had a greater appreciation that 'it's normal for scientists to disagree with each other' (91% vs 77% with no qualifications). Similarly, those with high science capital were more likely to agree with this than who had low science capital (94% vs 80%).

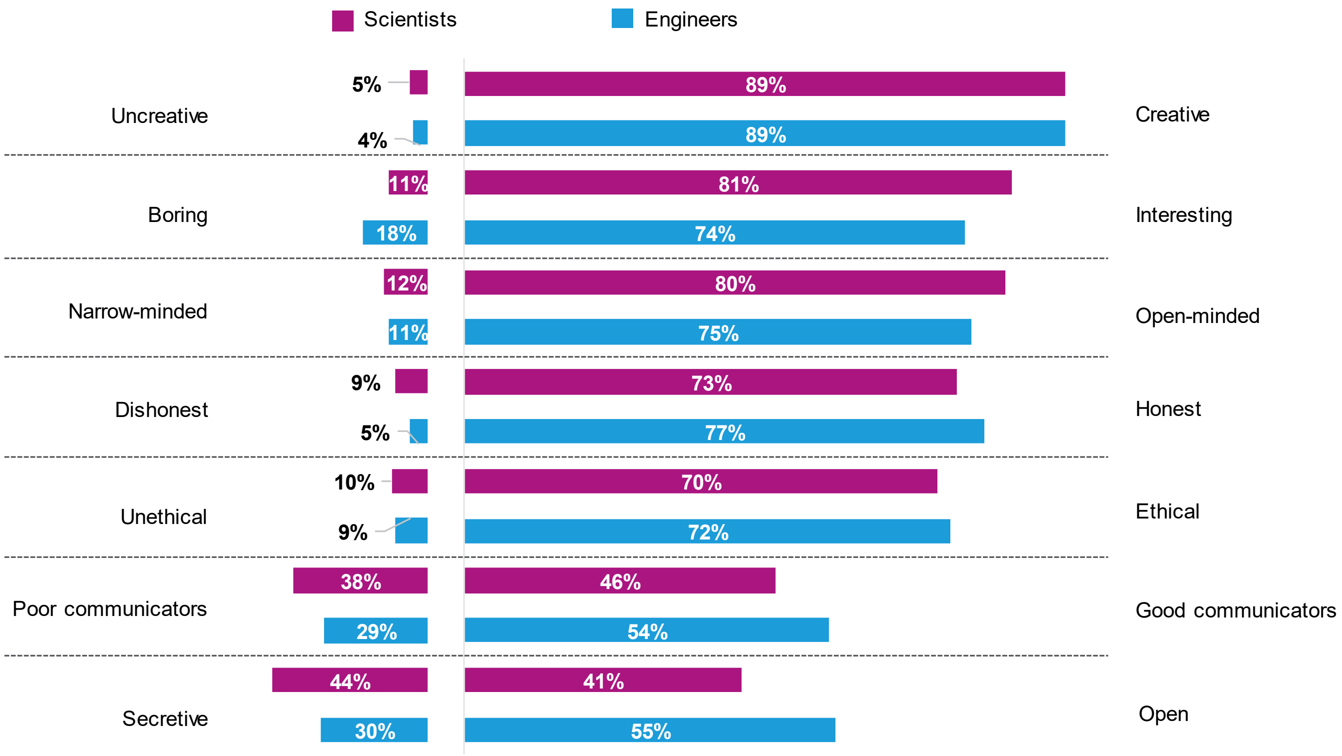
What attributes do people associate with scientists and engineers?

People were also asked how they viewed scientists and engineers in terms of the traits discussed above; for this they were asked to pick which out of a pair of opposing attributes came closest to their view of scientists or engineers. In general, scientists and engineers met people's expectations of them (Figure 7.5). At least seven in ten people thought that scientists and engineers were creative, interesting, open, honest, and ethical. However, it is clear that a substantial minority of scientists and engineers are not, demonstrating to the public that they are open about their work and able to communicate about it. This was particularly the case for

[28] Note: question wording changed slightly between 2016 and 2019 so it is not possible to compare with previous years

scientists where around four in ten considered that scientists were secretive (44%) or poor communicators (38%). Engineers were a little more highly regarded than scientists in these respects though the ratings are still low relative to other attributes (29% were viewed as poor communicators and 30% as secretive). The pattern of findings was very similar to 2014.

Figure 7.5: Which attributes do people associate with scientists?



Q16/17. Looking at these pairs of words or phrases, which one of each of these pairs comes closest to your current view of scientists/engineers?
Base: All respondents, half sample (n=860)

More detailed analysis of the PAS 2019 data reveals the following:

- Women were more likely than men to think of both scientists and engineers as boring (scientists: 15% vs 7%; engineers: 26% vs 10%).
- People with no qualifications were considerably more likely than degree-educated people to think of scientists and engineers as boring (scientists: 31% vs 2%; engineers: 31% vs 14%). This group was also more likely than degree-educated people to attribute a range of other negative traits to scientists, with a greater proportion thinking of them as narrow-minded (19% vs 8%), secretive (53% vs 37%) and dishonest (13% vs 5%).
- People who distrusted traditional media[29] were more likely than those who trusted it a great deal to think of scientists as narrow-minded (21% vs 10%), poor communicators (43% vs 32%) and dishonest (17% vs 2%).

[29] This is defined as the proportion who said they do not trust *traditional media such as newspapers, magazines, TV or radio news, or websites associated with these* to provide accurate information about science.

- People with low science capital were more likely with high science capital to attribute negative traits to scientists in all categories.

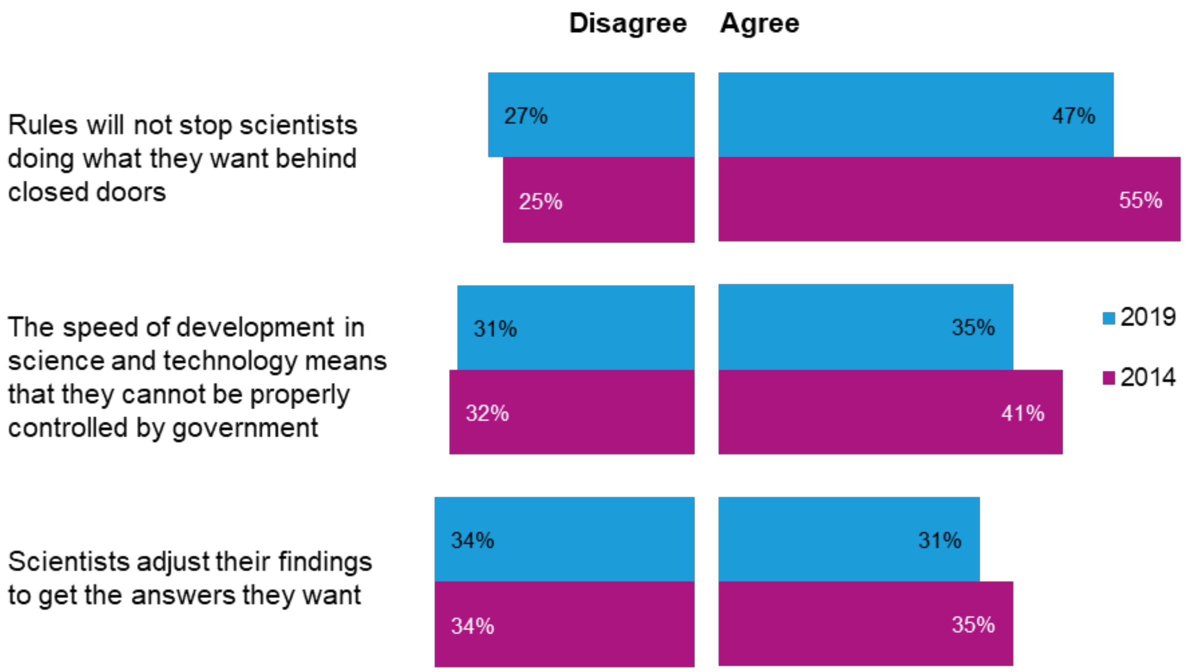
Do people have confidence that the regulation of science is effective?

Do people trust the integrity of scientists?

Many UK adults had reservations about the effectiveness of regulations (Figure 7.6). Around half considered that 'rules will not stop scientists doing what they want behind closed doors' (47% agree vs 27% disagree); one in three thought that 'scientists adjust their findings to get the answers they want' (31% agree vs 34% disagree); and a similar proportion felt that 'the speed of development in science and technology means that they cannot be properly controlled by government' (35% agree vs 31% disagree).

However, since 2014, there were some positive shifts in attitudes towards scientists and governance frameworks, with slightly lower proportions in 2019 agreeing that scientists adjust their findings to get the answers they want, that rules won't stop scientists doing what they want, and that the speed of scientific and technological development is affecting the government's ability to provide adequate control.

Figure 7.6 Perceptions about the integrity of scientists and effectiveness of government regulation



Q23. Here are some statements about working in science. For each, please could you tell me the extent to which you agree or disagree?
Base: All respondents (n=1749)

There were some differences on these measures by socio-demographic characteristics consistent with those seen for other measures of trust:

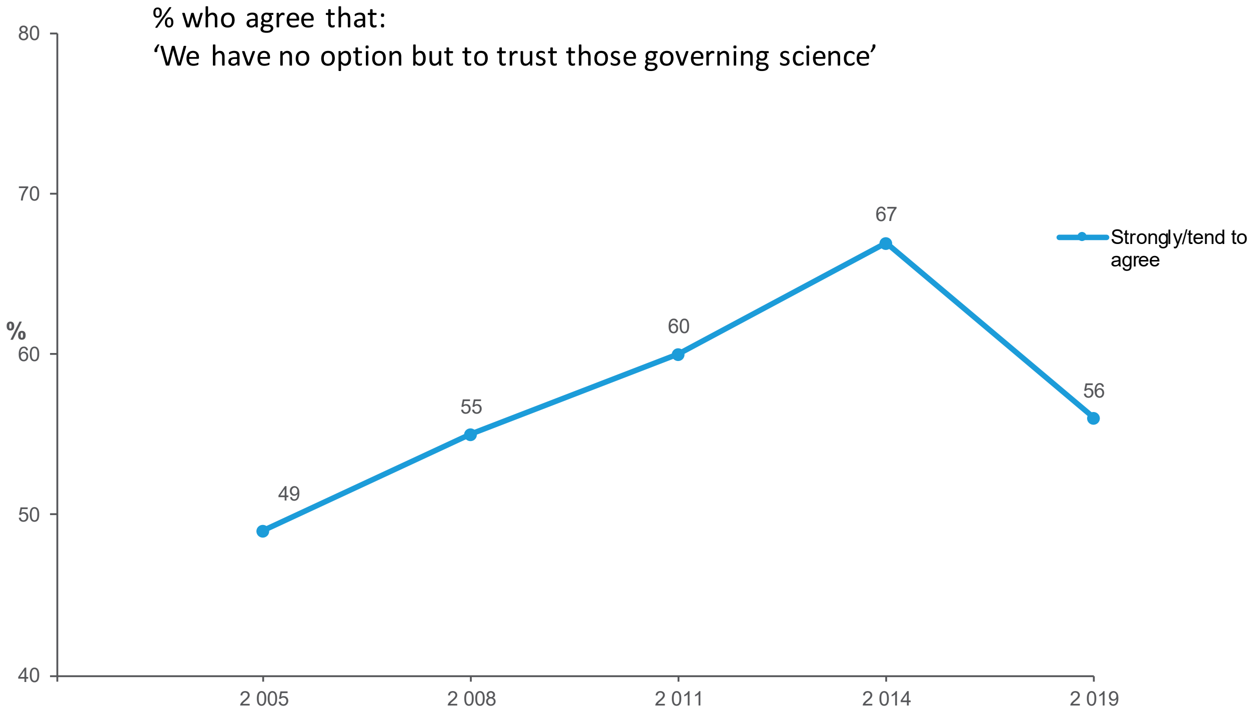
- Older people aged 65 or over were more likely than 16 to 34 year-olds to feel that science regulation is not always effective (56% vs 44% feeling that rules will not stop scientists doing what they want, and 42% vs 31% feeling that the speed of scientific development is too fast to allow adequate government control).
- People with higher level qualifications tended to have more faith that scientists were carrying out their role with integrity. Those with degree-level qualifications were less likely than people who lacked qualifications to agree that scientists adjust their findings (24% vs 39%) and that rules will not stop scientists doing what they want (39% vs 58%).
- Similarly, those with high science capital were less likely than those with low science capital to consider that that scientists adjust their findings (23% vs 38%) and that rules will not stop scientists doing what they want (38% vs 56%).

Is 'resigned trust' on the decline?

As noted above, scientists remained highly trusted by the public. However, despite this, just over half (56%) felt that 'we have no option but to trust those governing science'. This concept has been referred to in previous reports as 'resigned trust' and is seen as an indication that many people feel they have a lack of control over how science impacts on their daily life and are therefore obliged to accept that scientists are acting in their best interests.

Between 2005 and 2014 there was a linear increase in the proportion agreeing to this, a trend which appears to have been reversed in 2019 (Figure 7.7). This might be linked to the positive shifts between 2014 and 2019 noted above in relation to people's confidence in the effectiveness regulation.

Figure 7.7: Proportion who feel that they 'have no option but to trust those governing science' over time



Q23. Here are some statements about working in science. For each, please could you tell me the extent to which you agree or disagree? *Base: All respondents 2019 (n=1749)*

Levels of resigned trust were higher among those with no qualifications (63% vs 52% with degree-level qualifications), older people (65% of those aged 65+ vs 46% of those aged 16-24) and people with low science capital (67% vs 49% of those with high science capital).

Resigned trust was also associated with the degree to which people engage with and feel informed about science; it was higher than average among people who:

- agreed that ‘Science and technology are too specialised for most people to understand them’ (64%);
- felt ‘not at all informed’ about science and scientific developments (67%);
- considered that they ‘cannot follow developments in science and technology because the speed of development is too fast’ (65%);
- disagreed that ‘science is such a big part of our lives that we should all take an interest’ (66%).

On average, 20% disagreed that ‘we have no option but to trust those governing science’. Supporting the hypothesis that resigned trust is linked to feelings of knowledge, agency and control, levels of disagreement were higher than average among people who:

- disagreed that ‘there is so much conflicting information about science it is difficult to know what to believe’ (40%);
- said they would like to be actively involved in decision-making about science (34%);
- felt connected with science by actively seeking out science news and events (30%).

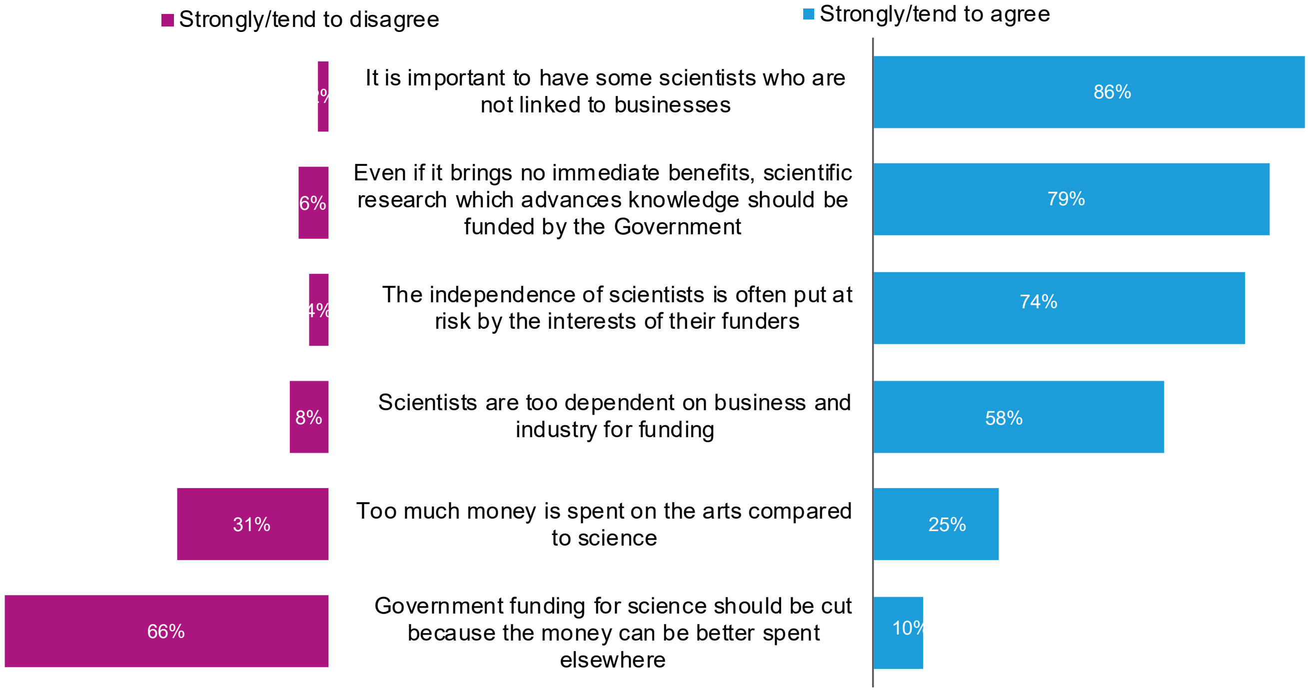
What do people think about UK science funding?

The 2019 survey indicates that people still strongly supported government spending on science: eight in ten (79%) agreed that scientific research should continue to be funded even if it brings no immediate benefits (Figure 7.8). While a majority (66%) disagreed that government funding for science should be cut in favour of other spending priorities, just a minority (25%) agreed that too much money is spent on the arts compared to science. This indicates the challenges involved in measuring attitudes towards spending priorities. While very few wanted to see spending on science cut in the abstract, people have to be asked to compare or rank different calls on public spending in order to identify priorities.

While support for government funding remained high, the public continued to have concerns about the influence of the funder, and the role of the private sector in scientific funding. Around three in four (74%) agreed that the independence of scientists was often put at risk by the interests of their funders while six in ten (58%) felt that scientists were too dependent on business for funding. The preference for public over private funding of science was reinforced by the high proportion (86%) agreeing that it is important to have some scientists not linked to business.

These findings have all remained unchanged since 2014.

Figure 7.8: Attitudes towards science funding



Q23. Here are some statements about working in science. For each, please could you tell me the extent to which you agree or disagree?
Base: All respondents (n=1749)

There were some socio-demographic differences in attitudes towards science funding:

- Men, the more affluent AB group, the more educated, and people with high science capital were relatively more likely to agree that scientific independence is put at risk by the interests of funders (79% of men vs 69% of women; 81% of ABs vs 65% of DEs; 82% of degree-educated people vs 61% of those with no qualifications; and 83% high vs 68% low science capital). These same groups were also more likely than average to disagree that government science funding should be cut in favour of other priorities.

- Those with no qualifications (40% vs 13% with a degree) and from DE backgrounds (32% vs 15% of ABs) were more likely to feel that too much money was spent on the arts compared to science. Those who considered themselves more connected to the arts by actively seeking out arts news and events were more likely to disagree with this (47%) than those who considered that ‘art is not for me’ (20%).

8. Perceived benefits and risks of developments in science

This chapter explores: attitudes towards the pace of scientific development; perceived risks and benefits of different scientific applications (including driverless vehicles and the use of animals in research); public views on the link between scientific advances and inequalities; and the relationship between religious views and attitudes to risk. Where relevant, findings have been tracked since 2014 and over the longer-term.

Key findings

On the whole, people were more positive than fearful about various technologies, although concerns were higher in the case of driverless vehicles, GM crops and using animals in research. Most people considered that scientists appropriately manage risk, although sizeable minorities were concerned about the pace of scientific development, and the potential for scientific development to disproportionately benefit the wealthy. Most measures remained stable since 2014, although there was an increase in support for renewable energy, and a decrease in support for using animals in research.

Changes over time

- Overall, concerns about the pace of scientific and technological development have been falling over time. This may be a sign that UK adults are becoming more familiar with, and more adaptable to, an ever-accelerating pace of change.
- There was a notable increase between 2014 and 2019 in the belief that the benefits of renewable energy outweigh the risks, from 66% to 79% among those who had heard of this.
- However, there was a marked decline in the proportion who support the use of animals in medical research. The proportion who agreed that 'scientists should be allowed to carry out research with animals if this can lead to improvements in health', fell from 67% in 2014 to 56% in 2019.

2019 findings

- Sizeable minorities had concerns about the pace of scientific development, with 38% struggling to follow developments in science and technology 'because the speed of development is too fast', and 27% agreeing that 'science makes our way of life change too fast'.
- The public wants risks to be well-managed: 75% believed government should delay new technologies until scientists are certain of their safety. Encouragingly, a majority (69%) felt confident that scientists appropriately consider such risks. However, this left around a quarter who did not feel confident that scientists appropriately manage risk.
- On the whole, people were more positive than fearful about various technologies. Vaccination and renewable energy attracted near universal public support, while

driverless cars, GM crops, nuclear power, and animals used in research were the most contentious. On balance, more people felt benefits outweighed risks in all technology areas asked about, except for driverless cars (where more felt the risks outweighed the benefits) and GM crops (where opinion was fairly evenly split).

- In general, belief that the benefits outweighed the risks for different technologies was higher among those who had some knowledge of the relevant technology.
- A sizeable minority (30%) thought that scientific advances benefit the rich more than the poor. There was greater concern about the impact of advances on inequalities in relation to specific technologies: 77% felt that if robots replace human jobs, people in low-skilled jobs will find it harder to get alternative employment, while 67% felt that new medical treatments to allow people to live longer would only be available to the wealthy.
- Men, degree-educated people, and people with high science capital were, in general, more likely than average to see benefits rather than risks of scientific applications. Older people were more concerned about the pace of change, and about driverless cars; however, they were less concerned about using animals in research.
- Although this wasn’t consistent across all measures in this chapter, there was a general tendency for people actively practising a religion to feel more concerned about the potential risks associated with science.

Context

The PAS 2019 literature review (Burchell, 2019) acknowledges that public perception of risk is often based on subjective, uncertain and assumption-laden assessments (Slovic, 1997). Media reporting of science can add to this confusion, while the growth in social media has allowed the proliferation of misinformation campaigns (commonly referred to as ‘fake news’), for example misleading or false information spread by climate change deniers or people who oppose vaccination.

Slovic further notes that public concerns are likely to be greater when technology presents risks that are new, not observable, delayed, not well understood, evoke a sense of fear, are increasing, involuntary, not in the control of the individual and not easily reduced. Addressing some of these issues, McNaughten & Chilvers (2014) note that people are more likely to support technologies when they: involve the public at an early stage; reflect public interest rather than commercial benefits; offer clear and necessary benefits that are widely available and affordable; are well-regulated; and are transparently communicated.

Smallman (2018) finds that while the public is broadly supportive of new scientific developments, they see the risks and social and ethical issues associated with them as unpredictable but inherent parts of the developments (referred to as a public perception of ‘contingent progress’). This is seen to be at odds with the more enthusiastic ‘science to the rescue’ discourse set out by scientists and policymakers.

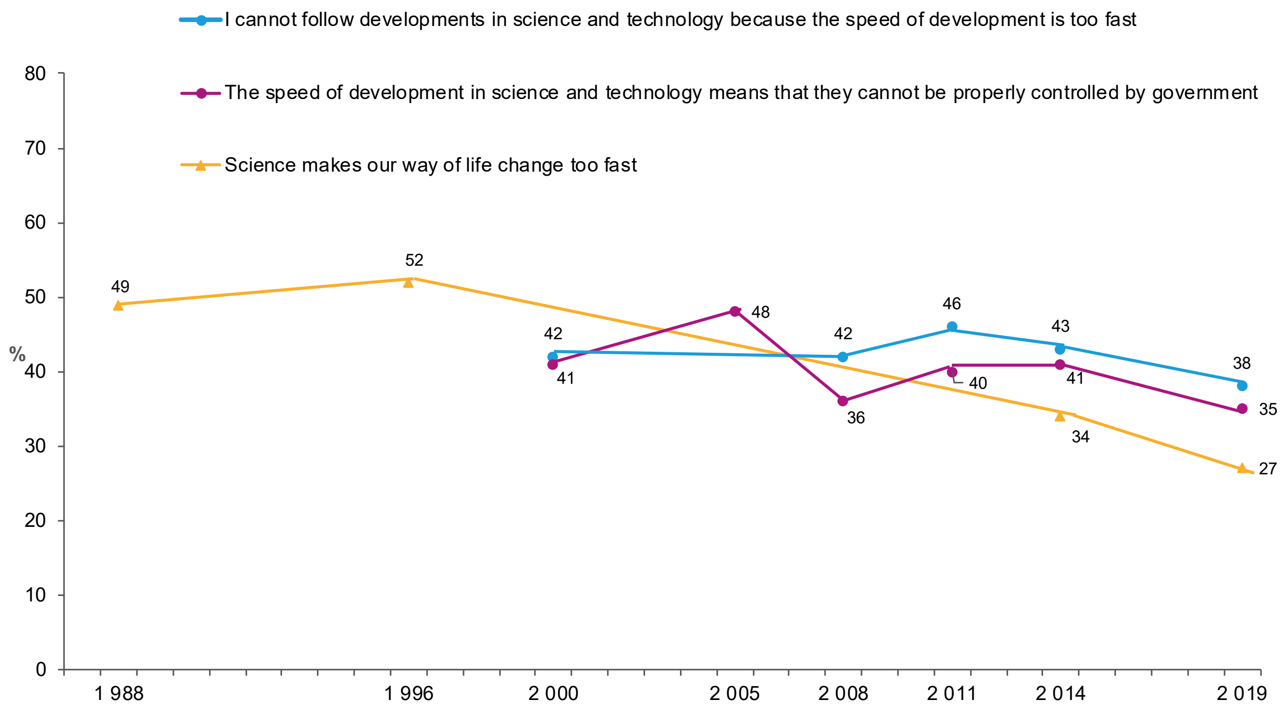
There are three further areas which have the potential to exacerbate concerns about science and technology: that the pace of scientific advancement is changing our life too quickly and becoming difficult to manage; that the benefits and risks of science are not equally distributed in society; and the association between religious views and scientific progress as set out below.

What do people think about the pace of scientific development?

Just over a third had some concerns about the pace of development, with 38% agreeing that they 'cannot follow developments in science and technology because the speed of development is too fast', and 35% agreeing that 'the speed of development in science and technology means that they cannot be properly controlled by government'. A slightly lower proportion (27%) agreed that 'science makes our way of life change too fast'.

However, the proportion of people with concerns about the pace of scientific and technological development has, on the whole, been falling over time (Figure 8.1). This may be a sign that UK adults are becoming more familiar with, and more adaptable to, a constantly accelerating pace of change.

Figure 8.1 Attitudes towards pace of change in science and technology and longer-term trends



Q. Here are some statements about science. For each, please could you tell me the extent to which you agree or disagree?
Base: All respondents in 2019 (n=1749)

In general, older people, the less well-educated, people with low science capital, and those who practised a religion were most concerned about the pace of scientific change.

- Concern about the pace of change was greater among older people than younger people. A quarter (25%) of people aged 16-24 found that the speed of development makes it difficult to follow developments in science, compared with two-thirds (67%) of people aged 75+. There was a similar pattern of difference by age regarding the proportion who agree that 'science makes our way of life change too fast': lowest at 23% of those aged 16-24 and highest at 49% of those aged 75+.

- People with degree-level qualifications were much less likely than those with no qualifications to feel that the pace of change makes it difficult to follow scientific developments (27% vs 64%), that this means government cannot provide adequate control (34% vs 43%), and that science changes our way of life too fast (18% vs 45%).
- People with low science capital were more likely than those with high science capital to struggle to keep up with scientific developments (59% vs 20%) and to feel that life changes too fast (37% vs 17%) as a result of the speed of scientific progress.
- People who actively practised a religion[30] were more likely than those with no religion to feel that the speed of development makes it difficult to follow developments in science (47% vs 30%) and that it makes it more difficult for government to provide adequate control (42% vs 30%).
- In addition, women (44%) were more likely than men (31%) to find that the speed of development makes it difficult to follow developments in science.

What are people's attitudes to benefits and risks in scientific development?

General attitudes towards benefit and risks

With any scientific or technological advancement, there is a need to appropriately manage any potential risks alongside the intended benefits. Consistent with PAS 2014 findings, UK adults in 2019 were broadly content that the benefits of science outweigh the risks, and that risks are appropriately managed.

A far higher proportion of adults agreed (52%) than disagreed (13%) that the 'benefits of science are greater than any harmful effects'. Consistent with this finding, a higher proportion disagreed (46%) than agreed (26%) that 'the more I know about science the more worried I am'. This is further backed up by the 2018 British Social Attitudes Study (Curtice et al, 2019) where just over half of the GB public (55%) rejected the idea that 'modern science does more harm than good'.

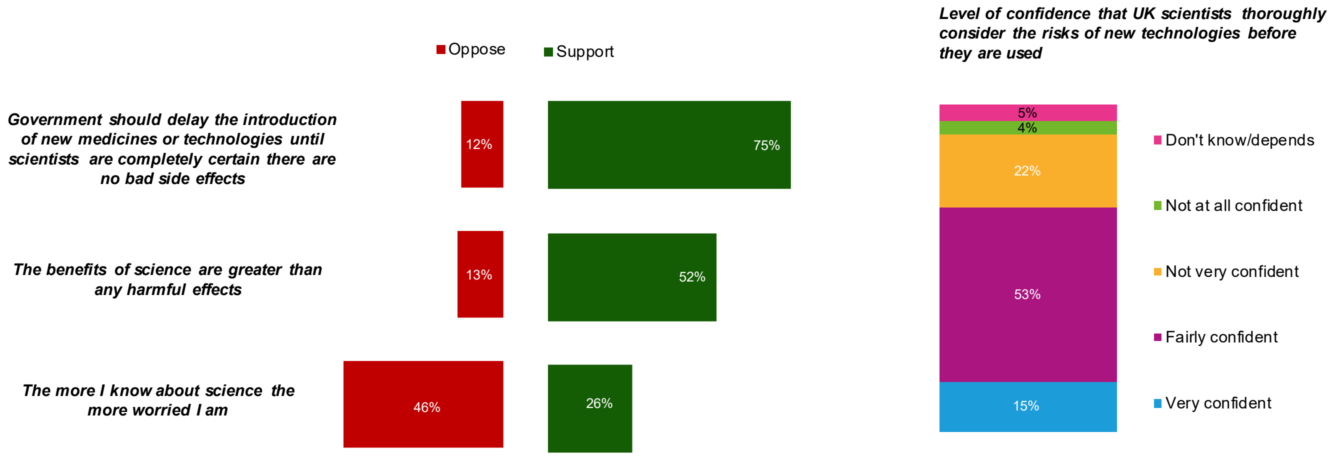
A majority (75% agreed vs 12% disagreed) felt that government should delay the introduction of new medicines or technologies until scientists are completely certain there are no bad side effects (Figure 8.2). Encouragingly, a majority were also confident that scientists do consider the risks of new technologies before they are used (69% confident vs 26% not confident).

However, this leaves round a quarter of individuals who were concerned in some way: 26% felt that 'the more I know about science the more worried I am', while 26% were not confident that scientists appropriately consider risks of new technology.

There were no changes on these measures since 2014.

[30] Defined as people who attend religious services or meetings at least once a week (see the last section in this chapter for more detail on religion classification)

Figure 8.2: Attitudes towards the benefits and risks of science (2019)



Q23. Here are some statements about working in science. For each, please could you tell me the extent to which you agree or disagree?
Q9. How confident, if at all, are you that scientists in the UK have thoroughly considered the risks of new technologies before they are used
Base: All respondents (n=1749)

More detailed analysis of the PAS 2019 data reveals the following:

- Men were more optimistic than women on some measures: men were more likely to feel confident that scientists consider risks appropriately when developing new technologies (75% vs 63%) and more likely to disagree that 'the more I know about science the more worried I am' (53% vs 39%)

- People with degree-level qualifications were more likely than those with no qualifications to feel that the benefits of science outweigh any harmful effects (59% vs 46%), and to feel confident that scientists appropriately consider risks (73% vs 50%)

- People with high science capital were more likely than those with low science capital to be optimistic on all of these measures; for example, to feel confident that scientists appropriately consider risks (82% vs 53%) and to feel that the benefits of science outweigh the risks (61%vs 43%). This group was also less likely than people with low science capital to consider that technologies should be delayed pending a full assessment of the side effects (63% vs 81%).

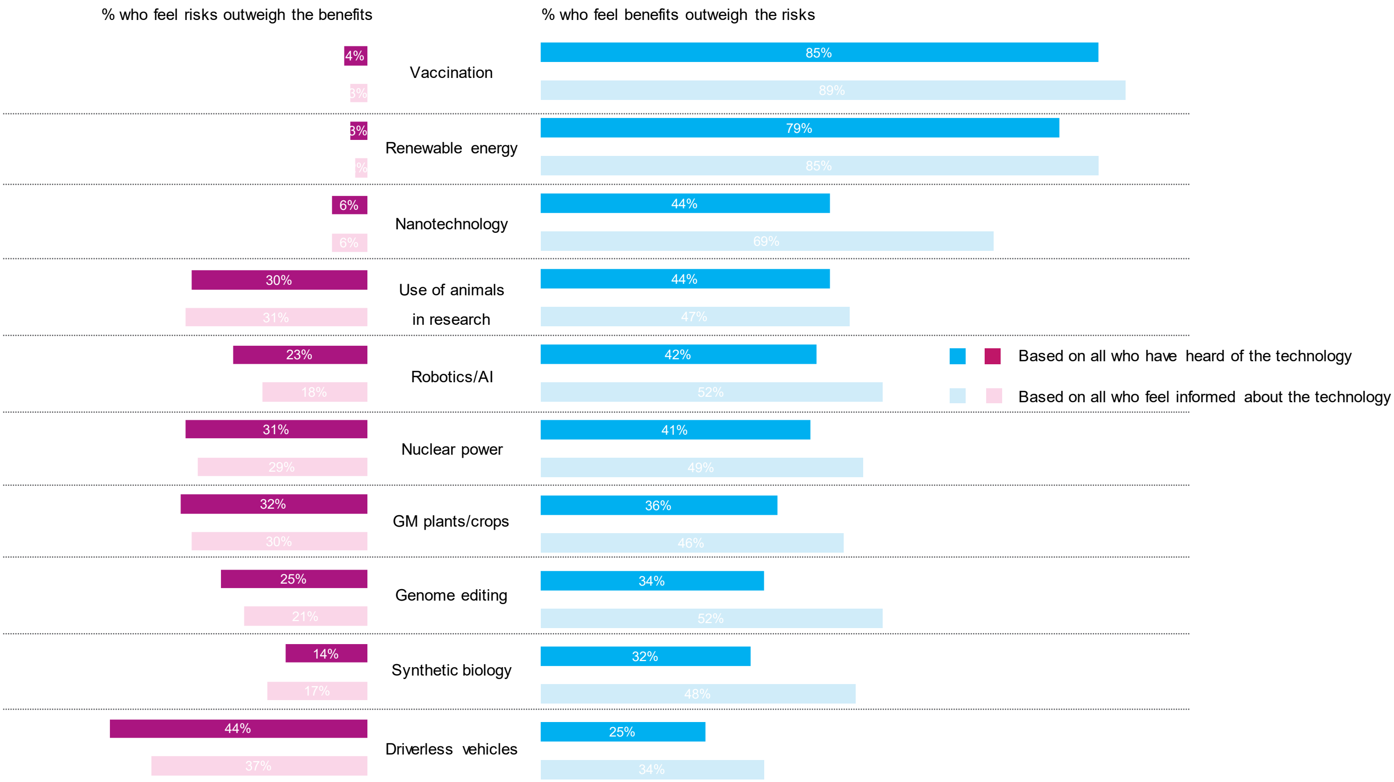
- People who actively practised a religion were more likely than those with no religion to feel that the more they knew about science the more worried they became (35% vs 23%).

Attitudes towards benefits and risks of specific technologies

While people, on balance, believed that the benefits of science outweigh any harmful effects (see above) different patterns emerged with respect to specific technologies.

Figure 8.3 charts the proportion who feel the benefits outweigh the risks, and *vice versa*, based on a) all have heard of the technology and b) all who they say they are 'very or 'fairly' well informed about the technology.

Figure 8.3: Perceived benefits versus risks of different technologies



Q8. From what you know or have heard about [ISSUE], which of these statements, if any, most closely reflects your own opinion?
Base (darker bars): All who have heard of the technology (base sizes vary from 594 to1630)
Base (lighter bars): All who feel informed about the technology (base sizes vary from 192 to 1241)

Vaccination and renewable energy attracted near universal public support, with only negligible proportions (3% to 4%) feeling that the risks outweigh the benefits. Support for vaccination remained strong despite recent media attention about the growing “anti-vaccine” movement[31]. These findings are backed up by a recent report (RSPH, 2019) which found that support for vaccinations among parents remains near-universal despite a high proportion being exposed to negative or ‘fake news’ stories about vaccines on social media.

The most contentious areas, as measured by the proportion feeling risks outweigh benefits, were driverless cars (44%), GM crops (32%), nuclear power (31%), and the use of animals in research (30%). However, with the exception of driverless cars which attracted considerable levels of concern, and GM crops where public opinion was more evenly split, people were still more likely to appreciate the benefits over the risks in each of these technology areas[32].

For most items which were measured in both 2014 and 2019[33], opinions remained stable over time. However, there was an increase in support for renewable energy: the proportion thinking

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[31] https://www.bbc.co.uk/news/health-47417966
[32] GM crops and genome editing are covered in more detail in the module-specific chapter.
[33] There were three new items in 2019: driverless vehicles, robotics/AI and genome editing. Although nanotechnology and synthetic biology were also asked about in 2014, the way in which they were asked changed (the 2014 survey included definitions for these which were removed in 2019 as this was felt to be inconsistent with other items). Also, the item about animal testing changed from the ‘The use of animals in research’ in 2014 to ‘The use of animals in medical research’ in 2019. Therefore, it is not possible to provide time series comparisons for any of these measures.

that benefits outweigh the risks increased from 66% to 79% among those who have heard of this. This reflects a more general rise in support for renewable energy over this time (see BEIS, 2019).

More detailed analysis of the data reveals the following:

- Women were more likely than men to feel that risks outweigh benefits in several technologies, especially GM crops (38% vs 27%), nuclear power (37% vs 23%), and using animals in research (38% vs 25%).
- Younger people aged 16 to 34 were more likely than older people to feel that risks outweigh benefits for using animals in research (36% vs 26%).
    - The reverse pattern was true for driverless cars, where older people were more concerned about risks outweighing benefits (54% of those aged 65+ vs 34% of 16 to 34 year-olds).
- People from BAME backgrounds were more likely than those from a white background to have concerns about some technologies, being more likely to say that risks outweigh benefits for GM crops (40% BAME vs 31% White) and genome editing (42% BAME vs 22% White).
- People who actively practised a religion were more likely than those who did not identify with a religion to feel that risks outweigh benefits for GM crops (42% vs 28%) and driverless cars (49% vs 38%).
    - However, the reverse was true in the case of the using animals in research: those who actively practised a religion were more likely to feel benefits outweighed risks (57% vs 40% among those without any religion).
- People with low science capital were more likely than those with high science capital to feel that risks outweigh the benefits for using animals in research (38% vs 23%) and driverless cars (52% vs 36%).

The relationship between knowledge and attitudes towards benefits and risks

As shown above in Figure 8.3, people who felt informed about a technology were more likely to feel the benefits outweigh the risks. This was particularly the case for technology areas about which the public feels least well-informed (See Chapter 2). For example, support for nanotechnology was higher at 69% among those who feel informed compared with 44% of all who had heard of it, with similar differences for genome editing (52% vs 34%) and synthetic biology (48% vs 32%).

For some areas – notably the more recently emerging technologies of robotics, driverless vehicles, and genome editing - having some knowledge about the technology also tended to slightly depress levels of opposition towards it.

Attitudes towards driverless cars and the use of animals in research

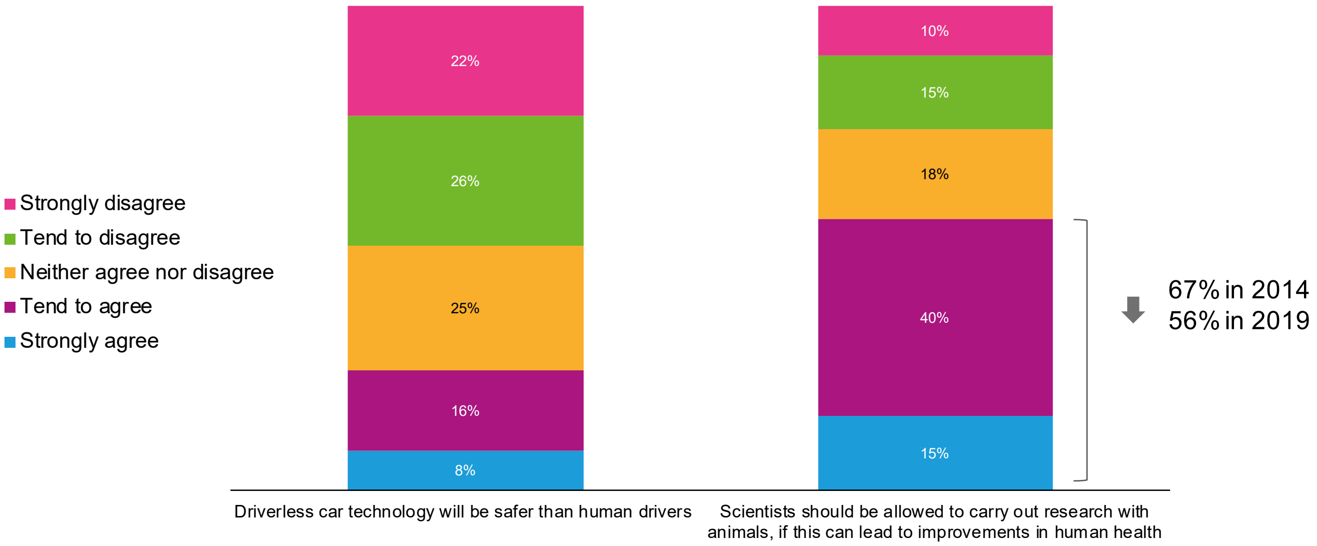
As noted above, driverless cars and the use of animals in research were two areas associated with relatively high levels of public concern about risks; respectively 44% and 30% of people who had heard of these technologies felt that risks outweighed benefits. In fact, driverless technology was the one area where a higher proportion (44%) thought the risks outweighed the benefits than the reverse (25%).

Views about these two technologies were unpicked further. Supporting the finding above, twice as many people disagreed (48%) than agreed (23%) that ‘driverless car technology will be safer than human drivers’ (Figure 8.4). These findings are backed up by the DfT 2018 Public Attitudes Tracker (Kantar Public, 2018) which found that more people could name disadvantages (82%) than advantages (51%) in relation to automated vehicles; concerns largely centred on safety issues such as equipment failure and the inability to react to unexpected situations.

The public was more supportive in relation to the use of animals in medical research, being twice as likely to agree (56%) than disagree (25%) that ‘scientists should be allowed to carry out research with animals, if this can lead to improvements in human health’. These findings corroborate the BEIS Public Attitudes to Animal Research study (Ipsos Mori, 2018b) which found that 56% of the public believed it is acceptable to use animals in research to help us understand the human body, where there is no alternative.

There was, however, a notable decline in the proportion who support animal research for medical advancement: the proportion who agreed that this is acceptable fell from 67% in 2014 to 56% in 2019. This change over time is supported by BEIS research (Kantar Public, 2018) which found that opposition to using animals in any research on animal welfare grounds had increased from 31% to 38% over a similar period.

Figure 8.4: Attitudes towards driverless vehicles and using animals in research



Q. I am now going to read out some statements. For each, please could you tell me the extent to which you agree or disagree? *Base: All respondents (n=1749)*

Similar to findings noted above regarding level of support for these technologies, men (34%), people aged 25-44 (30%), people with high science capital (43%), and degree-educated people (32%) were more likely than average (23%) to feel that driverless cars will improve safety. Men were also more supportive of scientists using animals in health research (65% of men vs 47% of women).

Do people feel that scientific advancement leads to inequalities?

As noted in the PAS 2019 literature review (Burchell, 2019), the benefits and risks of science can be unequally distributed, with more socially disadvantaged groups benefitting less and experiencing more risks from developments in science and technology. Furthermore, there is consistent evidence in the PAS surveys and elsewhere that more positive attitudes towards science tend to be found among people with higher levels of education and from higher socio-economic groups. This has led some to hypothesise that less positive public attitudes to science may be partly shaped by feelings of inequality and exclusion among those who stand to benefit the least and experience more risks.

The 2018 Wellcome Global Monitor[34] found evidence that people recognise that there are social inequalities: in the Global Monitor 82% of UK adults agreed that science benefits them personally, but only around 50% believed that science benefits ‘most’ people in their country.

While there was evidence in PAS 2019 that some people associate advances in science and technology with widening inequalities, there was more mixed evidence of a relationship between this viewpoint and socio-economic background.

Focussing first on science in general, around three in ten (30%) agreed that scientific advances benefit the rich more than the poor, while 41% disagreed with this (Figure 8.5). However, there was greater concern about the impact of advances on inequalities in relation to two specific technologies:

- Three in four (77%) felt that if robots began to replace jobs currently done by humans, people in low-skilled rather than high-skilled jobs will find it harder to obtain alternative employment
- Two in three (67%) felt that if new medical treatments to slow the ageing process were developed only wealthy people would have access to this.

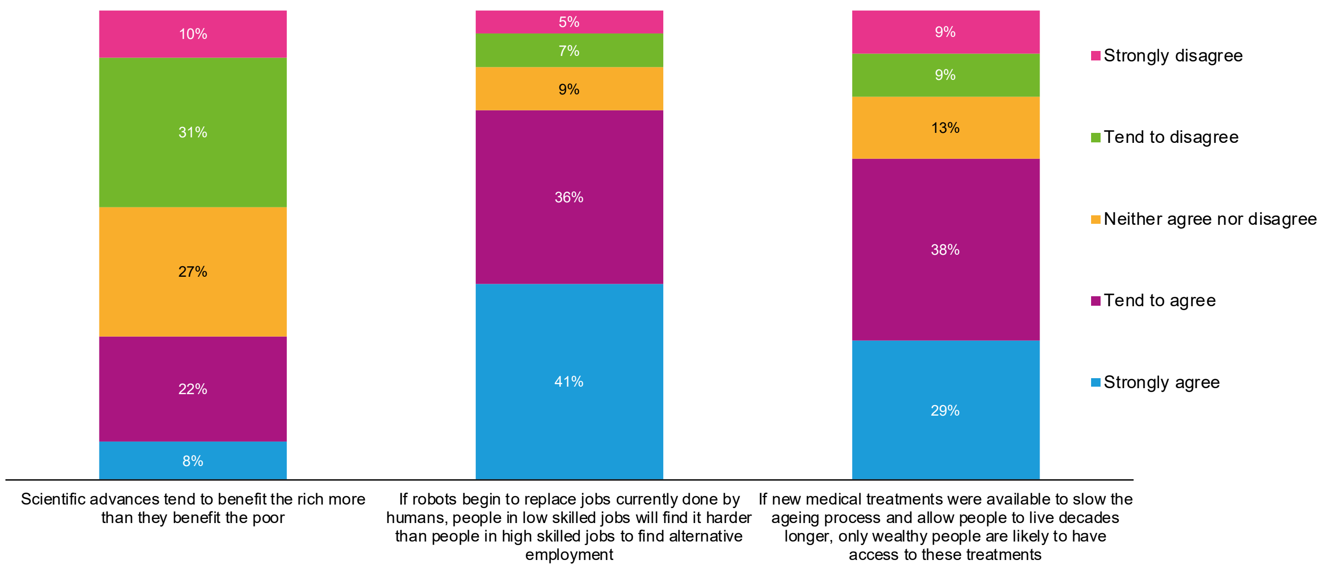
Looking in more detail by subgroup, generic feelings of inequality are more concentrated within minority and disadvantaged groups. However, when it comes to more specific applications the picture is less clear-cut. This is possibly because these items are presented more as ‘factual’ type attitude statements and therefore agreement rates may be a measure of knowledge rather than attitudes.

- Minority and more disadvantaged groups were most likely to consider that scientific research benefits the rich more than the poor: people with no qualifications (42%), from BAME backgrounds (41%), and from less affluent DE backgrounds (38%) were more likely than average (30%) to agree with this.
- However, the level of agreement that the more widespread use of robots in the workplace will lead to inequalities was similar across these demographic subgroups. In fact, people from BAME groups (70%) and with no qualifications (68%) were slightly *less* likely than average (77%) to feel that inequalities will be widened by robots.
- Similarly, there was little variation by demographic groupings with respect to widening inequalities in life extension technology. Again, those with no qualifications were slightly less likely than average (59% vs 67%) to feel this technology would be exclusively

[34] https://wellcome.ac.uk/reports/wellcome-global-monitor/2018

available to the wealthy. There was however an age variation on this measure, with younger people much more likely than older people to feel that life extension technology would be targeted to the wealthy: 75% of 16-24 year-olds compared with 55% of those aged 75+.

Figure 8.5: Attitudes towards inequalities in science and technological developments



Q. I am now going to read out some statements. For each, please could you tell me the extent to which you agree or disagree?
Base: All respondents (n=1749)

How are people's views on religion related to attitudes to risk?

Consistent with wider population statistics, overall 59% of people identified as having a religion, although only three in ten (30%) were practising (defined as attending religious services or meetings at least once a year) and only 11% were actively practising (defined as attending services at least once a week).

PAS 2019 found that just under half (44%) of people in the UK believed in evolution, agreeing that "humans and other living things evolved over time by natural selection, in which God played no part". A third (36%) believed that God played a part, either believing in evolution as "a process guided by God" (18%) or taking a more creationist viewpoint (18%), believing that "humans and other living things were created by God and have always existed in their current form". The remainder is accounted for people who have an alternative viewpoint or who do not know. These findings were broadly similar to the belief mindset held in 2014.

Unsurprisingly, the creationist viewpoint was most prevalent among those actively practising a religion (57%). Although the evolutionary viewpoint was most prevalent among those who do not identify with any religion (64%), it is notable that 29% took an alternative view.

Although this was not consistent across all measures reported in this chapter, as evidenced earlier in this chapter, there was a general tendency for people actively practising a religion to feel that scientific development presented more risk or concerns (see above for the detailed findings). Compared with those who did not identify with any religion, those actively practising were:

- more likely to be concerned about the speed of development in science and technology;
- more likely to feel that they more they knew about science, the more worried they became
- more likely to perceive that the risks outweighed the benefits in some scientific applications

The one area where people with a religion were less concerned was the use of animals in research to improve human health. Those who actively supported a religion were more likely than those without any religion to support this.

9. Attitudes towards careers in science and engineering

This chapter considers perceptions of science and engineering as careers, including what attracts people to jobs in STEM, the extent to which STEM skills are viewed as important for young people, and the contribution of science and engineering to the UK economy. Where relevant changes since 2014 are tracked.

Key findings

Science and engineering careers were regarded as interesting, future-focused and accessible to both genders. Furthermore, science and computer science were regarded as important skills to equip young people for the future, and to help drive economic growth in the UK. Somewhat concerningly, however, young people aged 16-24 stood out as being more negative than older groups about science and engineering study and careers.

Changes over time

- Between 2014 and 2019 there was a positive shift in perceptions of the engineering industry, with the proportion of people who view this as a dying industry dropping from 29% to 15%. In addition, for both engineering and science, smaller proportions of people than in 2014 felt that studying each of these subjects would not necessarily lead to a good job.
- Between 2014 and 2019, there was a small drop from (from 62% to 57%) in the proportion feeling that science and technology will provide more opportunities for the next generation.

2019 findings

- People were more likely to think of science as different from engineering (44%) than see them as the same (30%), although people with higher levels of education and science capital tended to think of these disciplines as more aligned.
- The factors most commonly regarded as attracting people to jobs in STEM were interest or stimulation, and level of pay. Younger people and those from BAME backgrounds were most likely to view level of pay as a motivating factor.
- Most people viewed both science and engineering jobs as interesting and accessible for both genders. In general, science was seen as a more interesting and future-focussed career, while engineering was regarded as better career choice in terms of pay and career opportunities. Despite the large majority of both genders considering engineering as equally suitable for both genders, men were more likely than women to view engineering as an interesting and future-focussed career.
- Most people viewed science as important to the UK's economy, competitiveness and future prosperity, with men displaying a greater strength of agreement than women. In

addition, people's support for science as an economic driver was greater for those with higher educational attainment and science capital.

- Most people (63%) viewed computer science as an essential skill for young people, and 43% viewed science as an essential skill. Overall, at least 80% viewed these two subjects as very important or essential, and these subjects were seen as more important for young people than humanities and creative subjects.
- Somewhat concerningly, young people aged 16-24 stood out as being more negative than older groups about science and engineering study and careers. In particular, they were considerably less likely than older age groups to view engineering as an interesting career, and to feel that computer science is an essential skill for future career opportunities. This group was also less convinced of the benefits of science and technology on the economy. This trend may be because young people are basing their views on their own current or recent experience of STEM education (a minority of school students continue with STEM education after GCSE), whereas older people might be basing this on a wider societal perspective.

Context

Engineering and science are held in high regard in terms of their contribution to society. For example, Eurobarometer research (European Commission, 2013) reported that a majority of the UK public thought that the overall influence of science and technology on society was positive, while research for the 2017 Queen Elizabeth Prize for Engineering (QEPE, 2017) showed that the vast majority of people in the UK thought that engineering could make a difference in addressing the world's challenges; is valuable for the economy; has driven progress in the past; and has an impact on people's daily lives.

Even though careers in science and engineering are well regarded among the UK public (QEPE, 2017), there is a shortage of STEM skills in the UK. Research undertaken in 2018 by STEM Learning[35] found that almost half of STEM businesses were seeking people with the right skills from abroad, while the Institute of Engineering and Technology's 2017 Skills and Demand in Industry Survey (IET, 2017) found that 46% of employers faced recruitment difficulties due to a lack of suitably skilled applicants, and a quarter reported skills gaps/limitations in their workforce.

In terms of the pipeline of potential STEM employees, research undertaken by Archer et al (2013) found that, among those aged 10-14 in the UK, aspirations to become a scientist were relatively low (although somewhat higher in relation to engineering and medicine); while Hamlyn et al (2017) found that two in five (43%) young people aged 14 to 18 were interested in science. These same research studies indicate a gender imbalance in aspirations to become a scientist, as well as differences by socio economic indicators and ethnic background. Indeed, the gender imbalance in engineering is an ongoing concern: in 2018 the Women's Engineering Society estimated that only 11% of UK engineers were women (Neave et al, 2018), and research from 2017 showed that 60% of the UK public thought that that engineering is more accessible to men than women (QEPE, 2017).

There are signs, however, that initiatives to improve perceptions of STEM careers are having an impact on young people. OECD found that 29% of UK students aged 15 felt that a science-

[35] https://www.stem.org.uk/sites/default/files/pages/downloads/stem-skills-indicator-findings.pdf

related career was an expectation for them[36], while Engineering UK's latest research (Neave et al, 2018) shows an increase in the proportion of those aged 11 to 19 who would consider a career in engineering (from 40% in 2013 to 51% in 2017).

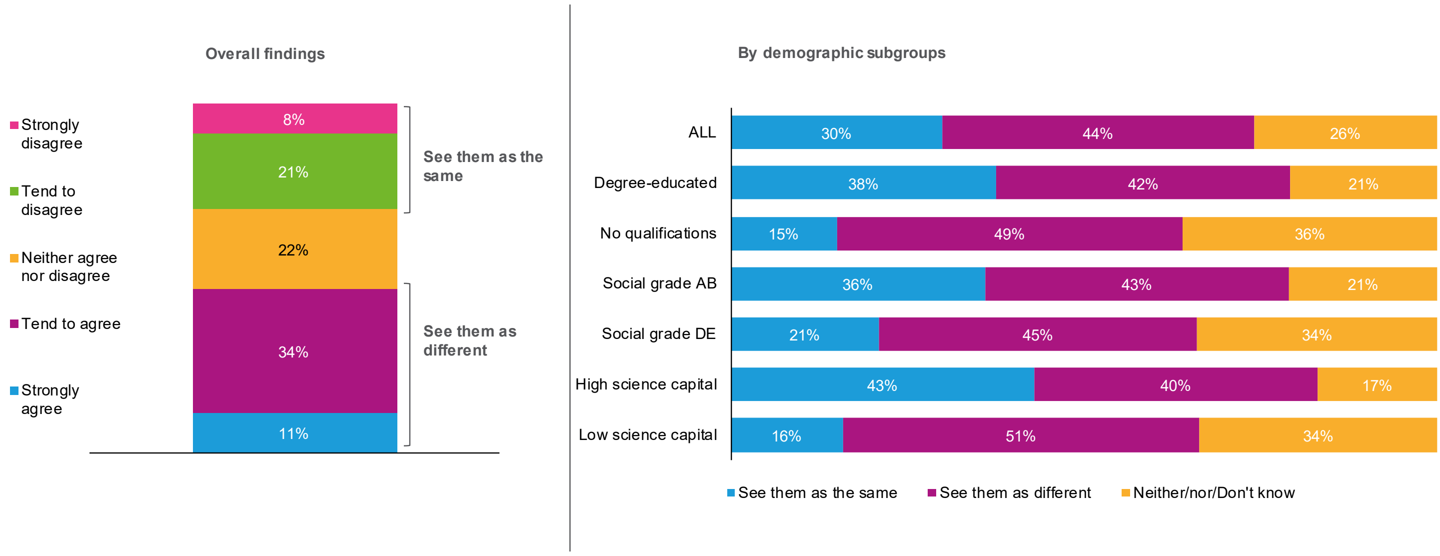
Against this backdrop, PAS 2019 continues to explore people's views of the contribution of science and engineering to society in general, and more specifically, as career options, including – for the first time - what attracts people to jobs in STEM.

Do people see science and engineering as different?

Before looking at science and engineering careers in more detail, it is important to set the scene by exploring whether people see science and engineering as different or essentially the same. This was achieved by asking people to what extent they agreed or not with the statement 'I see engineering as different to science'.

The survey found that people were more likely to see the two subjects as different: 44% agreed that science and engineering were different, compared with 30% who felt they were not different[37]. On the whole, the more educated, the more affluent, and those with higher science capital were more likely to see engineering and science as not different. On the other hand, those with lower levels of education, affluence and science capital were more likely to be undecided (Figure 9.1).

Figure 9.1 Agreement/disagreement with the statement 'I see engineering as different to science'



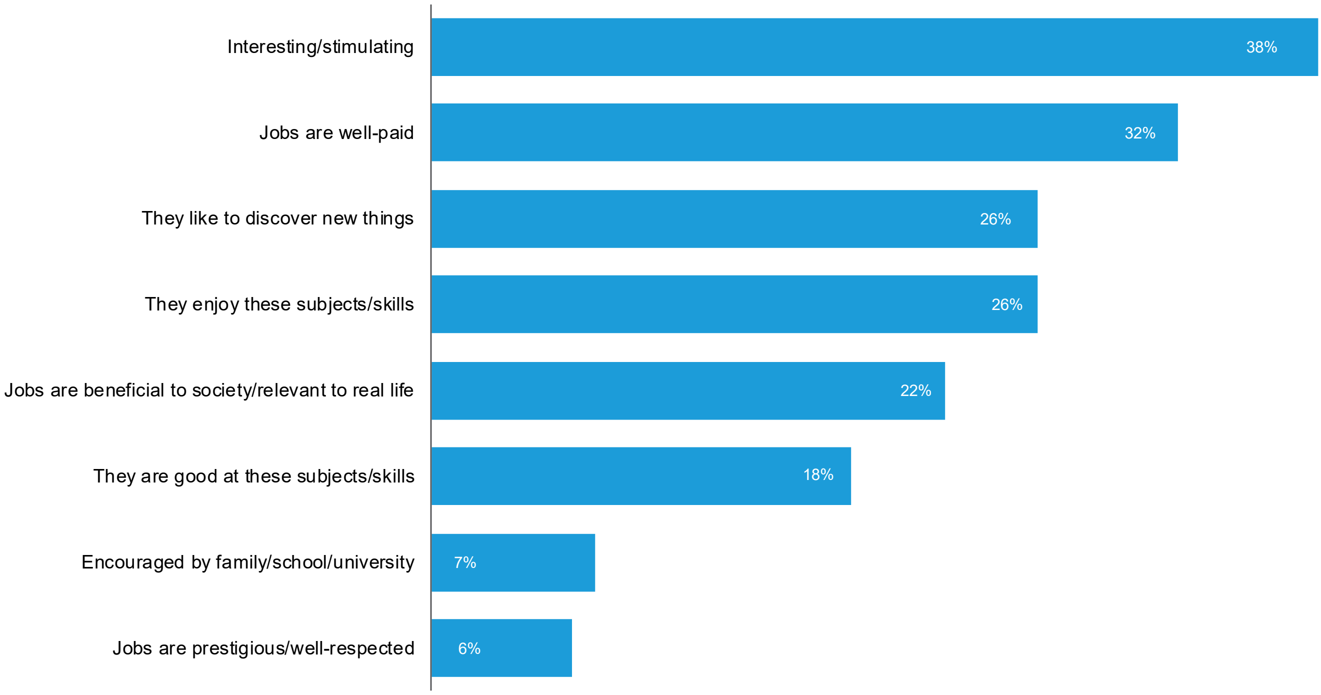
Q. Here are some statements about science. For each, please could you tell me the extent to which you agree or disagree?
Base: All respondents (n=1749); social grade AB (563); social grade DE (391); high science capital (332); low science capital (321); degree-educated (558); no qualifications (249)

36 http://www.oecd.org/pisa/ Note that the OECD definition encompassed medicine and other health-related careers
37 The wording of this statement was altered in 2019 (in 2014 the statement was 'I see science and engineering differently') so only broad comparisons can be made; the equivalent proportion of people thinking science and engineering were different in 2014 was 48%

What attracts people to STEM careers?

In general people were most likely to think that jobs in science, engineering and technology are interesting/stimulating and/or financially rewarding. When asked, unprompted, why people might choose to work in these areas (essentially STEM careers), the most common responses focussed on level of interest and financial remuneration (Figure 9.2). This also accords with Wellcome research (Hamlyn et al, 2017) among a younger audience, where the main reasons provided by young people aged 14-18 for being interested in a STEM career were level of interest, enjoyment and pay.

Figure 9.2: What do people think attracts people to jobs in science, engineering or technology?



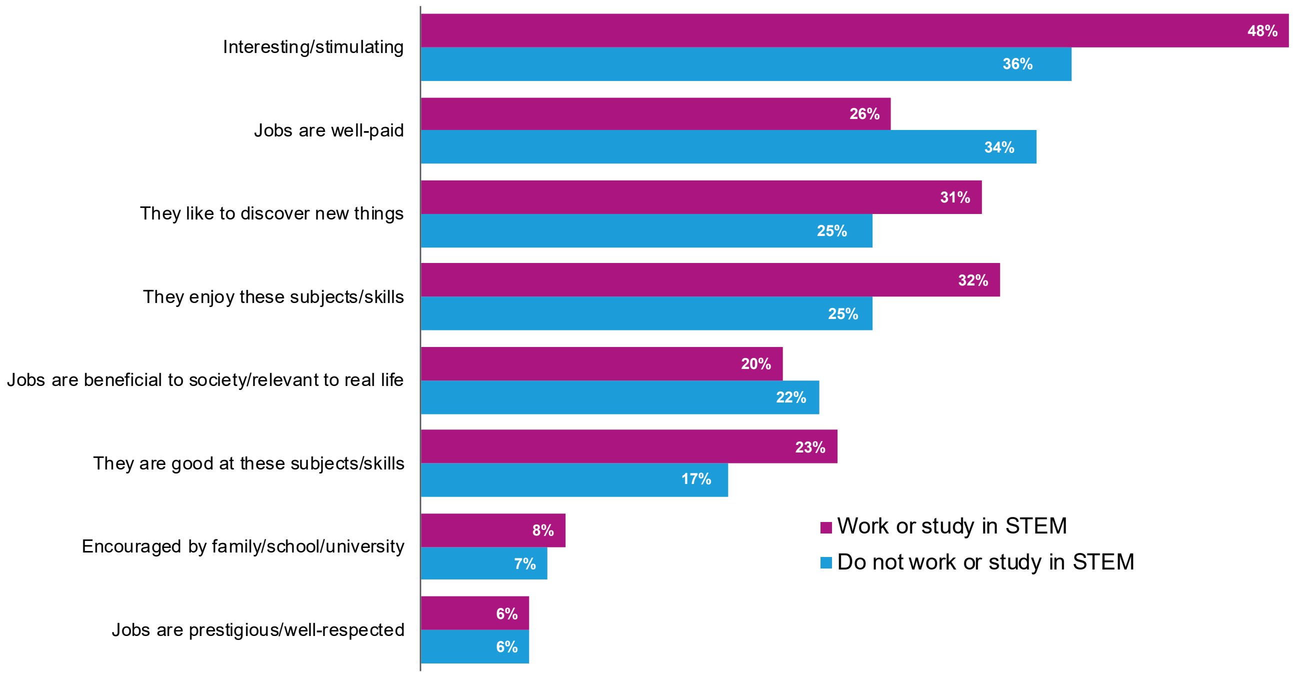
Q24. In your opinion, what do you feel attracts people to jobs in science, engineering or technology?
Base: All respondents (n=1749)

Examining responses by whether or not people worked or studied in a science-related area (Figure 9.3) is of interest as the first of these groups would have answered based on their own personal experience, while for others it was a hypothetical question. The analysis shows that those who worked or studied in these fields were more likely to think that people are attracted to STEM jobs because:

- Jobs are interesting or stimulating (48% vs 36% among those who don’t work/study in these areas)
- They like to discover new things (31% vs 25%)
- They enjoy the subjects/skills (32% vs 25%)

However, those who worked/studied in these sectors were less likely to think that jobs are well paid (26% vs 34%), and there were no differences between the two groups regarding whether jobs are beneficial to society or well-respected. This suggests that people working or studying in STEM were more attracted by personal factors (interest, intellectual stimulation, enjoyment) than because of the potential for these jobs to offer a substantive financial reward or to have a wider societal benefit.

Figure 9.3: What people feel attracts people to STEM jobs by whether work/study in STEM



Q24. In your opinion, what do you feel attracts people to jobs in science, engineering or technology?
Base: All who work or study in STEM (303); All who do not work or study in STEM (1446)

Further demographic analyses reveal that:

- Men were more likely than women to think that people are attracted to jobs in STEM because they are interesting or stimulating (42% vs 35% of women). However, aside from this there were notably few gender differences in reasons provided.
- Younger people aged 16-34 were particularly likely to view the level of pay as a motivation for a science career (36% declining to 26% of people aged 65+).
- People educated to at least degree level were more likely than those with no qualifications to think that attraction to a STEM career is driven by interest/stimulation (48% vs 24%); the ability to discover new things (35% vs 15%); a chance to benefit society/relevance to real life (25% vs 10%); and enjoyment (30% vs 18%).
- Those from a BAME background were more likely to think that people are attracted to these jobs because they are financially rewarding (42% BAME vs 31% of white people). On the other hand, white people were more likely to think that STEM jobs attract people because they are interesting or stimulating (40% of white people vs 27% of those from a BAME background).

Do people think science and engineering are good careers?

As a means of exploring different aspects of science and engineering as careers, people were presented with a number of different statements. For half the sample, the statements were worded in terms of *science*, while for the other half, the statements referred to *engineering*. This offered the opportunity to compare attitudes about the two professions.

Overall, as shown in Figure 9.4, people held broadly positive views of both, with majorities viewing these careers as interesting, well-paid, careers of the future (i.e. not dying industries) and suitable choices for both men and women. However, people were more likely to think that studying these subjects *will not* necessarily lead to a good career than *will* always lead to one.

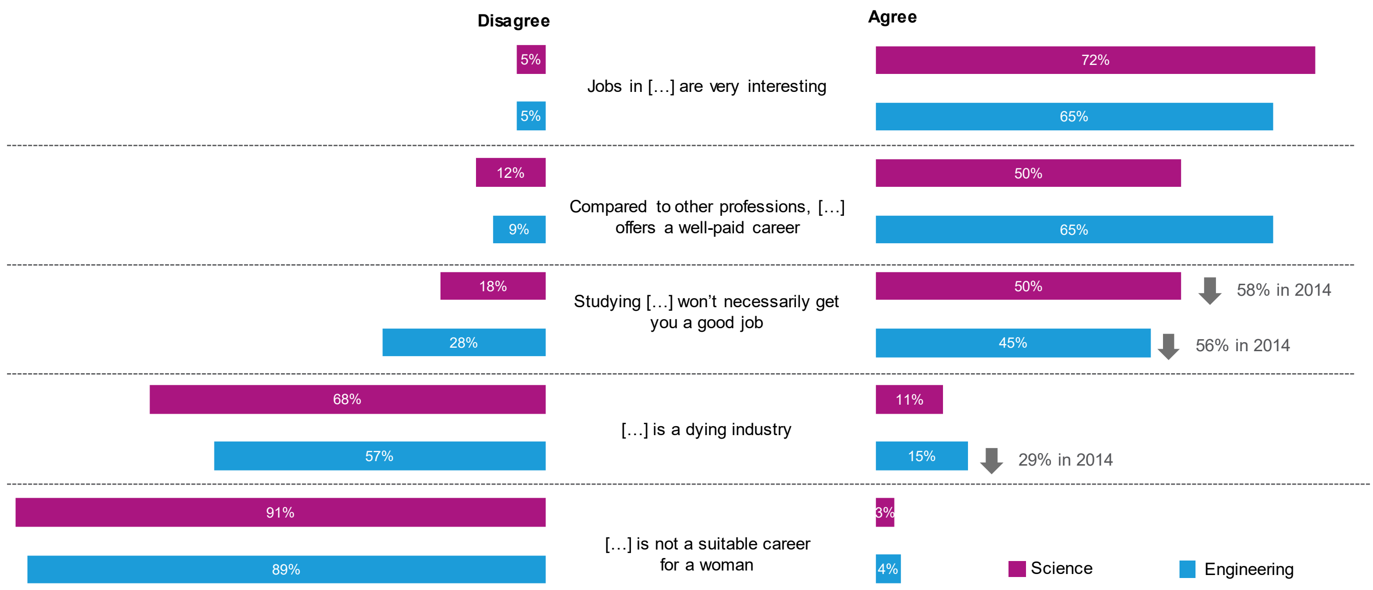
There were few differences when views of the two careers are compared. However, where there were differences, these suggest that while science is seen as a more interesting and future-focussed career, engineering is regarded as better career choice in terms of pay and career development. The latter finding is interesting in the light of the latest Engineering UK The State of Engineering research (Neave et al, 2018) which shows that engineering and technology graduates remained more likely than average to go into full time employment in 2015/16 (62% vs 56% on average), and that they earned higher than average starting salaries.

- More people saw science as an interesting career compared with engineering (72% vs 65%). This links with findings reported in an earlier chapter where scientists were more likely to be regarded as ‘interesting’ than engineers (see Chapter 7)
- More people saw science as a career of the future rather than a dying career of the past (68% disagree that science is a dying industry vs 57% for engineering)
- However, more people thought of engineering as a well-paid career compared with science (65% vs 50%) and people were more likely to *disagree* that engineering won’t necessarily get you a good job (28% compared with 18% science).

While the findings for PAS 2019 are similar to those seen in PAS 2014, there has been a noticeable shift relating to how people view the engineering industry: 29% of people agreed that engineering was a dying industry in the UK in 2014, but this halved to 15% in 2019. This may point to changes in people’s view of what constitutes ‘engineering’, with the growth of different types of ‘modern’ engineering.

In addition, people in 2019 were less likely to think that studying science and engineering will not necessarily lead to a good job (science: 58% in 2014 and 50% in 2019; engineering: 56% in 2014 and 45% in 2019).

Figure 9.4: Perceptions of careers in science and engineering



Q26. Here are some statements about studying and working in science. For each, please could you tell me the extent to which you agree or disagree?
Base: Science, half sample (860); Engineering, half sample (889)

More detailed analysis reveals the following demographic trends for science and engineering careers:

- In general, there were no gender differences in views about science careers.
- However, men were more positive than women about engineering, being more likely to perceive engineering careers as interesting (74% vs 56%) and to disagree that engineering is a dying industry (62% vs 53%).
- Degree-educated people were generally more positive about science careers; they were more likely than those with no qualifications to think of science careers as interesting (82% vs 54%), and more likely to disagree that science careers are dying (79% vs 49%) or unsuitable for women (95% vs 78%). There were no similar differences for engineering.
- Degree-educated people were also less likely than those with no qualifications to view science careers as well-paid (43% vs 54%).
- However, the opposite was true for engineering, where degree-educated people were more likely than those with no qualifications to view engineering jobs as well-paid (67% vs 59%).
- Younger people aged 16-24 were more negative about science careers. This age group was less likely than average to disagree that science careers are unsuitable for women (77% vs 91% overall), to disagree that science is a dying industry (58% vs 68% overall), and to disagree that studying science won't always lead to a good job (10% vs 18% overall).

- These age differences were not observed in opinions for engineering careers. However, it is notable that the youngest age group, those aged 16-24, were considerably less likely than all other age groups to view engineering as an interesting career (43% viewed this as interesting compared with between 60-75% among all other age groups). A 2018 Engineering UK survey (Neave et al, 2018) highlights that school pupils are less likely to understand what an engineering job is compared to career options in science or technology, and this lack of awareness may partly explain the differences in young people's opinions on careers in science and engineering (64% of 16-24s view science careers as interesting vs 43% who say this about engineering careers).
- These differences were not apparent for engineering careers, where no differences were noted.
- People with high science capital were much more positive than those with low science capital about science careers, being more likely to agree that science careers are interesting (91% vs 45%), and more likely to disagree that they are unsuitable for women (99% vs 86%) and that science is a dying industry (78% vs 59%).
- The pattern of differences in attitudes towards engineering careers in terms of science capital was similar.

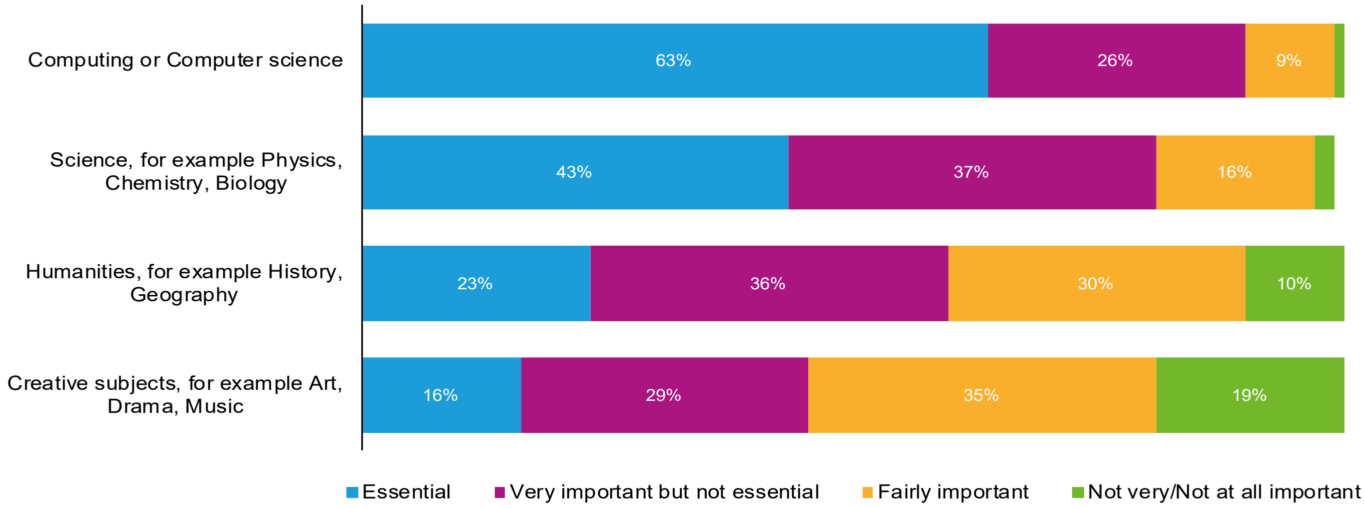
Do people think that science and/or engineering is a good career choice for young people?

As already noted, the public reported broadly positive views on science and engineering as careers, seeing these as interesting, well paid, industries of the future and suitable for all. There was also a belief that science is important for young people in terms of equipping them with the skills they need for the future (see next section). Related to this, both science and computing subjects were seen as relatively more important than humanities or arts subjects in terms of helping young people obtain relevant skills for the future (Figure 9.5):

- 88% of people thought computing/computer science either essential (63%) or very important (26%) for young people, to give them the skills they need
- 80% thought science essential (43%) or very important (37%)
- 59% thought humanities, and 44% creative subjects essential or very important.

This question was asked for the first time in 2019 and therefore no tracking data are available.

Figure 9.5 How important do you think each of the following subjects are in terms of helping young people obtain skills for the future?



Q26a. How important do you think each of the following subjects are in terms of helping young people obtain skills for the future?
Base: All respondents (1749)

In terms of subgroup differences, people with higher levels of education, science capital, from higher social grades and from a BAME background were more likely than average to view science as essential or very important to equip young people for the future. However, there were very few differences with respect to views about studying computing. The only exception was age, where young people aged 16-24 were less likely than average to view computer science as an 'essential' skill for the future (41% compared with 64-68% in all other age groups). This is possibly because young people are basing this view on their own personal subject choices which will have been made more recently, whereas older people might be basing this on a wider societal perspective. Given the continued low uptake in computer science (12% of all Key Stage 4 pupils in England in 2018[38]) it may be that young people who haven't taken Computer Science at school do not feel that this has disadvantaged them in terms of their own educational and career choices and therefore cannot necessarily see the wider need in society.

Importance of science to the economy

Science and computing were seen as important in helping to drive economic growth (Figure 9.6): nearly all (89%) thought that young people's interest in science is essential for our future prosperity, while around three in four agreed that scientific research makes a direct contribution to economic growth (75%) and that the UK needs to develop its science and technology sector to enhance its international competitiveness (78%).

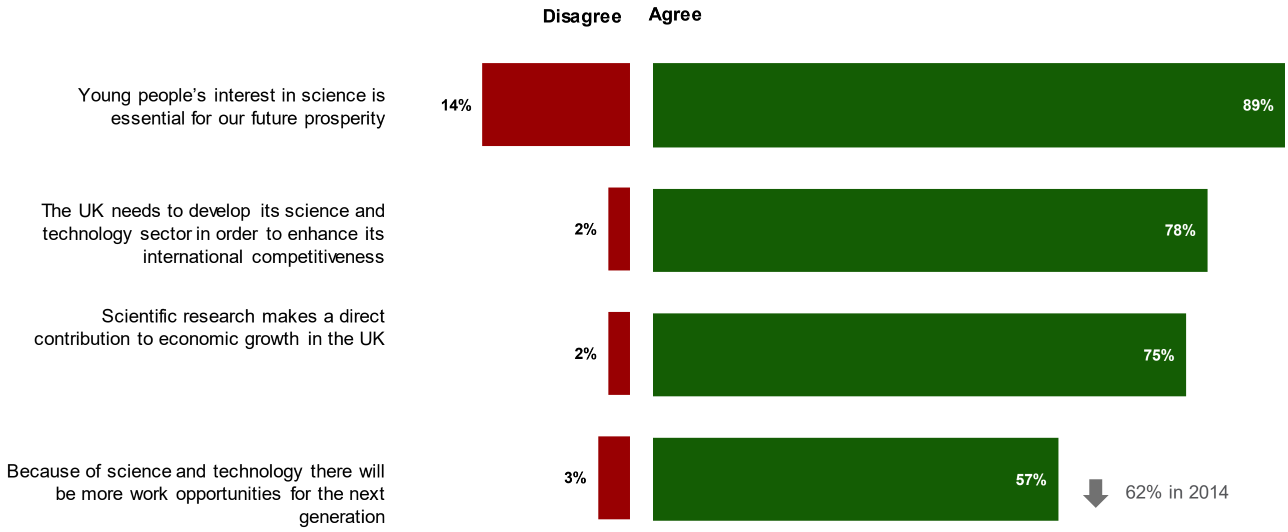
However, people were relatively more pessimistic about work opportunities for young people with 57% thinking that science and technology will help provide more work opportunities for the

[38] https://www.gov.uk/government/statistics/gcse-and-equivalent-results-2017-to-2018-provisional Though figures have been rising over recent years.

next generation, and there was a relatively high level of disagreement compared with other statements (14% disagreed).

There were no changes on these measures since 2014, aside from a small drop in the proportion who felt that science and technology will provide more opportunities for the next generation (a decrease from 62% in 2014 to 57% in 2019).

Figure 9.6: Perceptions of science and its impact on the economy



Q26. Here are some statements about studying and working in science. For each, please could you tell me the extent to which you agree or disagree?
Base: All respondents (n=1749)

Further analyses of the data reveal that:

- Men were more likely than women to see benefits of science and technology in terms of economic growth (81% vs 70%) and enhancement of international competitiveness (83% vs 73%).
- Those with higher levels of education and science capital were more positive about the impact of science on the economy across all four of these statements.
- Younger people aged 16-24 were generally less convinced of the benefits of science and technology on the economy. Compared with those aged 65+, young people aged 16-24 were less likely to feel that interest in science will boost prosperity (82% compared with 91%), that science and technology growth will enhance the UK's competitive edge (65% vs 83%) and that scientific research helps drive economic growth 63% vs 82%).

10. Ageing Society

This chapter explores public awareness of, and attitudes towards technologies aimed at supporting people in older life. Three main areas are explored: life extension technologies; technologies which aim to enhance cognitive and physical abilities in later life; and robots used in a social care role. 'Ageing society' is one of the three modular topics chosen for further exploration in PAS 2019. Unless otherwise stated, the survey questions covered in this chapter were asked of around a third of the main sample (563 adults), who were randomly selected. While the findings are still representative of the UK public, margins of error are higher.

Key findings

PAS 2019 provided evidence that the UK public clearly values quality of life over longevity at any cost. While the survey findings indicate that the public is cautiously receptive to the idea of technology to support people in later life, they were more enthusiastic about innovations aimed at helping people with practical tasks, and less enthusiastic about those which are either medically invasive or which have the potential to replace human contact.

- People prioritised quality of life over longevity: 84% would prefer to live only as long as they can ensure good quality of life, while 15% would choose to live as long as possible even with more limited health.
- Two-thirds (64%) of the UK public had heard about life extension technologies to slow the ageing process, while 54% had heard about robot caregivers to help people maintain independence and provide companionship. By age, older people aged 65+ were most aware of these technologies.
- Three in ten (31%) would choose life extension technology if this was available. However, people were more negative (62%) than positive (31%) about the impact this would have on society. People had concerns about burden on the NHS and increased taxes for working people, although there was some recognition that older people could have a more stimulating life if they work for longer.
- When asked about different enhancement technologies to assist older people in later life, the public was largely in favour of cognitive enhancing drugs (80%) and somewhat in favour of robotic clothing to improve mobility (59%). However, there was much less support for brain chip implants to improve intelligence and cognition (24%).
- Around half (45%) said that they would use a robot caregiver in later life if available, either for themselves or for a relative. People felt more comfortable with the idea of a robot helping with household tasks (61%) or healthcare (57%) than providing companionship (29%). Eight in ten thought that robot caregivers would result in older people having less human contact.
- However, people did recognise that robot caregivers can help support relatives, with 63% agreeing that people would feel less worried about caring for older relatives.
- There was no evidence that people thought that the introduction of these kinds of technologies would lead to either reduced age discrimination or reduced inequalities in society. People were far more likely to disagree than agree that life extension

technologies would reduce age discrimination, and there were mixed views among the public as to whether the development of robot caregivers would mean that robots would only be used by people who could not afford a human caregiver.

- On the whole, men, more affluent people (ABs), white people, younger people, those with high science capital, and those who described their health as 'very good' were more receptive to the idea of technologies to support older people. However, there were some exceptions to this; for example, people in poorer health were more likely to think they would use a robot caregiver in later life, and older people felt more comfortable with the idea of a robot in a companionship role.

Context

The UK population, as in other developed countries, is ageing. Currently, people aged 65 or over make up 18% of the total population, though the Office for National Statistics (ONS) projects that this will rise to more than 24% by 2042[39]. As a result of medical advances, better drugs, healthier lifestyles, and safer working environments, people are now living longer. One in three girls born in 2019 are expected to live to 100-years-old[40].

This demographic shift brings many challenges. As one of the four Grand Challenges set out by the Government as part of their Industrial Strategy[41], the Government aims to harness innovation to help meet the needs of an ageing society. Within this Grand Challenge domain, the government has set itself the following mission:

Grand Challenge mission: Ensure that people can enjoy at least 5 extra healthy, independent years of life by 2035, while narrowing the gap between the experience of the richest and poorest[42].

This mission aims to help support people to remain at work for longer; build markets for consumer products and services that better met the needs of older people; drive improvements in public health; and drive innovation across the social care sector.

Some of these challenges will be met through new technologies designed to enhance physical and cognitive capabilities and quality of life as people get older. Changes will also be required within society and the social care sector to ensure that people are supported to lead independent lives, for example to stay in their homes longer, to continue to participate at work, and to feel less socially isolated. Through allowing the population to participate more fully it is hoped that age discrimination, and social disparities in healthy life expectancy, will be reduced.

It is important to note the focus on *healthy* ageing as part of this mission statement. The ONS notes that improvements in life expectancy have now outpaced improvements in healthy life

[39] https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/ageing/articles/howwouldyousupportourageingpopulation/2019-06-24
[40] https://www.gov.uk/government/publications/industrial-strategy-the-grand-challenges/missions#healthy-lives
[41] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf
[42] https://www.gov.uk/government/publications/industrial-strategy-the-grand-challenges/missions#healthy-lives

expectancy[43], which means that people are living an increasing number of their later years in poor health. So, while some scientists are working on technologies to extend lifespans even further, this could potentially lead to people spending an even larger share of their life living with chronic illness and disability.

This chapter explores public opinion of all these issues, focussing on three developing technologies:

- **Life extension technologies:** exploring whether people favour quality of life over longevity; and awareness and attitudes towards medical treatments and drugs that slow the ageing process.
- **Technologies to increase the capabilities of older people**: measuring propensity to take up a range of technologies in later life including cognitive-enhancing drugs, brain chip implants and 'smart' clothing.
- **Robot caregivers:** measuring awareness and attitudes towards the concept of robots taking over more social care functions.

Note on analysis by age and health status

In this chapter, given the focus on ageing society, there was an interest in analysing by age and health status in more detail compared with other chapters. As such, in this chapter, results have in places been analysed by different bandings compared with other chapters in this report. More detailed age and health status breakdowns have been used as shown below (Table 10.1). Groupings have been based on ensuring minimum sample sizes for analysis.

Table 10.1: Age and health status

Age breakdown	Sample size (unweighted)		Health status*	Sample size (unweighted)
16-29	75		**Very good**	183
30-39	95		**Good**	230
40-49	93		**Fair, bad, very bad**	140
50-59	100			
60-69	89			
70+	105			
Total in Module A[44]	563			

* QI2 How is your health in general? Is it…?

[43] https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/bulletins/healthstatelifeexpectanciesuk/2015to2017#healthy-life-expectancy-fails-to-keep-pace-with-life-expectancy-for-males-and-females

[44] While 563 respondents were assigned to Module A, 6 refused to provide their age which is why the numbers do not add to the total.

How much do people know about life extension technologies?

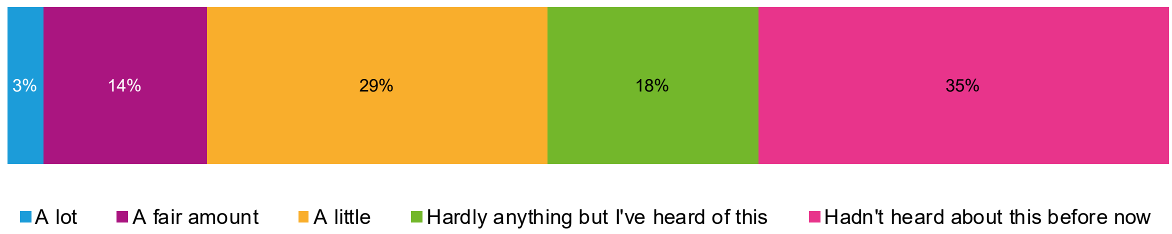
People were provided with the following definition of life extension technology:

Survey definition of life extension technology: Currently, the average life expectancy in the UK is about 80 years old. In the future, new medical treatments and drugs may slow the ageing process and allow people to live decades longer, to at least 120.

While two-thirds (64%) of the UK public had heard about developments in life extension technologies, only a minority considered themselves to be informed; 17% had heard or read either ‘a lot’ or ‘a fair amount’ about this (Figure 10.2).

A 2013 study of US citizens (Pew, 2013) measured overall awareness of this technology, using similar question wording, at 45%. The difference is likely to be explained by the five-year time difference, as well as cultural, social and political differences between the UK and the US in relation to access to healthcare and related information.

Figure 10.2: Level of awareness of life extension technologies



QA2. Currently, the average life expectancy in the UK is about 80 years old. In the future, new medical treatments and drugs may slow the ageing process and allow people to live decades longer, to at least 120. Before today, how much, if anything, have you read or heard about this?
Base: All respondents, module A (n=563)

The more affluent AB group (76%), people educated to degree-level (78%), older people aged 65+ (74%), and those with high levels of science capital (90%) were more likely than average to be aware of these types of technology. The contrast by social grade and by science capital was particularly marked: 57% of DEs said that they had never heard of this compared with 24% of ABs; and 59% of those with low science capital had never heard of this compared with 10% of those with high science capital.

What do people think about life extension technologies?

As noted above, an increase in life expectancy could potentially mean that people spend an increasing number of their later years in poor health.

There was therefore an interest in measuring the extent of public acceptance of this concept, both in terms of whether people would want to take up this technology themselves, and its wider impact on society.

Survey respondents were asked two questions which explored this theme.

The first question was asked before the concept of life extension technology had been introduced and explored whether people wanted longevity regardless of quality of life:

If you had a choice, which of the following would you prefer for yourself?

- To live only as long as I have good quality of life

- To live for as long as possible, even if this means more limited quality of life

The second question was asked **after** the concept of life extension technology had been introduced and explored whether people would choose longevity if new technologies were available to slow the ageing process:

If this were possible in your lifetime, which of the following would you choose for yourself?

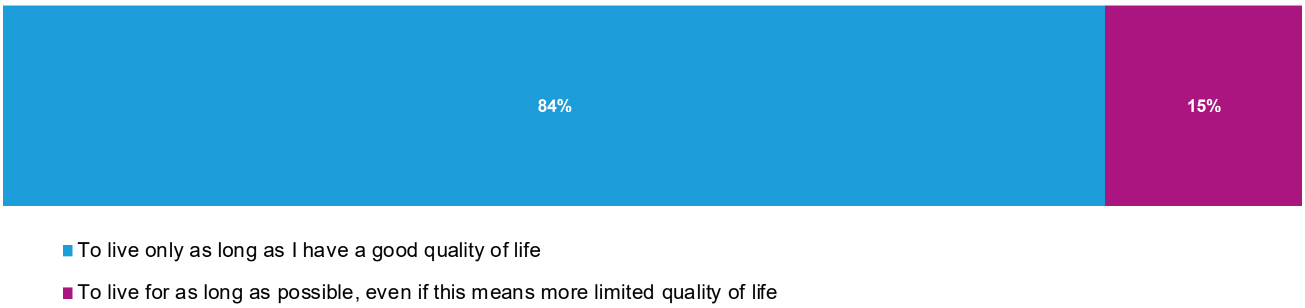
- To take advantage of these new medical technologies and drugs, and prolong your life for as long as possible

- To live to a natural age

Longevity versus quality of life

An overwhelming majority (84%) wanted to live only as long as they could guarantee a good quality of life; 15% wanted to live for as long as possible even if this meant a more limited quality of life (Figure 10.3).

Figure 10.3: Preference to live as long as possible versus as a long as you have good quality of life



QA1. If you had a choice, which of the following would you prefer for yourself.
Base: All respondents, module A (n=563)

There were few differences on this measure by demographic subgroups. Those in the less affluent DE group were more likely to want to live as long as possible (22% compared with 13% of ABs). There was no difference by age group or by self-reported health status.

Propensity to take up life extension technologies

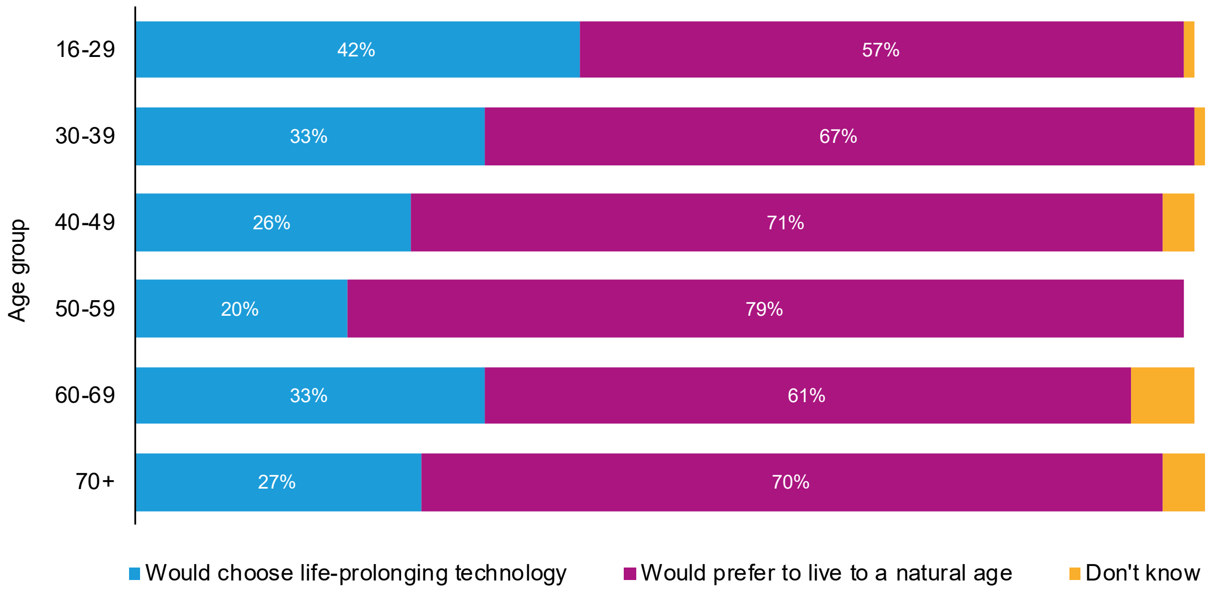
As noted above, only a minority were in favour of living as long as possible regardless of their quality of life. There was more enthusiasm, however, for the uptake of life extension technologies with 31% of the UK public saying that they would take advantage of such technologies if they were available.

The following groups were more inclined to want to take up life extension technology:

- Men - 39% of men compared with 24% of women would choose to take advantage of this technology
- Younger people – There was a curved pattern of propensity to favour life extension technology, higher than average at 42% of people aged 16-29, then lower for each successive age group to a low of 20% of people aged 50-59, then higher again among those aged 60+. People aged 50-59 were most in favour of living to a natural age without technological intervention (see Figure 10.4)
- People with high science capital – 57% of this group said they would choose to take life extension technologies up compared with 19% of those with low science capital.
- People in good health – based on a self-reported measure, those who considered themselves to be in 'very good' health (39%) were more likely to choose this option than those who said their health was either 'fair', 'bad' or 'very bad' (24%).
- People who saw life extension as positive for society – 62% of this group said that they would choose to take up this technology themselves compared with only 15% of those who thought this would have a negative impact on society.

Clearly, there will be some correlation between the latter two measures; however, sample sizes were not large enough to investigate the interaction between age and health status.

Figure 10.4: Propensity to take up life extension technology by age

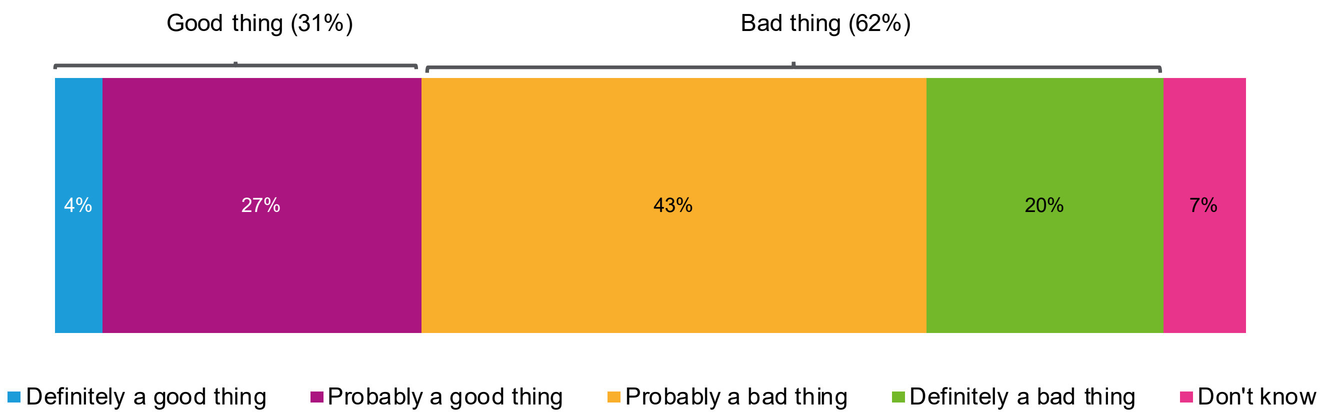


QA4.If this were possible in your lifetime, which of the following would you choose for yourself?
Base: All respondents, module A (n=563), 16-29 (n=75), 30-39 (n=95), 40-49 (n=93), 50-59 (n=100), 60-69 (n=89), 70+ (n=105)

The impact of life extension technologies on society

As shown in Figure 10.5, on the whole people were more negative than positive about the potential impact this technology would have on society, with twice as many thinking this would be a ‘bad thing’ rather than a ‘good thing’ for society (62% vs 31%).

Figure 10.5: Whether people think life extension technology will be good or bad for society



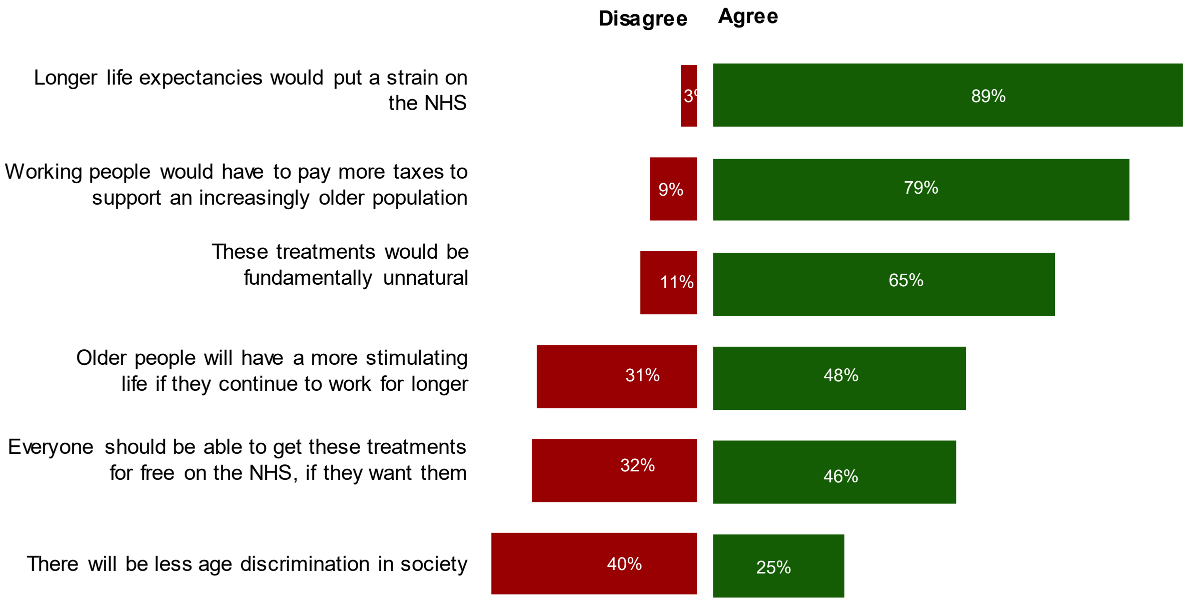
QA3. If new medical treatments and drugs slow the ageing process and allow the average person to live decades longer, do you think that would be a good thing or a bad thing for UK society?
Base: All respondents, module A (n=563)

Looking at more specific potential impacts of life extension technology, the responses in Figure 10.6 reinforce the more general finding above and show that the public had a range of concerns about the development of this type of technology.

The large majority agreed that an increasingly ageing population would have a financial impact, with 89% worried about the strain this would put on the NHS and 79% feeling this would lead to increased taxes for the working age population. Two-thirds (65%) objected to this technology in principle, thinking it to be ‘fundamentally unnatural’.

There was some support for the idea that older people could have a more stimulating life if they were able to work longer (48% agree vs 31% disagree) and, on balance, people favoured free access to such treatments (46% agree vs 32% disagree). However, the public was sceptical that life extension technologies would reduce age discrimination with people far more likely to disagree (40%) than agree (25%) that this would happen.

Figure 10.6: Attitudes towards life extension technologies



QA5. Thinking again about new medical treatments and drugs that slow the ageing process and allow the average person to live decades longer. How much do you agree or disagree with each of the following?
Base: All respondents, module A (n=563)

While there were some attitudinal differences by demographic subgroups, there were no clear or consistent patterns:

- Men were more likely than women to feel that a longer working life would be more stimulating for older people (54% vs 43%)
- People aged 40-59 were the age group that was most negative about life extension technology overall, with 70% of this group viewing this as a 'bad thing' compared with between 56% and 61% in all other age groups. Older people aged 70+ were most likely to feel that a longer working life would be stimulating (57%) while younger people aged 16-39 were least likely to think this (42%). Older people aged 70+ were also much more likely than average (65% vs 46%) to favour this type of treatment being free on the NHS.
- The most affluent AB group were more likely than the least affluent DE group to think that this will lead to a more stimulating life (60% vs 46%) but also to agree that it would lead to an increased tax burden for working-age people (83% compared with 69%). The AB group were also less likely than DEs to consider that this should be available for free on the NHS (44% vs 57%).
- People who described their health as 'fair', 'bad' or 'very bad' were more likely than those in 'very good' health to feel that such technologies would reduce age discrimination (35% vs 24%).

Would people use enhancement technologies to assist them in later life?

To meet the needs of an increasingly ageing population, scientists are developing innovations to enhance abilities in later life, including pharmaceutical, surgical and wearable technologies. Survey respondents were asked about their propensity to take up three different enhancements in later life:

- To take drugs which help improve memory and concentration
- To have a brain chip implant to improve intelligence and memory
- To wear clothing which contains artificial muscles, which could help older people to stand for longer, walk faster, or lift objects

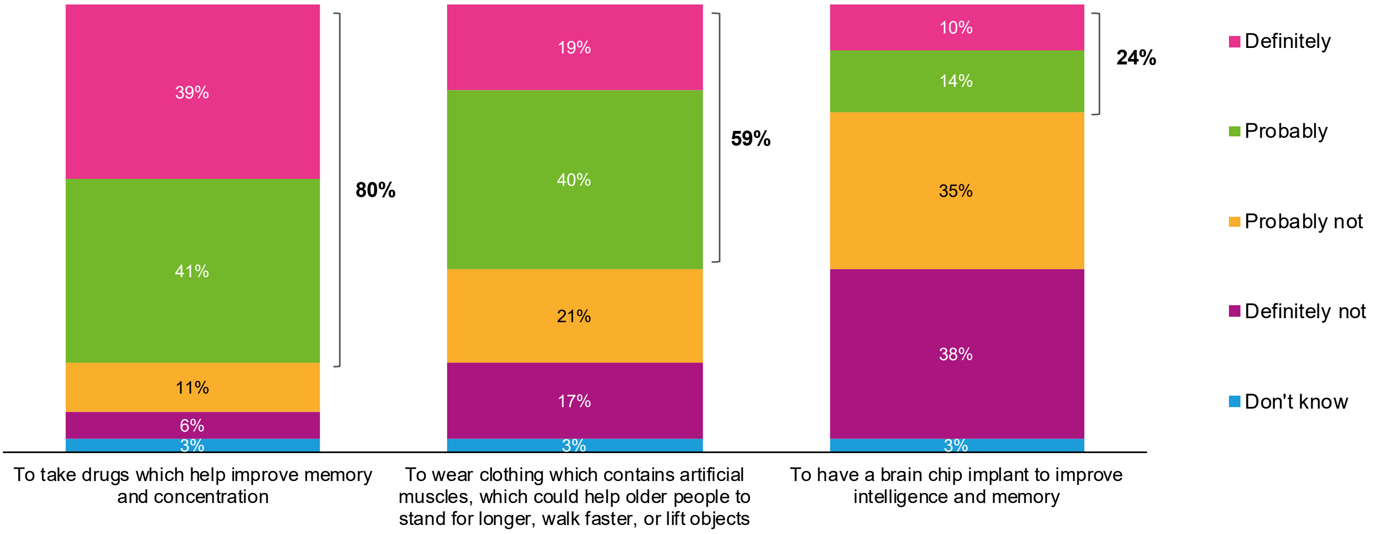
Cognitive enhancement drugs for the elderly are already widely used today, and in fact there is evidence that increasing numbers of younger people are taking these so-called 'smart drugs' to boost cognitive performance[45]. Against this backdrop, it is perhaps of no surprise that the public was most in favour of this type of technology, with 80% saying that they would 'definitely' or 'probably' take this (Figure 10.7).

Wearable technologies, also referred to as 'smart clothing', are currently in development and the aim is to develop robotic clothing solutions with artificial muscles to assist older people with walking, standing, and lifting[46]. Although this developing technology is probably not widely known about, the public was broadly supportive, with 59% thinking they would 'definitely' or 'probably' use this.

The least appealing option for the public was to have a brain chip implant to improve intelligence and memory, with 24% thinking that they would take this up in later life but the majority (73%) thinking it unlikely. Responses to a similar question asked by Pew (2016) suggest that US adults are slightly more in favour of a brain chip implant for improved cognition (32% thought they would definitely or probably want such an enhancement); however, the Pew question was not only focussed on uptake in older years.

[45] https://www.nature.com/articles/d41586-018-05599-8#ref-CR1
[46] See for example https://epsrc.ukri.org/newsevents/news/elderly-could-keep-their-mobility-thanks-to-the-right-trousers/

Figure 10.7: Whether people would be likely to take up enhancement technologies in later life



QA6. If the following were available to you, how likely is it that you would want this when you are older?
Base: All respondents, module A (n=563)

Focussing on the proportion who say they would either 'definitely' or 'probably' want this when they are older, more detailed analysis of the data suggests that the following groups were most in favour of these technological solutions for later life:

- Men were more likely than women to think they would take up brain chip implants (31% vs 17%) and smart clothing technology (68% vs 51%)
- Young people aged 16-29 were more likely than older people aged 70+ to think they would take up brain chip implants (28% vs 15%) and smart clothing technology (71% vs 43%)
- More affluent people (ABs) had a higher propensity than the less affluent (DEs) to favour cognitive enhancing drugs (86% vs 76%) and smart clothing (64% vs 48%)
- White people were more inclined than people from BAME groups to want to take up cognitive enhancing drugs (82% vs 70%) and brain chip implants (25% vs 16%).
- People with high science capital were more likely than those with low science capital to think they would take up brain chip implants (37% vs 22%) and smart clothing (75% vs 52%).

What do the public feel about the use of robots to provide social care?

A wide range of robotic devices are being developed to help meet the demands of an ageing population including robots to assist with the care of elderly people in the social care sector. Japan has been at the forefront of such technology, and early models have already been adopted in the UK. For example, "Paro"[47] a robotic seal is currently being used by the NHS to help provide therapy for dementia patients, while "Pepper"[48] a humanoid robot is already used within some UK social care settings to help provide stimulation for dementia patients. (Figure 10.8)

Figure 10.8: Examples of robots used in some UK social care settings

'Paro'

'Pepper'

Robotics companies are looking to develop more advanced models which will eventually be able to take over many of the tasks traditionally performed by human care-workers including helping with household chores, lifting, testing vital signs, and providing companionship.

People were provided with the following definition of robots used in social care before being asked about their awareness and opinions towards this.

Survey definition of robots used in social care: In the future, older people could be provided with a robot caregiver to allow them to continue living in their own home as they age. This robot would be available 24 hours a day to help with household chores, test vital signs, or dispense medication. It would also have conversational skills and could serve as a companion for people who live alone.

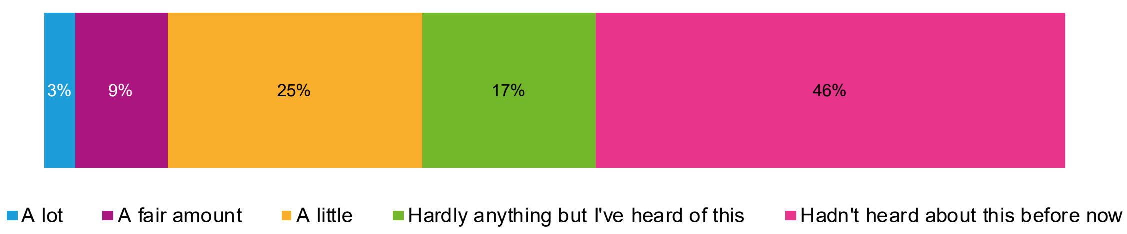
[47] http://www.parorobots.com/
[48] https://www.softbankrobotics.com/us/pepper

Awareness of robots used in social care

As shown in Figure 10.9, while a half (54%) had heard of this concept, overall knowledge was very low. Only one in eight (12%) said they knew either a fair amount or a lot.

The Royal Society measured overall awareness of robots used in social care (using similar but not the same wording) at 41% (Ipsos Mori, 2017), while Pew (2017) measured awareness among US adults using similar wording at 35% in 2017. Though neither of these are directly comparable to PAS 2019 this does imply that awareness has been increasing over the last two to three years.

Figure 10.9: Awareness of concept of robots used in social care



QA7a. Before today, how much had you heard or read about the idea of robots helping to care for older people?
Base: All respondents, module A (n=563)

Based on the proportion who said they knew either ‘a lot’ or ‘a fair amount’:

- Those educated to degree level (20%) and the more affluent AB group (20%) were more aware than average (12%).
- People with high science capital (29%) were much more aware than those with low science capital (3%)
- It is also notable that people aged 65+ (21%) were much more aware of this idea than people in younger age categories (ages 16-34: 11%; ages 35-54: 8%; ages 55-64: 11%).

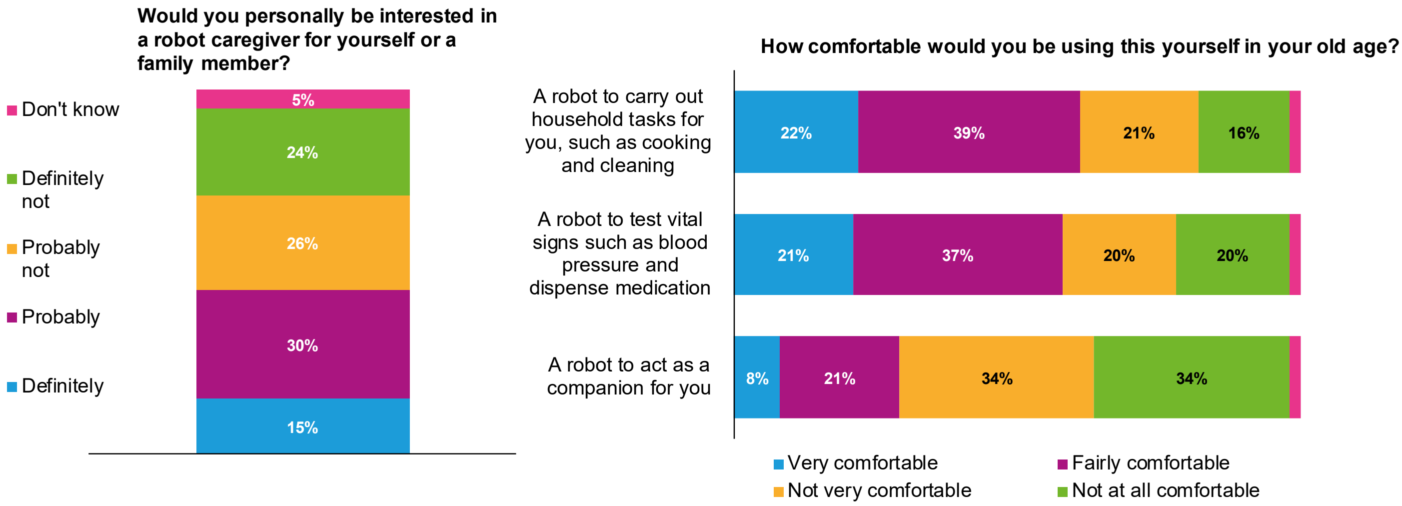
How comfortable do people feel about the use of robots in social care?

Propensity for people to want these services when they are older

People were evenly split as to whether they would be interested in this type of robot caregiver for themselves or for a member of their family, with 45% saying they would definitely or probably take this up, and 50% saying they definitely or probably wouldn’t (Figure 10.10).

When asked about their level of comfort with robots carrying out specific tasks to assist them when they are older, people were broadly comfortable with the idea of robots carrying out household tasks such as cooking and cleaning (61% comfortable, 37% uncomfortable) and carrying out health checks and dispensing medication (57% comfortable, 40% uncomfortable). However, people were much less comfortable with the idea of a robot providing companionship (29% comfortable, 68% uncomfortable).

Figure 10.10: How comfortable do people feel about the idea of robot caregivers?



QA7b. Would you, personally, be interested in this type of robot caregiver for yourself or a member of your family?
QA.8 For each of the following, how comfortable you would feel about using this yourself in your old age?
Base: All respondents, module A (n=563)

Other studies have produced mixed findings with respect to support for robots used in social care, and support appears to depend on how the role of robot is presented. When the question focusses on the *companionship* role of robots, support appears to be much lower.

For example, PAS 2014 found that the UK public was more likely to oppose (47%) than support (33%) robots acting 'as companions for older people and people with dementia', while the 2017 Eurobarometer (European Commission, 2017) found that 55% of UK adults felt uncomfortable (vs 21% comfortable) with the idea of 'a robot to provide you services and companionship when infirm or elderly'. However, 2016 research for the Royal Society (Ipsos Mori, 2017) found that, on balance, people in GB were more likely to think the benefits of 'robots that can adapt to the home environment, for example helping to care for older people' outweighed the risks. In this context, PAS 2019 reinforces these findings and clearly demonstrates that while the public broadly supports the concept of robots used for practical tasks (household tasks, healthcare support) they largely reject the idea of robots taking on a more 'human' companionship role.

More detailed analysis by subgroup indicates the following groups as being most favourable towards the concept of robot caregivers:

- Men were more likely than women to see the benefits of robot care services, being more likely to think they would use this for themselves or a relative (55% vs 36%), and to feel more comfortable using a robot for household tasks (66% vs 55%) and healthcare support (68% vs 47%).

- People educated to degree level were more likely than people without a degree to think they would use this for themselves or a family member (56% vs 40%) and to feel comfortable with the idea of a robot for household tasks (74% vs 55%), healthcare support (66% vs 53%).

- The more affluent ABs were also more likely than the less affluent DEs to want to use this for themselves or a relative when older (54% vs 34%) and to feel comfortable using this for household tasks (71% vs 46%) and healthcare support (75% vs 42%)
- People who knew at least a fair amount about robots used in the care sector were more positive than those who had never heard of this idea; they were twice as likely to say they would use one themselves or for a relative (75% vs 38%) and much more comfortable with the idea of using one for all three types of service.
- White people were more comfortable than people from BAME backgrounds to feel comfortable with robots performing household tasks (64% vs 41%) and medical care (59% vs 48%).
- People with high science capital were considerably more likely than those with low science capital to say that they would use a robot caregiver for themselves or a relative (63% vs 24%) and were also much more comfortable about a robot carer performing all three types of caring role.

When the findings are analysed by age group and health status, the picture is a little less clear cut.

- Older people aged 70+ were more likely than the youngest age group 16-29 to feel comfortable with the idea of robots in a companionship role (31% vs 19%). However, the 70+ age group were less likely than 16-29 year-olds to feel comfortable with the idea of robots used to provide healthcare support (49% vs 61%).
- Similarly, those who described their health as ‘fair’, ‘bad’ or ‘very bad’ were more likely than those in ‘very good’ health to think they would use a robot carer when older (49% vs 38%) and to feel comfortable with a robot as a companion (34% vs 25%). However, they were less likely to want a robot performing healthcare support (49% vs 62%).

These findings tentatively suggest that older people, and those who perhaps foresee themselves as having more care needs in old age due to their health, are less dismissive of the idea of having a robot as a companion. However, it is notable that these groups of people - who are likely to have more contact than average with healthcare services - feel much less comfortable with the idea of a robot in a healthcare role.

Views on the impact of robots in social care on society

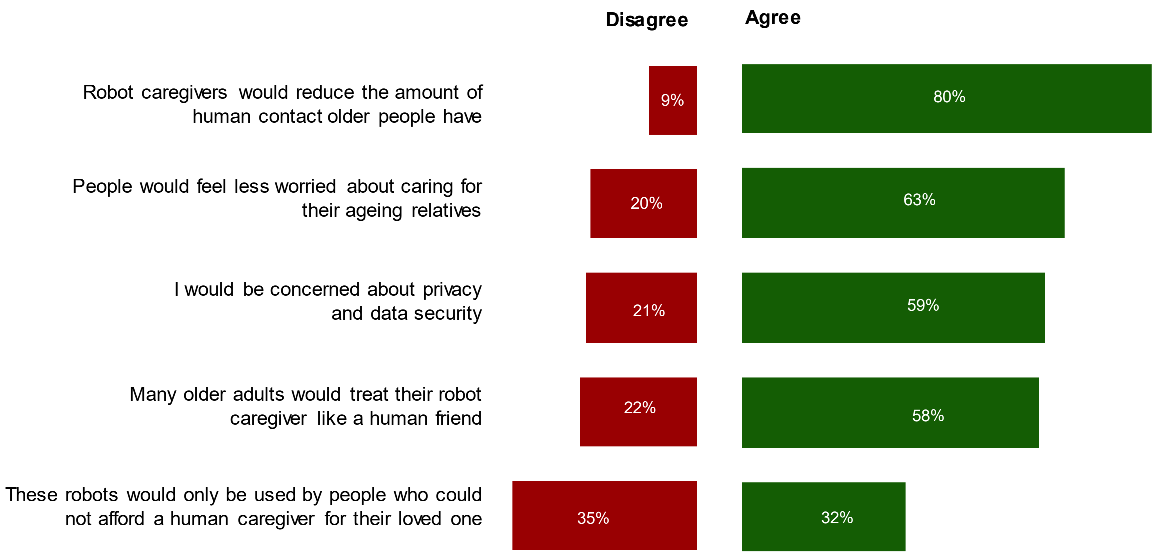
When asked about more general views on the impact of robot caregivers on society, reinforcing the findings above, the chief concern among the public is the loss of human contact; 80% agree that robots would reduce contact for older people (Figure 10.11). While 58% agree that many older adults would treat a robot caregiver like a human friend, they do not necessarily think this is a good thing (85% of people who think this also feel that robot carers would lead to a loss of human interaction).

Aside from loss of human contact, the public is also concerned about data privacy and security, with 59% agreeing vs 21% disagreeing that they would be concerned about this.

On the positive side, people broadly acknowledged that there could be a role for robots in terms of providing support to relatives, with 63% agreeing that ‘people would feel less worried about caring for their ageing relatives’. This supports the findings of Pew (2017), which reported that the main motivations among US adults interested in a robot caregiver were to reduce the burden on family, to provide better quality of care, and to help older people be more independent.

A key part of the government's mission statement for the 'Ageing Society' challenge is to narrow the gap between the rich and poor in terms of access to good quality care in later life. However, there were mixed views among the public as to whether the development of robot caregivers would mean that robots would only be used by people who could not afford a human caregiver: 32% agreed and 35% disagreed. The large proportion of people who gave a neutral or don't know response here (33%) implies that people are not yet aware how these types of technology might be accessed in society.

Figure 10.11: Attitudes towards the use of robots in social care



QA9. Please think about a situation in the future where robot carers are being used in society How much do you agree or disagree with the following?
Base: All respondents, module A (n=563)

More detailed analysis by subgroup reveals that:

- The most affluent ABs were more likely than the least affluent DEs to think that older people would treat their robot carer as a human friend (65% vs 52%) and that this would lead to reduced human interaction (81% vs 73%). The DE group on the other hand were more likely than ABs to feel that access to a human vs robot carer would depend on income (36% vs 26%).
- People with high science capital were generally less concerned about robot carers than those with low science capital, being more likely to think it could help relatives feel less worried (73% vs 54%) and less concerned about data privacy (48% vs 68%). They were also more likely to feel that older people would come to see the robot carer as a human friend (77% vs 52%).

11. Artificial intelligence, robots and data

This chapter explores the UK public's familiarity with and attitudes to the use of Artificial Intelligence (AI), robots and data technology in society. Three main areas are covered: AI in healthcare; AI in the workplace; and the use of personal data to develop AI.

'AI and data' is one of the three modular topics chosen for further exploration in PAS 2019. Unless otherwise stated, the survey questions covered in this chapter were asked of around a third of the main sample (633 adults), who were randomly selected. While the findings are still representative of the UK public, margins of error are higher.

Key findings

The public was broadly supportive of the use of AI and robots in healthcare, and there was some recognition of its potential to speed up diagnosis. People were, however, less supportive of the shift towards people's jobs becoming more automated. A key concern, across both these contexts, was the potential loss of human interaction and human skills. While people trusted the NHS with their patient data, there was more limited support for sharing data with private companies to develop AI for both healthcare and other applications.

Awareness of AI technologies

- There was a high level of awareness of a range of AI applications in use today. However, people had more in-depth knowledge about applications commonly used across web platforms, including targeted advertising, speech recognition and processing, and facial recognition. People were less well-informed about AI used in more specific contexts such as to sift job applications or to diagnose medical symptoms.
- Men, younger people, daily internet users, those with high science capital, and the more affluent AB group were the most informed about these technologies.

The use of AI and robots in healthcare

- Although most (81%) had heard about AI used in healthcare to diagnose patients, only 30% said they knew either 'a lot' or 'a fair amount' indicating that this technology is still not widely accessible or used.
- Most people were open to the use of AI or robotics in healthcare, but only when used to *support* rather than *replace* a doctor.
- There are significantly differing levels of recognition of the potential benefits of AI in healthcare. While 58% believed it will accelerate progress in medicine and 64% thought it would lead to earlier diagnosis and treatment, only 48% thought it could bring cost savings and 37% that it could surpass the accuracy of human doctors in diagnosis and treatment of medical conditions.
- The chief concerns among the public were related to loss of human skills and interaction, with 68% thinking it likely that doctors would start to lose their medical skills and 78% that patients would lose the 'human touch' in healthcare.

- In general, men, the more affluent, and those with higher education and science capital were the most optimistic about the potential benefits of AI use in healthcare.

The impact of AI on jobs in the future

- Nine in ten people (90%) had heard about the idea that AI and robots could begin to take over many human jobs, beyond the more routine jobs.
- Most working people recognised that aspects of their job could be automated in the future: 51% thought that their job could be at least partially automated within the next 5 years, rising to 69% within a 20-year timeframe. Smaller proportions felt that their job could become mostly or fully automated: 18% within 5 years, doubling to 37% within 20 years.
- People were mostly pessimistic about a future in which AI takes over more jobs. Only 16% thought this would lead to the creation of new and better jobs, while 37% thought that jobs would become more fulfilling. Almost everyone (87%) believed that more widespread automation would lead to declining levels of human interaction.
- Although it is predicted by economists (see e.g. PWC, 2018) that men and lower-skilled workers are most at risk of losing jobs to automation, there was no difference by either gender or education level in the proportion who thought their job would be replaceable. Younger people aged 16-34 were most likely to think their job could be automated in the future.
- Men, the more educated, the more affluent (ABs), and those with higher science capital were most positive about the shift towards more automation of jobs, especially in terms of jobs becoming less menial and more fulfilling.

The use and sharing of data

- For the purposes of developing healthcare-related AI, the large majority were willing to share their personal health data with the NHS (90%), somewhat less willing to share data with research organisations (73%) and the government (61%), and much less keen on sharing data with private companies (35%).
- There was considerable reluctance among the public for companies to use personal data to target personalised content on the web. While there was a degree of acceptance that companies could use data to target news articles or develop new products and services, there was widespread disapproval of the use of data to target adverts or political campaigning messages.
- On balance people were more distrustful (55%) than trustful (44%) about the ability of UK data protection regulations to ensure their data is not shared without permission. Most people favoured the oversight of the safety of AI by an independent regulator rather than by the technology industry.
- More educated people tended to have more trust in data UK regulations, though they were more likely to oppose the use of their data for targeting and profiling. Younger people were most trusting of data regulations and were more open to sharing personal data with private companies.

Context

As one of the four Grand Challenges set out by the Government as part of their Industrial Strategy[49], the Government aims to put the UK at the forefront of the AI and data revolution.

The strategy describes many potential benefits of AI across all sectors in society, for example to improve the accuracy and efficiency of medical diagnoses, to support the development of autonomous vehicles, and to enable people to communicate across the globe using speech recognition and translation technology. Increased use of AI in the workplace could also boost productivity and drive economic growth.

However, these changes also have the potential to significantly disrupt the way in which we live our lives. Concerns have been raised about the social and economic impacts of AI, including loss of jobs and declining human interaction. In this chapter, as well as measuring general awareness of different AI applications, there is a focus on three areas of popular public debate:

- **The use of AI in healthcare**. There are many potential benefits to the use of AI in healthcare. For example, it is expected that developments in AI will improve outcomes through earlier and more accurate diagnosis of chronic conditions, and better patient monitoring and management. However, it is important to measure the extent to which the public feels comfortable with changes in the way they access healthcare. How do people feel about using AI or robots to support or even replace doctors either as part of consultation or in surgery? Are there concerns about the potential loss of human interaction in healthcare?
- **The impact of AI on work.** Most people now recognise that robots and AI will change the future of the workplace, with jobs both lost and created. To what extent do the public embrace or fear this shift, and which groups of people think they will be impacted most? AI will also impact on the nature of work, affecting people both as workers and service users. As core parts of job roles become automated, this could free people up to work on more creative tasks or to work fewer hours; although it could also lead to a more depersonalised society. PAS 2019 explores public perception of these issues.
- **The use of data to drive AI.** Personal data is used to drive AI algorithms in both the public and commercial sectors, for example to help diagnose illness, to predict energy consumption, to recommend a financial product, or decide which adverts are most relevant. However, there are public debates around the need to balance our right to privacy with our desire for more personalised products and services. In this chapter, we explore public willingness to share personal data in different contexts, and the extent to which people trust UK data protection to keep their data safe.

49 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf

How much do people know about different robot and AI applications?

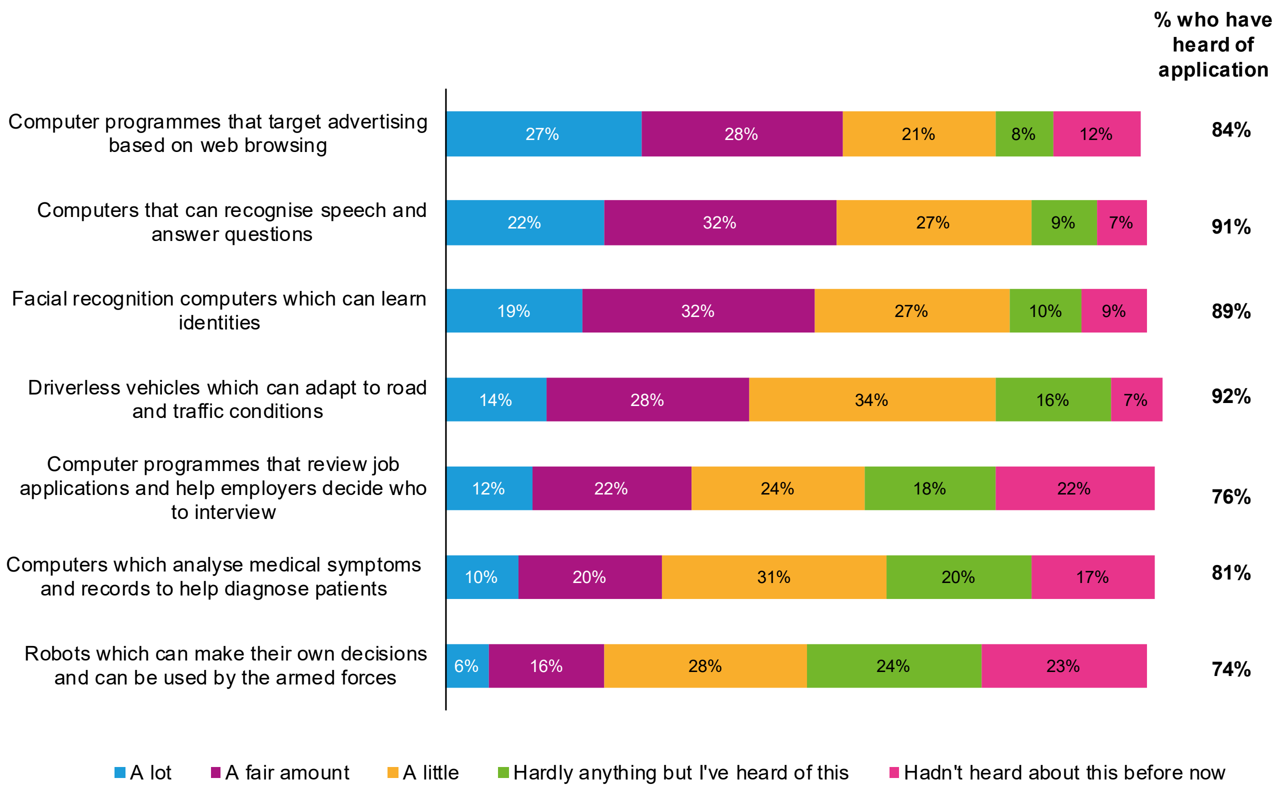
People were provided with the following definition of AI and robots, before being asked about their awareness of different applications.

> **Survey definition of robots and AI:** I now want to ask you some questions about artificial intelligence & robots. By this we mean robots or computer programs that can perform intelligent tasks normally requiring human input.

As shown in Figure 11.1, public awareness was highest for applications commonly used across web and social media platforms with around half having heard or read at least a fair amount about applications that involved algorithm-based targeted advertising (55%), speech recognition and processing (55%), and facial recognition (51%). There was also a reasonably high level of awareness of driverless vehicles (42%).

Applications which were not as well-known to respondents included AI used to sift job applications, AI used to analyse and diagnose medical symptoms, and intelligent robots used by the armed forces. In each of these areas around 40-50% said that they heard or read either 'hardly anything' or 'nothing at all'.

Figure 11.1: Level of awareness of different AI and robot applications



QB1. I now want to ask you some questions about artificial intelligence & robots. By this we mean robots or computer programs that can perform intelligent tasks normally requiring human input. Before today, how much, if anything, have you heard or read about the following areas?
Base: All respondents, module B (n=633)

Between 74% and 92% had heard or read at least something about each of these applications. It is worth noting that these overall awareness figures are considerably higher than similar survey measures recorded by the Royal Society in 2016 (Ipsos Mori, 2017). A direct comparison of the two surveys[50] suggests that over the past three years, awareness of speech-recognition AI has grown from 76% to 91%, driverless vehicles from 75% to 92%, and medical diagnostic AI from 47% to 81%. This is likely to reflect increased levels of exposure to these applications both in everyday digital interactions and via the media and emphasises the speed at which these types of applications are being developed and implemented in society.

Focussing on the proportion who considered themselves to be informed, that is saying they knew either ‘a lot’ or ‘a fair amount’ about the different applications:

- Men felt more informed than women about all applications, for example speech-recognition AI (67% vs 42%), driverless vehicles (55% vs 29%) and facial recognition AI (61% vs 41%).
- Younger people aged 16-34 were more informed than those aged 65+ about most applications, for example facial recognition (68% vs 38%), web-based targeting of adverts (70% vs 38%), and AI used to select candidates for jobs (45% vs 26%). However, for driverless cars and medical diagnostic AI there was no clear pattern by age.
- The more affluent ABs were much more likely to feel informed about most applications, and in most cases the differential between ABs and DEs was around 20%. There was a particularly pronounced differential in the use of web-based targeting of adverts (68% of ABs vs 37% of DEs).
- People with high science capital were considerably more informed about all applications. The differences were striking. For example, 78% of people classified as having high science capital felt informed about speech recognition AI and 52% about health diagnostic AI, compared with 26% and 6% respectively among those with low science capital.
- There was evidence that people from BAME (BAME) groups were more informed about each of these applications, though the sample size of the BAME subgroup was small[51] and this finding should therefore be interpreted with some caution.
- Unsurprisingly, people who used the internet daily were much more likely than those classified as either ‘light users’ or ‘non-users’ to feel informed about each of these applications.

[50] The wording used in the Royal Society survey was the same for speech-recognition and driverless vehicles, and almost the same for medical diagnostic AI.
[51] n=65

How comfortable do people feel about the use of AI and robots in healthcare

One of the Grand Challenges set out by BEIS involves putting the UK at the forefront of the AI and data revolution. Within this Grand Challenge theme, the government has set itself the following mission:

> **Grand Challenge mission:** Use data, Artificial Intelligence and innovation to transform the prevention, early diagnosis and treatment of chronic diseases by 2030[52]

There is therefore an interest in measuring the extent of public acceptance to the increased use of AI and data in diagnosis and treatment of medical conditions.

Should AI and robots support or replace doctors?

As shown in Figure 11.1, while most (81%) had heard about computers which analyse medical symptoms and records to help diagnose patients, the knowledge base is still quite low: only 30% said they knew either 'a lot' or a 'fair amount' about this.

Exploring this theme further, people were asked about their level of comfort with the following two situations:

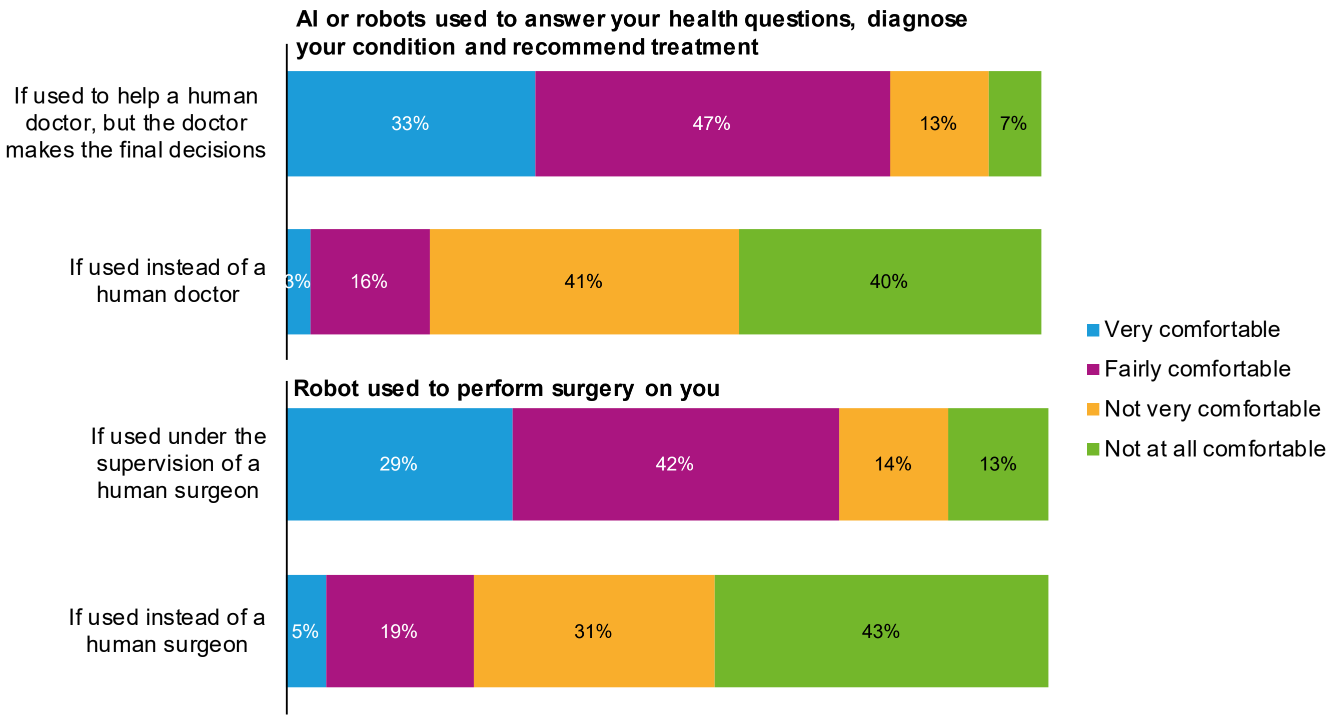
> Where a computer or robot is used to answer your health questions, diagnose your condition and recommend treatment
>
> Where a robot is used to perform surgery on you

The results shown in Figure 11.2 show that people were broadly open to the use of AI or robotics in healthcare, but only when used to *support* rather than a *replace* a doctor.

A large majority felt comfortable about AI and robots being used to support a human doctor to make a diagnosis (80%), or in surgery (71%), and around three in ten felt 'very comfortable' in each of these situations (Figure 11.2). The opposite pattern was found when asked about technology *replacing* human doctors; the clear majority felt uncomfortable about AI used instead of doctors for diagnosis and treatment (81%) or robots used instead of surgeons (75%).

[52] https://www.gov.uk/government/publications/industrial-strategy-the-grand-challenges/missions#early-diagnosis

Figure 11.2: Level of comfort with the use of AI and robots in different healthcare scenarios



QB2. Thinking first about a situation where a computer or robot is used to answer your health questions, diagnose your condition and recommend treatment. How comfortable would you in each of the following situations?
QB3. Now thinking about a situation where a robot is used to perform surgery on you. How comfortable would you in each of the following situations?
Base: All respondents, module B (n=633)

By way of context, evidence from other recent surveys also finds that the public is more supportive of the use of AI or robots as a diagnostic tool rather than to perform operations[53]. research for The Royal Society (Ipsos Mori, 2017) found that the public was on balance more positive (40%) than negative (30%) about ‘computers which analyse medical records to help diagnose patients’, while the 2017 Eurobarometer (European Commission, 2017) found that only 25% of UK adults were comfortable with the idea of having a medical operation performed on them by a robot. Similarly, PWC research in 2016[54] noted that 39% of UK adults were willing to use AI for diagnosis and to recommend treatments, dropping to 26% willing for a robot to perform major surgery on them.

In general, men and those with higher levels of education and science capital were more open to the idea of using AI and robots in healthcare. There was no difference on any measures by whether or not people had a longstanding health condition.

- Men were more likely than women to feel comfortable about the use of technology to support doctors in diagnosis (89% vs 71%) or surgery (83% vs 60%), as well as to replace doctors (26% vs 12%) and surgeons (34% vs 15%) in these settings.

[53] Due to question wording differences, these figures cannot be directly compared to PAS 2019.
[54] https://www.pwc.com/gx/en/industries/healthcare/publications/ai-robotics-new-health/survey-results.html

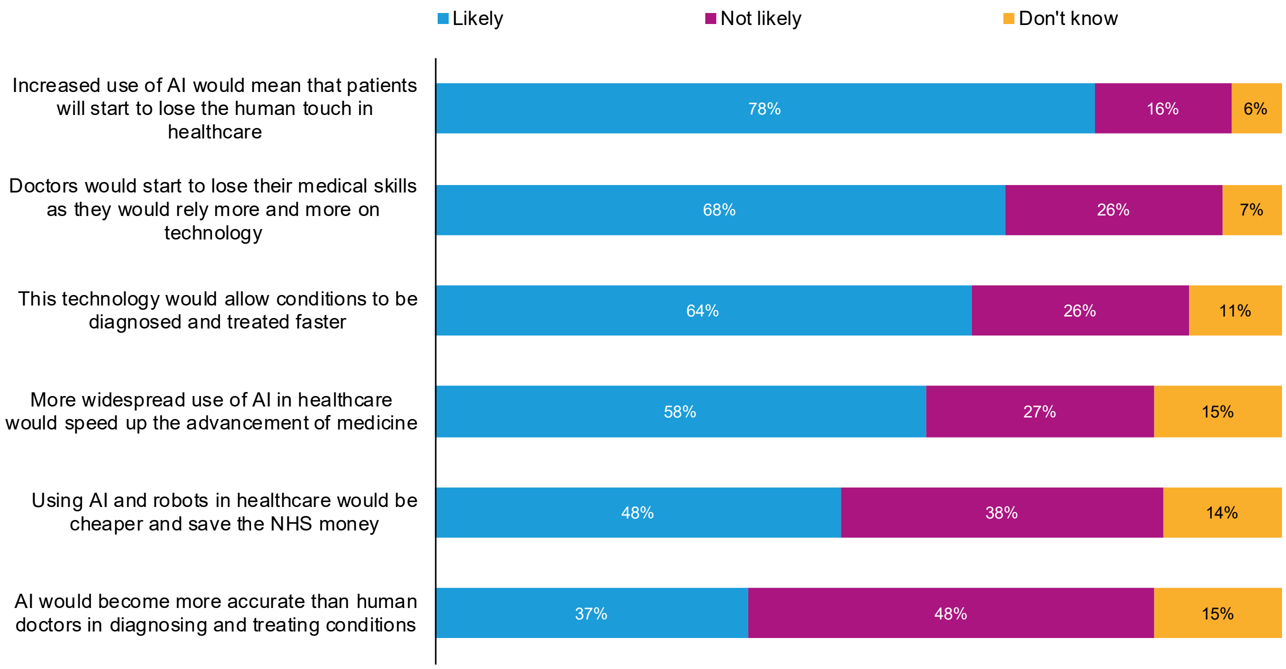
- Degree-educated people were more likely than people without a degree to feel comfortable in each of these four situations.
- People with high science capital were also much more likely than those with low science capital to feel comfortable in all four situations.

Attitudes towards the use of AI and robots in healthcare

PAS 2019 revealed some uncertainty among the UK population when it comes to trusting their health to AI, with people recognising both benefits and drawbacks. So, while 64% believed it will speed up diagnosis and treatment and 58% believed it will speed up the advancement of the medicine, a high proportion also expressed concerns (Figure 11.3). The predominant concerns regarded the loss of the 'human touch' in healthcare (78%) and the loss of doctors' medical skills as they come to increasingly rely on technology (68%).

There was some ambivalence around the possible benefits of cost savings and increased accuracy. Around a half (48%) anticipated that increased use of AI and robots would result in costs savings for the NHS, while just over a third (37%) expected AI to surpass the accuracy of human doctors in diagnosing and treating conditions. These results broadly echo findings from the above-cited 2016 PWC survey of the UK public which found that speed of access to healthcare and diagnosis were seen as the main opportunities of AI in healthcare, while a failure to react to the unexpected, to use intuition, and the loss of human touch were regarded as the chief threats.

Figure 11.3: Attitudes towards the use of AI and robots in healthcare



QB4 If artificial intelligence, also known as AI, or robots becomes widespread, which of the following do you think are likely to happen as a result?
Base: All respondents, module B (n=633)

More detailed analysis of the data reveals that men, the more affluent, and those from higher educational groups were most optimistic about the use of AI in healthcare:

- Men were more likely than women to recognise potential benefits of faster diagnosis and treatment (74% vs 54%), accelerated advancement in medicine (66% vs 49%), increased accuracy (46% vs 28%) and cost savings (52% vs 43%); while women were more concerned than men about loss of human medical skills (74% vs 62%).
- The more affluent ABs were more positive than the least affluent DEs about speedier diagnosis and treatment (73% vs 48%) and faster advancement in medicine (64% vs 45%). There were similar differentials when comparing degree-educated people with those who have lower-level qualifications.
- Those with high science capital were considerably more positive than those with low science capital about the benefits of AI and robots in healthcare on all six measures.
- There was no difference by health status; those with a long-standing health condition gave a similar pattern of responses to healthy people.

How do the public think AI will impact on jobs in the future?

Awareness of increased use of AI in the workplace

Survey respondents were introduced to the following concept:

> New developments in AI & robots are changing the nature of many jobs. Today, these technologies are mostly being used to perform routine tasks. But in the future, artificial intelligence and robots may be able to do many of the jobs that are currently done by humans today.

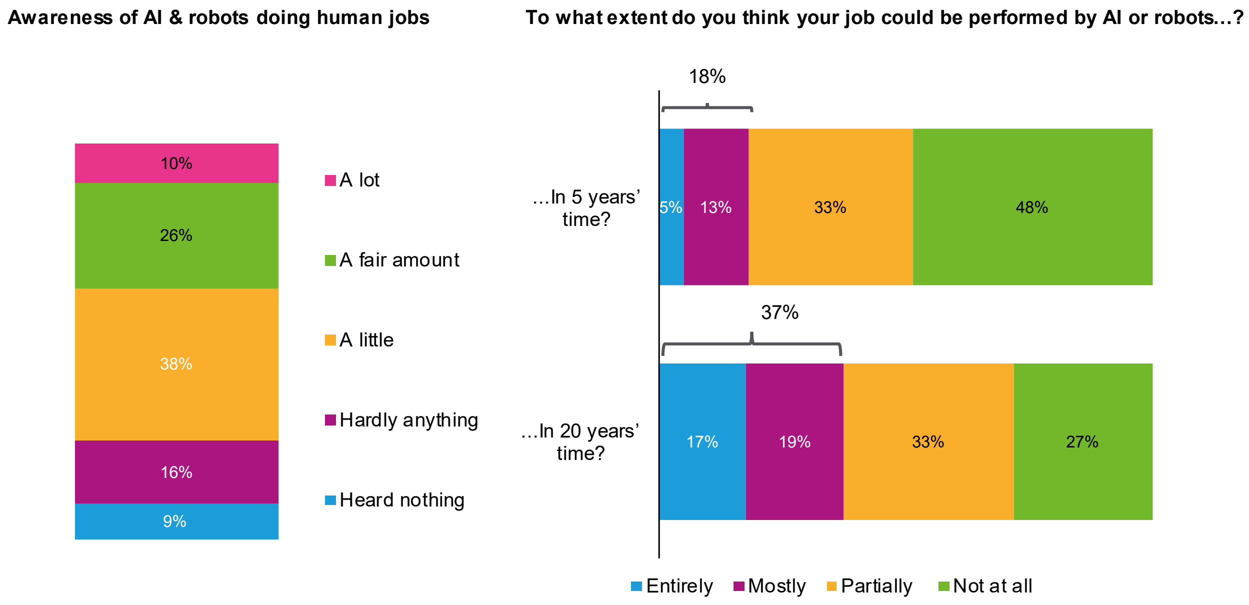
As shown in Figure 11.4, nine in ten people (90%) had heard something about this idea, although only a third (36%) considered that they knew either ‘a lot’ or ‘a fair amount’. Based on this latter measure, men (47%), those educated to degree level (53%), those with high science capital (61%), and the more affluent AB group (43%), were all more informed than average.

Do people feel their own job is at risk of automation?

Among those in work, most people recognised that some aspects of their job could be taken over by AI or robots. Half (51%) felt that their job could at least be partially automated within the next 5 years, this figure rising to 69% thinking this might happen within the next 20 years.

However, smaller proportions felt that their own job is at impending risk of being entirely or mostly replaced by AI or robots. Overall, 18% of working people considered that this was likely within the next 5 years, though this doubles to 37% thinking this will happen in the next 20 years.

Figure 11.4: How much do people know about technologies taking over jobs and do they feel their own job is at risk?



QB5. In the future, artificial intelligence and robots may be able to do many of the jobs that are currently done by humans today. Before today how much have you heard or read about this idea?
Base: All respondents, module B (n=633)
QB7. Thinking ahead, to what extent do you think your current job could be done by AI and robots in 5 years' time? / in 20 years' time?
Base: All respondents in work, module B (n=332)

Other surveys have asked similar questions though none are directly comparable due to the different time frames asked about. The 2017 Eurobarometer (European Commission, 2017) found that 15% of UK adults thought that their current job could be entirely or mostly done by a robot or by artificial intelligence in the future while Pew (2017) found that 30% of Americans thought that their job would be replaced by robots or computers in their lifetime.

Which groups of people are most likely to think their job will be replaced by robots or AI?

When looking at differences by subgroup, it is interesting to reference analysis from PWC (2018) which used OECD data to estimate that jobs done by men will face a higher automation risk than jobs done by women in the longer term because men are more likely to be employed in manual-task-focused sectors such as manufacturing. In comparison, female employment tends to be more concentrated in sectors such as education and health requiring more personal and social skills that are less easy to automate.

The report also notes that those with lower levels of education (especially men) face the highest long-term risk of their jobs being automated. The lower risk for more highly educated workers '*reflects the fact that their roles involve skills of supervision and intellectual reasoning that will still be needed alongside AI-based systems. Higher levels of education also allow workers flexibility to move around different occupations and industries and thus potentially escape automation risks.*'

In PAS 2019, when asked how much they agreed or disagreed that 'if robots begin to replace jobs currently done by humans, people in low skilled jobs will find it harder than people in high skilled jobs to find alternative employment', a majority (77%) agreed. However, as noted in

Chapter 8, it is notable that those judged to be most at risk (males, those with lower levels of education, DEs) were not more likely to view this as a concern. In fact, people with no qualifications (69%) were *less* likely to be concerned about this than those educated to degree level (78%).

Further reinforcing this pattern of findings, there were no significant differences in people's perceived level of risk of losing their own job to automation by gender, age or education level. There were, however, some differences social grade, with those in lower-skilled DE jobs more likely to feel that their job is at risk over the longer-term.

Focussing on the proportion of the working population who consider that their job could be entirely or mostly done by AI or robots, the less affluent C2DE group were no more likely than ABC1s to consider that their job could be automated within the next 5 years, although they were more likely to feel this could happen within the next 20 years (44% vs 33%).

What do the public feel about increased automation on the workplace?

The UK public was evenly split as to whether the concept of robots and AI beginning to replace jobs currently done by humans was positive or negative for society, with 49% considering this to be a 'good thing' and 45% 'a bad thing'.

Exploring this in more depth, survey respondents were asked their opinion on different possible consequences of the increased use of AI and robots in the workplace:

> In the future Artificial intelligence & robots may be able to perform most of the jobs currently being done by humans. To what extent do you agree or disagree with the following statements if this were the case.

As shown in Figure 11.5, the public recognised that there are both positive and negative impacts to a future society in which robots and AI are more prevalent in the workplace, although on balance people are more pessimistic than optimistic.

One of the most striking findings is the large majority (87%) who believed that increased use of robots and AI in the service industry (banks, shops, restaurants etc.) would lead to people having less contact with each other, which echoes the opinion noted above about increased automation in healthcare leading to the loss of a 'human touch'.

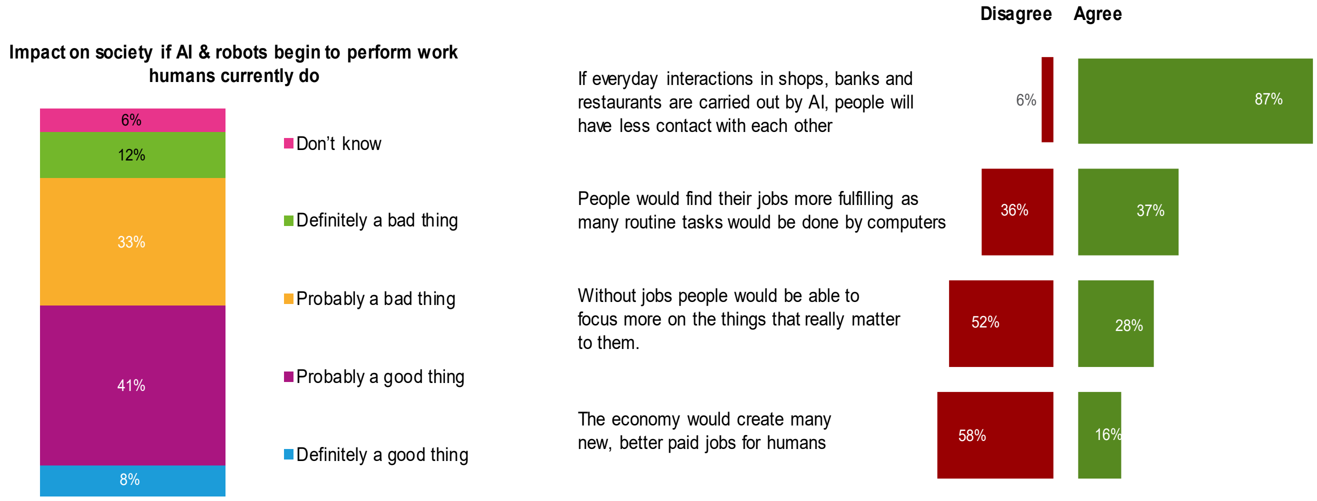
Recent reports provide predictions of large-scale job losses to automation in the next 10-20 years. For example, Future Advocacy (Fenech et al, 2017) estimates that about 30% of jobs in the UK are at risk of automation. This same report also notes, however, that there is disagreement among economists about the extent to which these jobs will be replaced by new and alternative work. Against this backdrop, it is perhaps unsurprising that most people rejected the idea that a shift towards increased automation would lead to improved job prospects for people: far more people disagreed (58%) than agreed (16%) that this would lead to the creation of new and better jobs.

Similar concerns have been expressed in other studies. For example, the 2017 Eurobarometer (European Commission, 2017) found that 67% of the UK public agreed that robots and AI would lead to more jobs disappearing than new jobs created and 63% believed that robots and AI would 'steal people's jobs'.

One of the advantages of increased automation cited by technology experts is that robots and AI will take over more of the menial tasks, leaving people to focus on more interesting or creative aspects of their jobs. Again, there is scepticism here. People were as likely to agree (37%) as they were to disagree (36%) that people would find their jobs more fulfilling if computers took over more routine tasks.

Finally, only 28% agreed that, without jobs, people would be able to focus on the things that really matter to them.

Figure 11.5: Attitudes towards the idea of increased automation in the workplace in the future



QB6. Overall, do you think it would be a good thing or a bad thing for society if artificial intelligence and robots began to perform some of the work humans currently do?
QB8. In the future Artificial intelligence & robots may be able to perform most of the jobs currently being done by humans. To what extent do you agree or disagree with the following statements if this were the case.
Base: All respondents, module B (n=663)

There are some interesting patterns of difference by subgroup:

- **Gender:** As noted above, although men potentially face a higher risk of their jobs being automated than women, they tend to be more positive than women about the impact of more widespread automation in the workplace, especially in relation to the *nature* of jobs. Overall, 60% of men vs 38% of women considered the shift to automation to be a good thing, 33% vs 23% thought that, without jobs, people would able to focus more on the things that matter to them, and 45% vs 29% thought that jobs would become more fulfilling.

- **Education and social grade:** As noted above, those in lower-skilled jobs are likely to be at greater risk of losing their jobs to automation and may find it harder to re-skill. In this context it is perhaps unsurprising that those with an AB social grade and educated to degree level were much more likely to see the shift to automation as a 'good thing' (61% of ABs vs 36% of DEs; 61% of degree-educated vs 31% with no qualifications). Degree-educated people were also more likely to think that jobs may become more fulfilling (43% vs 31%).

- **Science capital:** Those with higher science capital were considerably more likely than those with low science capital to think of this shift as a 'good thing' (71% vs 24%) and to see benefits in terms of job creation (20% vs 8%) and making jobs more fulfilling (43% vs 21%).

- **By whether consider own job is at risk of automation:** On most measures there was no difference between those who did and did not consider that their job was at risk of automation. However, there was some evidence that those who viewed their job as automatable within the next 20 years were more likely to see the benefits in this. Working people who thought their job was likely to be entirely or mostly replaced by AI within 20 years were more likely than those who did not feel their job was replaceable to think that this could lead to a more fulfilling job (42% vs 24%) and that it would allow them to focus more on the things that matter (33% vs 17%).

How do people feel about how their data is used?

Many AI algorithms are built on data. Data-driven AI can produce many benefits in society, for example medical and genetic data used to produce algorithms to help diagnose illness. However, recent events such as the use of data analytics for political profiling (Facebook/Cambridge Analytical) in March 2018, and the cyber-attack affecting NHS patient systems in May 2017 bring to light a range of ethical and data security issues.

In the light of these concerns, the government has set up an advisory body, the Centre for Data Ethics and Innovation (CDEI) to investigate and advise on how to maximise the benefits of data-enabled technologies in a fair and ethical way.

In this context, it is of interest to find out how much the public trusts the government to ensure their data is used appropriately and not shared without their permission, and how willing people are to share their data for different purposes.

Willingness to share patient data to help develop medical AI

New AI tools can help produce more accurate diagnosis of chronic conditions, and better patient monitoring and management. However, this will require that NHS data is shared with and used by the government, the NHS, and third parties such as research organisations and commercial technology firms.

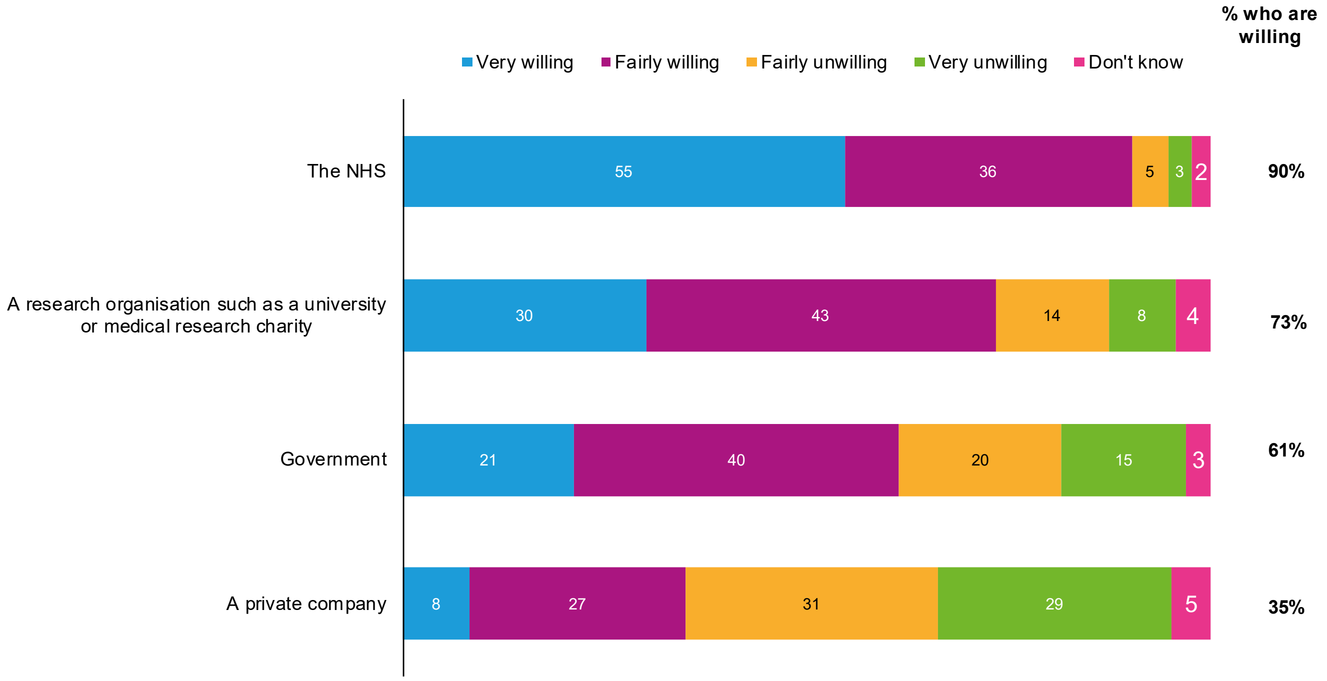
Survey respondents were introduced to this idea as follows:

> Scientists are developing new artificial intelligence tools to help diagnose long-term conditions earlier and more accurately, and to offer better treatment options. This will involve using individuals' health data. How willing or unwilling would you be to share your health data with the following organisations for this purpose?

People were overwhelmingly supportive about sharing personal health data with the NHS (90%), and mainly supportive about sharing data with research organisations (73%) and the government (61%). Support for sharing data with private companies to develop healthcare-related AI was considerably lower (35% - Figure 11.6).

These mostly positive results in terms of allowing the NHS and some third parties to access health data align with other studies (although none are directly comparable): for example, Healthwatch England in 2018[55] found 77% of English adults to be confident in the ability of the NHS to protect their patient data, and 73% happy for the NHS to use their information to improve the healthcare treatment of others. Similarly, Wellcome (Ipsos Mori, 2016) reported 77% of the UK public as being willing to allow their anonymised medical records to be used in a medical research study.

Figure 11.6: Willingness for people to share their health data with other organisations to develop healthcare AI



QA.10 Scientists are developing new artificial intelligence tools to help diagnose long-term conditions earlier and more accurately, and to offer better treatment options. This will involve using individuals' health data. How willing or unwilling would you be to share your health data with the following organisations for this purpose?
Base: All respondents, module A (n=563)

Some differences were seen between groups in terms of the willingness for their data to be shared to help develop new medical AI tools:

- Men were more willing than women to allow their data to be shared with the government (68% vs 56%) and private companies (40% vs 31%).
- Around nine in ten of those with high science capital were willing to share their data with the NHS (96%), a research organisation (94%) or government (85%) compared with 87%, 54% and 41% respectively of those with low science capital. They were also around twice as likely to be willing to share their data with private companies (55% vs 24%)
- People with a degree were more willing than people without a degree to share their data with government (74% vs 56%), research organisations (87% vs 68%), and private companies (43% vs 32%). There were similar differentials by social grade.

55 https://www.healthwatch.co.uk/news/2018-05-17/how-do-people-feel-about-their-data-being-shared-nhs

- People who described their health as 'very good' were more willing than those who described it as 'fair' or 'bad' to be happy to share their data with the government (72% vs 57%), research organisations (79% vs 71%) and private companies (46% vs 27%).
- People across all these groups were universally happy to share their data with the NHS.

How do people feel about the use of their data in other contexts?

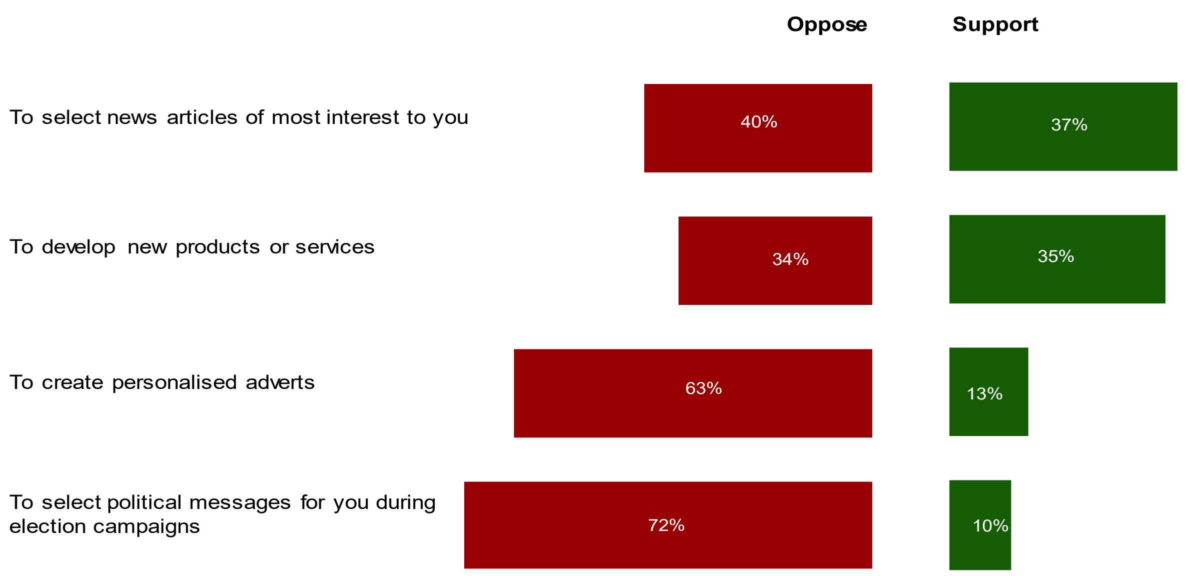
People were asked about their level of support or opposition towards the use of their personal data in other contexts, where personal data was defined as follows:

> The next question is about the use of your personal data. By this we mean things like your browsing history, social media use and online purchases. How much do you support or oppose the following uses of your personal data by companies?

As shown in Figure 11.7, there is considerable reluctance among the UK public for companies to use their personal data across a variety of settings. There was cautious acceptance towards the idea that companies can use personal data to target news articles or to develop new products and services, with people being as likely to support as oppose these. However, only around a third actively supported the use of their data in each of these situations.

Use of personal data to target personalised adverts and to select political messages was extremely unpopular with 63% and 72% respectively opposing these forms of data technologies. The latter finding is perhaps unsurprising given the above-cited widely reported scandal in March 2018 (around a year before fieldwork) where Facebook was accused of the unauthorised sharing of social media data for political profiling and targeting.

Figure 11.7: Level of support for use of personal data in different contexts



BQ9. The next question is about the use of your personal data. By this we mean things like your browsing history, social media use and online purchases. How much do you support or oppose the following uses of your personal data by companies?
Base: All internet users, module B (n=556)

More detailed analysis shows that opposition to use of personal data by companies was most strongly concentrated within the following groups:

- Older people - People aged 65+ were considerably more likely than younger people to oppose the use of their data in most circumstances. For example, 73% of people aged 65+ opposed the use of data to target adverts compared with 52% of people aged 16-34. Younger people were more open to data sharing more generally, especially to target news articles: 53% of 16 to 34 year-olds supported this, over twice the proportion among those aged 65+ (20%).

- **High science capital –** People in this group were much more likely than those with low science capital to oppose the use of their data to target adverts (72% vs 51%), news articles (47% vs 35%), and political messages (81% vs 67%).

- **More educated** – Degree-educated people were more likely than those without a degree to oppose the use of their data in all situations especially in relation to targeting adverts (74% vs 58% without a degree) and political messages (80% vs 68%).

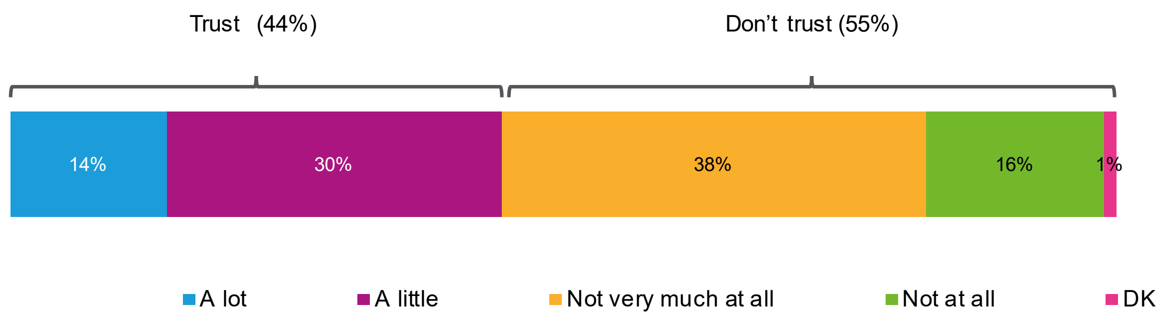
- **Social grade ABs** – More affluent ABs were more likely than DEs to oppose the use of their data to target adverts (74% vs 57%) and political messages (80% vs 60%).

Trust in UK data regulations

On balance, people were more distrustful (55%) than trustful (44%) about the ability of UK data protection regulations to ensure that their data is not shared without permission, and only one in eight (14%) trust these regulations 'a lot' (Figure 11.8).

These findings broadly reflect other consumer research in this area with 2018 ICO research (Harris, 2018) finding that 57% of the UK public disagree that 'current laws and regulations provide sufficient protection of personal information' while DMA (2018) reported 75% of UK adults being concerned about online privacy in 2017.

Figure 11.8: Trust in UK data regulations



BQ14. How much do you trust current UK data protection regulations to ensure that your personal data is not shared without your permission?
Base: All respondents (n=1749)

The level of confidence in UK data protection regulations to keep people's data safe was considerably higher among younger people and the more educated:

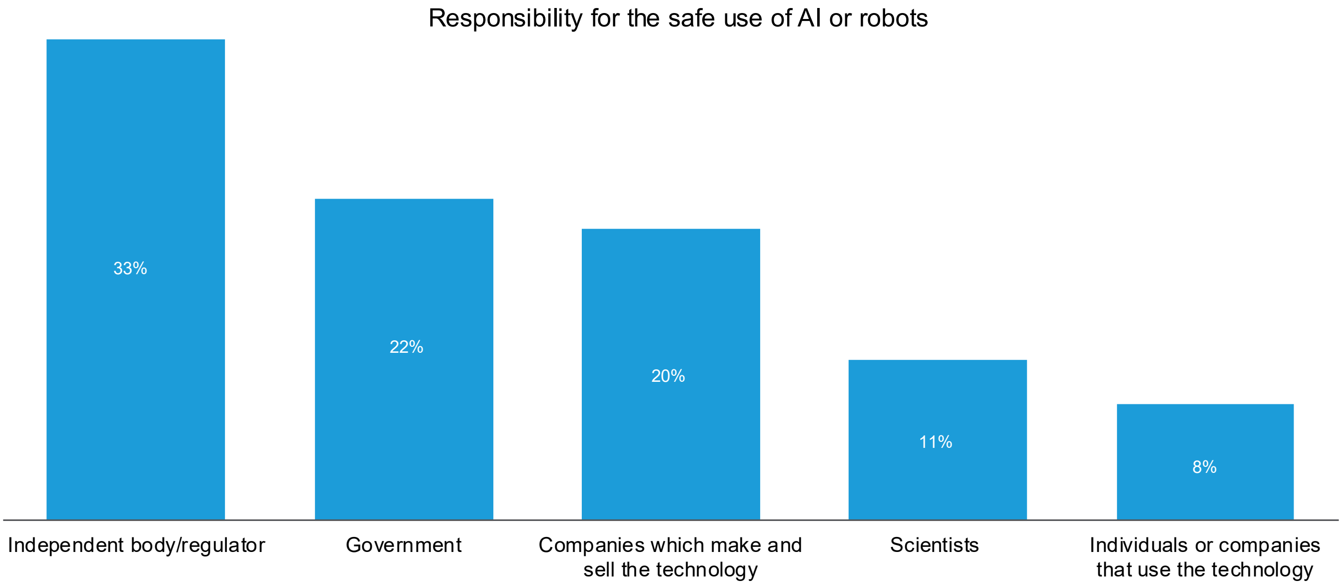
- About half (54%) of 16-34 year-olds trust data protection regulations either 'a lot' or 'a little', this proportion declining through the age groups to 37% of those aged 65+.

- About half (47%) of those educated to degree level have this level of trust, declining to 29% of those with no qualifications.

Who do people feel should regulate AI?

In terms of regulation across the use of robots and AI in general, overall, people favour independent regulation to ensure the safe use of robots and AI. When prompted with a list, a third (33%) favoured an independent regulator, a fifth (22%) wanted government to take on this role, and a further fifth (20%) thought that the technology industries themselves should regulate the sector (Figure 11.9).

Figure 11.9: Who do people feel should be responsible for the safe use of robots and AI?



QB11. Who do you think should be most responsible for ensuring the safe use of robots and artificial intelligence?
Base: All respondents, module B (n=633)

More detailed analysis revealed that:

- Older people aged 65+ were more likely to favour an independent regulator (36% of people aged 65+ compared with 20% of people aged 16-34) while younger people were more likely to prefer that the technology industry takes on this role (29% of those aged 16-34 compared with 18% of those aged 65+).
- Compared with the average (33%), those educated to degree level (50%) and the more affluent ABs (46%) were much more in favour of an independent regulator.

Wave 2: Drivers of levels of acceptability of the use of AI in healthcare

The second digital dialogue (33 participants) and focus groups (30 digitally excluded participants) explored attitudes to the use of AI in healthcare. Acceptance varied according to four key drivers:

Level of understanding of AI
Familiarity with AI covering a given task
Perceived level of control
Recognition of personal benefits

Greater levels of understanding of AI made participants more open to potential benefits. Those with lower levels of understanding tended to perceive AI as futuristic, distant and scary and focused more on the risks of the technology. Understanding grew through exposure to AI in the workplace, higher technological literacy, and interaction with factual information.

> “[AI scheduling] would relieve the stress of trying to book an appointment… like online booking but less stress.”
> *(Focus groups, Male)*

Participants were more open to the benefits of healthcare AI when they were more familiar with applications being used in a similar way outside healthcare. They were then more likely to focus on the benefits rather than the risks, and more likely to be interested in developing AI within that role. Consuming information about AI, and having higher technological literacy meant familiarity was likelier.

Having more control over the AI in a particular function made people more comfortable with the technology, especially if the technology was seen as potentially intrusive. Having a veto over data-sharing was a commonly-mentioned way of affirming control, especially by those affected by past data breaches. Control over whether AI was used was also desired, which may require keeping existing methods as options.

Finally, clear personal benefit (especially towards quality of life), such as using AI to support a more efficient healthcare system or facilitate personal connections, which people did not want lost, was key to people’s comfort around AI.

> “Surely this is a very sensitive area, and needs to be thoroughly thought through with some sort of law? I think every patient should give consent and be informed.”
> *(Digital Dialogue, Female)*

Use of AI in healthcare is seen as more acceptable when the benefits are clear, applications are similar to other widely-known technologies and users are able to control it.

Wave 3: Perceptions and acceptability of use of robotics technology, with a focus on the care sector

The third digital dialogue (31 participants) and focus groups (31 digitally excluded) explored the acceptability of the use of robots in the care sector. Participants with more exposure to robots tended to be more comfortable with them both in general and within the care sector.

There were four common conceptualisations of robots, as shown in the image below.

> “the [ultra-humanoid robot] freaks me out, it’s too life-like!” *(Female, digital dialogue)*

‘Traditional’ and humanoid robots were the types cited by some as posing a threat to ‘take over’ from humans, though younger participants and those with more personal exposure to robots were more critical of that view.

Popular culture was a key source of exposure to all four robot-types for many, especially film and TV (including fictional and factual programmes, and adverts). Personal experience was cited as a key information source for domestic robots, with AI, such as Siri and Alexa, being conflated with robotics.

School was also mentioned as an information source by younger participants.

> “I just think there are so many humans to do the work, why do we need computers and robots that look like humans?” *(Female, digital dialogue)*

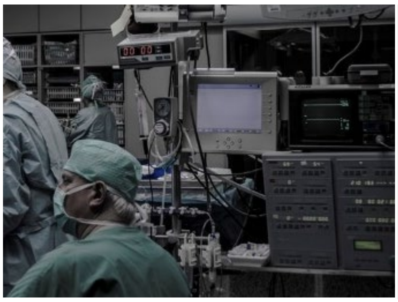
Humanoid robots were seen as uncanny and ‘creepy’ if they replicated humans too closely, particularly for digitally excluded and older participants.

Robots used in the care sector specifically were seen to be more acceptable when they satisfy the following conditions:

A degree of human control is required for it to perform its function
It looks like a gadget or animal rather than a human
Purpose was communicated clearly and transparently.
The consequence of malfunction was less severe for humans.

Prior exposure to robots was a key factor driving comfort with their use.

While acceptance of care robots tended to increase during the dialogue, some concern were expressed. These included potential job losses and the sense that humans played an irreplaceable role in companionship, especially towards the end of life. They did not want this to be lost if robots are used more widely.



An advanced surgical robot was popular among the robots presented. The consequences of malfunction were severe, e.g. during heart surgery, but the robot’s low level of autonomy and clear added value countered this.

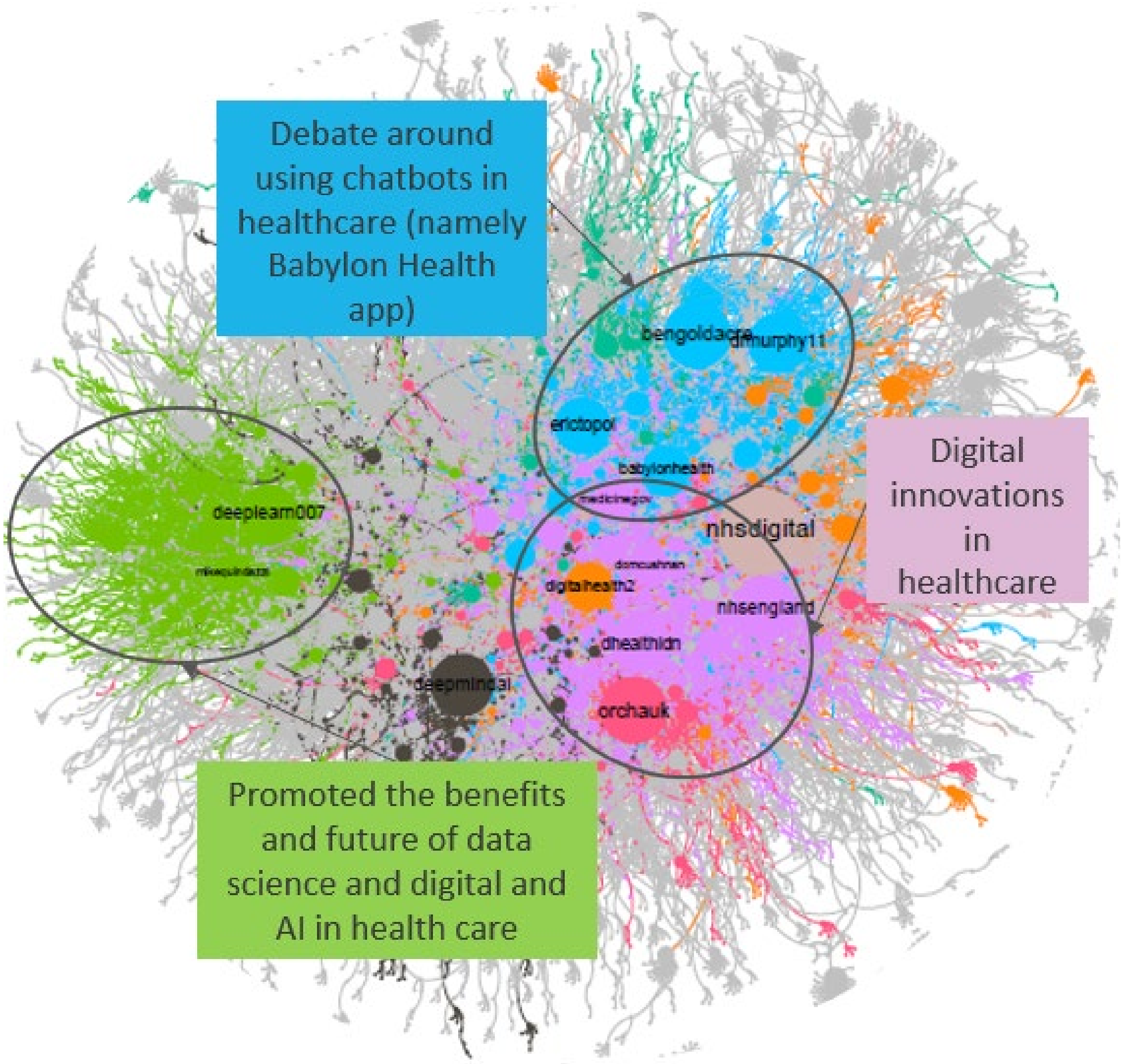
Wave 2 Social Media Analysis: Public attitudes to the use of artificial intelligence in healthcare

The second wave of social media analysis aimed to explore attitudes to the use of artificial intelligence (AI), algorithms and big data in healthcare on social media. The content of the conversational landscape was qualitatively explored to identify key influencers as well as the patterns of interaction across online communities.

Although there has been steady growth in conversation volumes on the topic of AI in healthcare over the last two years, analysis of the conversational landscape found that it is characterised by a series of closed business, academic and professional communities within the healthcare and technology sectors (see Figure 1) that achieve relatively little public engagement.

The three main topics of conversation in this landscape were identified as the use of big data and diagnostic tools; digital solutions for healthcare; and AI for medical diagnosis and healthcare in the digital age. However, these topics were generally too technical and obscure for the wider public to engage with. They were more likely to be interested in the implications of the introduction of AI in healthcare than any other topic, as this was seen as more tangible and relatable to people’s lives.

Figure 1: Social media network map



The online debate that exists around this topic serves as an additional barrier to public engagement as it is divided between communities that interact little with one another. Technology companies with a vested interest and government supported digital programmes have focused on promoting the benefits of AI in healthcare and with less engagement with critique from healthcare professionals in this space. In contrast, those in the healthcare space have challenged the concept, calling for more consultation, transparency and further validation when introducing new AI applications.

Wave 3 Social Media Analysis: Public attitudes to the use of robotics technology in the labour market

The third wave of social media analysis aimed to explore attitudes to the use of robotics technology in the labour market by identifying what was being discussed online, who the influencers and communities were and how people were interacting. The content of the conversational landscape was then qualitatively explored to establish key trends and themes.

One of the themes that emerged was lack of engagement from the public on this topic in the online space. Although the conversation on robots has grown over the last two years, the conversation landscape is nascent and diffuse, with communities very much in the early stages of development.

This has left a void for the online news media to act as a powerful influencer and initiator of conversation and to shape the debate in this space around the risks that robots present to the human workforce.

With less contribution from the science community, the news media may continue to drive conversations around robotic technology in the labour market, acting as an important information source and influencer.

With this in mind, and given the public desire to hear more from academics and scientists on the social implications of new technologies, there is an opportunity for scientists to engage to providing information about this technology and its possible implications.

12. Genome Editing

This chapter explores the UK public's familiarity with, and support for, genome editing and its application in different organisms (humans, animals and plants/crops). Genome editing is the third specific science topic chosen for further exploration in PAS 2019.

Genome editing (also called gene editing in the context of this research) is a group of technologies that give scientists the ability to change an organism's DNA. These technologies allow genetic material to be added, removed, or altered at particular locations in the genome. Several approaches to genome editing have been developed.

Unless otherwise stated, the survey questions covered in this chapter were asked of a randomly selected sub-sample, constituting around a third of the main sample (553 adults). While the findings are still representative of the UK public, margins of error are higher.

Key findings

The public were largely uninformed about genome editing and its applications in different organisms. Despite this, more people supported than opposed most applications of genome editing particularly where there was a clear benefit to human health. However, applications that are cosmetic in nature (e.g. making vegetables more attractive to the consumer) or increase the efficiency of animal food production were not strongly supported.

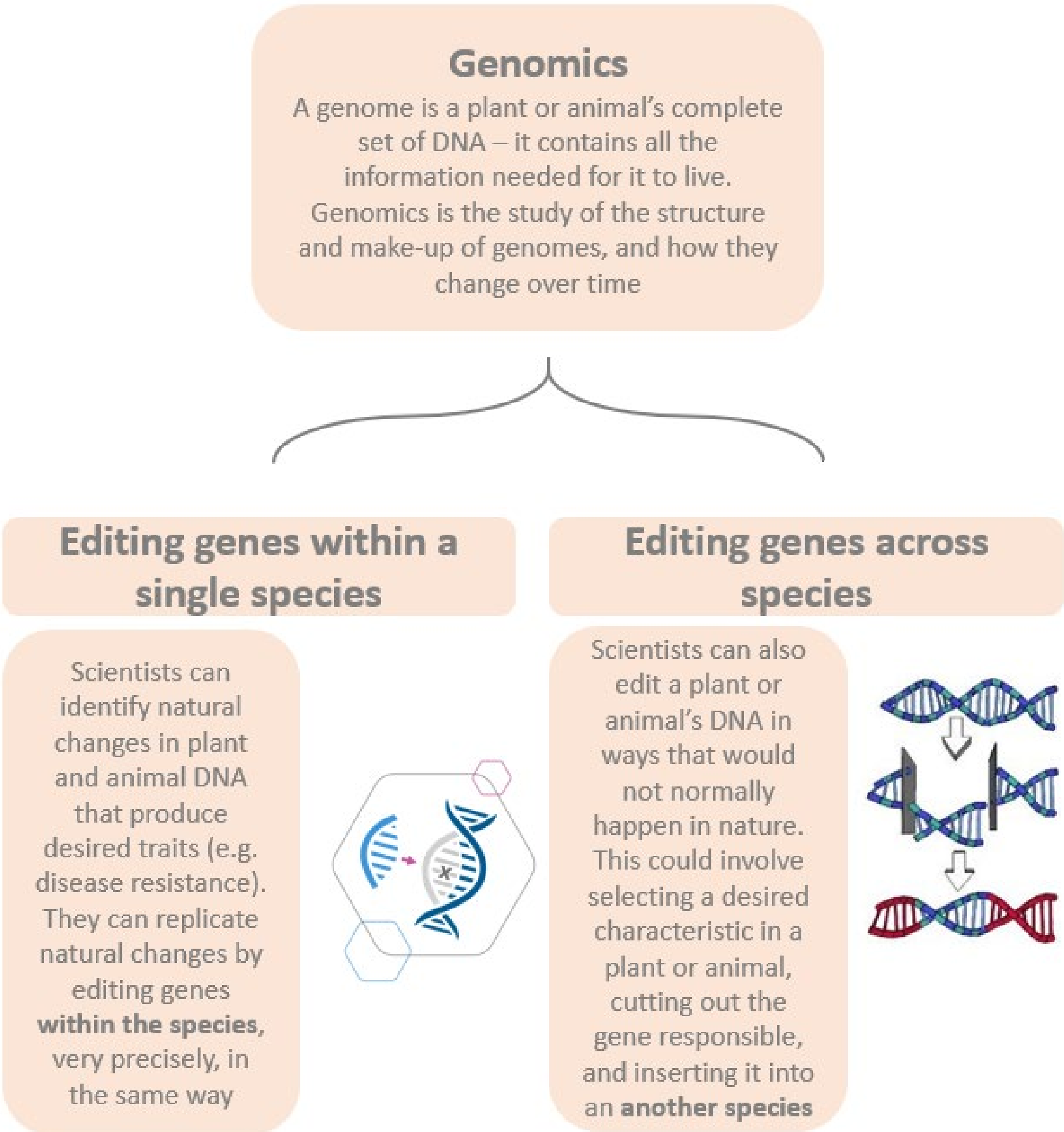
- The majority of the public were largely uninformed about genome editing and its application in humans, animals and plants, although some applications were better known than others.
- The genetic modification of crops was the most well-known application (38% had heard or read a lot or fair amount), while the use of genome editing in mosquitos was the least known (15% had heard or read a lot or a fair amount about this technique).
- Overall more people supported than opposed most applications of genome editing where there is a clear benefit to humans.
- However, making vegetables more attractive to the consumer and increasing the efficiency of animal food production were not widely supported.
- Those who felt more informed about a technique reported higher levels of support, suggesting that public engagement is important. However, a core level of opposition to many of the techniques, including making vegetables more attractive and efficiency of animal food production, seemed to exist irrespective of the level of knowledge.
- Women were generally less informed and less likely to support the different applications of genome editing explored in the survey compared with men.
- Younger people aged 16-34 were more likely than older age groups to support genetically modifying vegetables, except for cosmetic purposes and to support all applications of genome editing in animals for food production.

- Older people aged 65+ were more likely than 16-54 year olds to support using genome editing to correct for a genetic disease so that the correction passes on.

Context

Genomics is a field within biology focussed on the study of the structure, function and mapping of an organism's genes (the genome), including interactions of those genes with each other and with the person's environment. Genome editing is the deliberate alteration of a selected DNA sequence in a living cell. Genome editing techniques can be used to delete sections of DNA or alter how a gene functions: for example, by changing a variant that may give rise to disease to one that functions normally (see Figure 12.1).

Figure 12.1: Definition of Genomics



The potential genetic modification of humans, animals and crops/plants and its ramifications have long been debated. New scientific techniques are constantly being developed, and some have the potential to make a large impact on future research. One technique showing great promise is CRISPR-Cas9, which can be used as a genome-editing tool.[56]

Due to its ease of use and accuracy, the potential applications of CRISPR-Cas9 have become a popular topic of discussion, particularly the idea that it may one day be used to make edits to human reproductive cells or embryos (known as the germ line), so that edited genes can be passed to future generations.

However, public attitudes to genetic technologies, largely informed by tensions around Genetically Modified (GM) plants grown for food, in the UK and Europe have been characterised by high levels of concern about the risks they might pose. Sensationalised media coverage of potential uses of genetic technologies in humans, animals and plants have tended to increase the public's concerns around development of transgenic animals, biosecurity fears and the ethics of altering the design of human beings (for example, the creation of 'designer babies' by engineering certain traits such as eye colour). Negative public opinion may also have been reinforced by the precautionary approach to genetic technology regulation which has been taken by the EU (URSUS, 2018). In the past the UK government and scientific community's response to negative public opinion to genetic technologies has largely been based on a 'deficit' model of public engagement, which attributes public scepticism or hostility to a lack of understanding and assumes that if participants understand more of the underlying science and the opportunities it offers, then negative public opinions will be 'corrected'. However, over the last 20 years or so there has been a shift towards a more 'deliberative' model which involves informing, listening to, and working closely with the public to provide opportunities for everyone to engage with science so that the public can participate in helping decide what research should be developed and commercialised, why, and under what conditions (URSUS, 2018).

As genome editing has been singled out as an innovative biotechnology supported by the UK government[57] it is important to explore public opinion about different applications of genome editing. This is because support for the general principle of genome editing may depend upon exactly what is driving public views, for example if public views are being shaped by the techniques for cosmetic enhancements rather than techniques to treat serious diseases.

As with any scientific advance, it is important that the UK public has sufficient understanding of the (potential) use of these techniques to make informed decisions about how and when they should (and in some cases, should not) be used.[58]

Much of the formal public debate (engagement activities, and attitude surveys) has revolved around human genome editing as opposed to its applications in non-human animals, plants and microbes although there has, of course, been much public debate over the genetic modification of crops for human consumption. However, the topic of genome editing for human health cannot be easily separated from genome editing in other organisms, given that human health will potentially be affected by genome editing in crops and farm animals.

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[56] https://wellcome.ac.uk/news/what-genome-editing-and-how-does-it-work
[57] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/725632/Government_Response_to_the_Genomics_and_Genome_....pdf
[58] https://wellcome.ac.uk/news/what-genome-editing-and-how-does-it-work

In this chapter, as well as exploring general awareness of and attitudes towards genome editing and genetically modified crops, we explore four areas of genome editing/genetic modification.[59]

- **Genome editing for human health.** Scientists are exploring ways to treat diseases caused by a single mutated gene such as cystic fibrosis, Huntington's, and sickle cell disease. The patient's cells in the affected tissues are either edited within the body or edited outside and returned to the patient. In both cases, the correction is not passed on to the patient's offspring. In terms of human applications, the most widely debated research involves so-called germline gene editing. This process alters the genes in sperm, eggs, and early stage embryos to protect a child against inheritable diseases such as diabetes, Alzheimer's, and forms of cancer.
- **Genome editing in animals to prevent human disease.** In medicine, gene editing is being used to engineer mosquitoes, so they no longer spread viruses such as malaria or Zika, and mice so they no longer transmit Lyme disease to ticks, thereby reducing infection rates among humans.
- **Genome editing in animals for food production.** With livestock, genome editing can be used to produce leaner meat, to make livestock more resistant to infection, to remove allergens from eggs and milk, to reduce the use of antibiotics, and to achieve other outcomes that benefit human nutrition and health. While some techniques can also benefit animal welfare there are concerns that others have a potentially harmful impact on animal welfare.
- **Genetic modification of crops.** Because so many biological applications involve the modification of DNA and because genome editing promises to make this easy, genome editing provides opportunities for a wide range of new non-human biotechnologies such as modifying crops to increase yield or drought tolerance.

How well informed are the UK public about genome editing and genetically modified plants?

Although most questions on genome editing were asked of a random third of survey respondents, everyone was asked how well informed they felt about:

- Genome editing
- Genetically modified plants (GM crops)

As the term 'genetically modified' is more widely used when referring to plants and crops the survey explored opinions on both genome editing and genetically modified plants. Opinions on genetically modified plants were also explored in 2014 (see Chapter 8 for the time trend data).

Despite genome editing featuring predominately in life science journals as well as featuring in mainstream news, only 13% of the public felt either 'very' or 'fairly' well informed about the technique. Almost half (48%) of the public said they were not very or not at all informed, while a further 38% had never heard of the technique. This suggests that there is not currently substantial public discussion of the topic.

[59] https://www.americanscientist.org/article/the-gene-editing-conversation

While familiarity with the technique of genetically modified plants (GM crops) was higher, the majority (59%) said that they were not very or not at all informed. However, only 8% said they had never heard of the technique, suggesting the term does have more public recognition than genome editing. Just around a third (32%) said they felt either 'very' or 'fairly' well informed about GM crops; 5% said they felt very well informed while 27% felt fairly well informed. See chapter 2 figure 2.3.

Due to the complexities involved in defining and understanding these terms, survey respondents were not provided with definitions of these techniques. It is therefore difficult to know whether people who feel informed do actually have an understanding about the details of the techniques.

While not directly comparable, the 2012 Wellcome Trust Monitor[60] found that the public were more far more familiar with the term 'GM or genetically modified' than 'human genome'. Only one in ten (10%) adults had never heard of the term genetically modified plants while around half (52%) of adults had never heard of the term human genome.

Focussing on the proportion who felt either 'very' or 'fairly' well informed, more detailed analysis of the data reveals the following

- Men were more likely than women to feel informed about genome editing: 17% of men felt informed compared with 9% of women. Women were more likely to report they had never heard of genome editing (45% compared with 31% of men). The same pattern was seen with GM crops: 36% of men said they felt informed compared with 29% of women.
- People with degree-level qualifications were more likely than those without qualifications to feel informed about both genome editing (22% vs 3%) and GM crops (41% vs 24%).
- People from BAME backgrounds were more likely than those from a white background to say they had never heard of GM crops (17% vs 6%).
- People without a religion were more likely than those with a religion to say they were informed both about genome editing (16% vs 11%) and about GM crops (37% vs 29%).
- People with high science capital were considerably more informed about both GM crops and genome editing. For example, 35% of people classified as having high science capital felt informed about genome editing and 57% about GM crops, compared with 2% and 15% respectively among those with low science capital.

Do the benefits of genome editing and genetically modified plants outweigh the risks?

Given that most people did not feel informed about genome editing or genetically modified plants, their ability to weigh up the benefits and risks of such technology is likely to be limited. Nevertheless, there is value in gauging public opinion to help shape and focus future public engagement and communication activities.

[60] https://wellcome.ac.uk/what-we-do/our-work/public-views-science-and-health

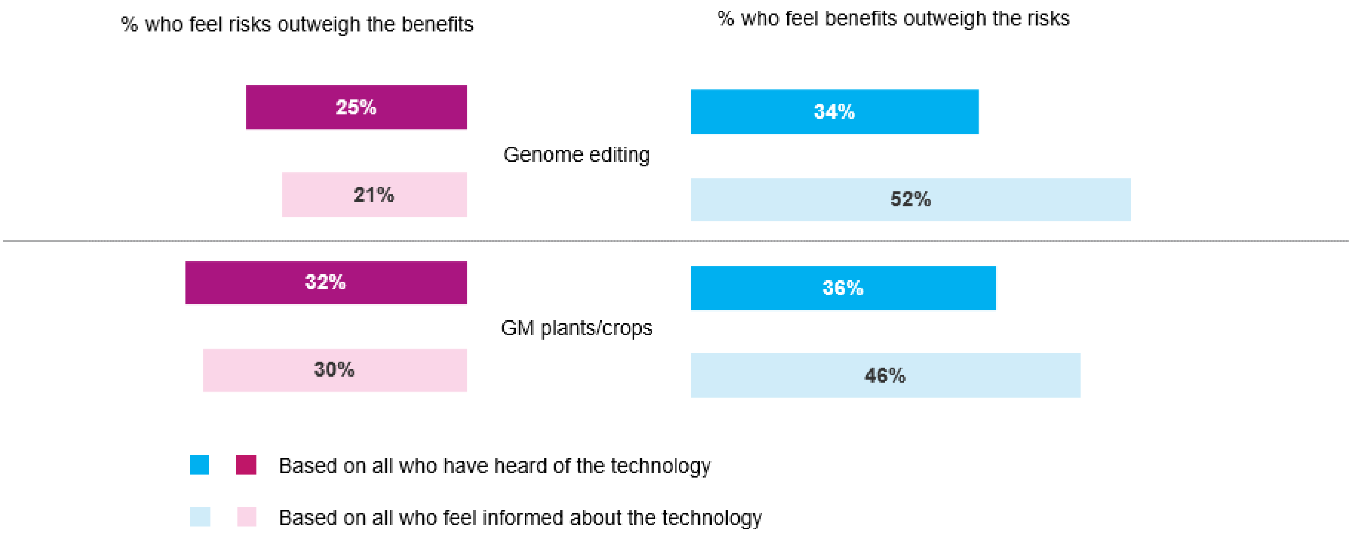
People who felt that they were informed to some extent about genome editing (34%) and genetically modified (GM) plants (73%) were asked their opinion on the balance between benefits and risks.

Figure 12.2 shows the proportion who felt the benefits outweigh the risks, and *vice versa*, based on a) all who had heard of the techniques and b) all who said they were ‘very or ‘fairly’ well informed about them. See chapter 8 for further information.

Public opinion was fairly divided on both issues but on balance slightly more people felt the benefits outweigh the risks than vice versa. People were slightly more positive about genome editing than about GM crops. For genome editing 34% of people who had heard of it felt that the benefits outweigh the risks compared with 25% who felt the opposite was true. For GM crops a similar proportion (36%) felt the benefits outweigh the risks but almost as many (32%) thought the opposite was true. This may be because the public feel more aware of the potential risks of GM crops, given that public attitudes to genetic technologies are largely informed by tensions around GM crops grown for food (URSUS, 2018), while the risks of genome editing are perhaps less well known.

People who felt either ‘very’ or ‘fairly’ well informed about each of genome editing and GM crops were more likely to be in support of them, as measured by the proportion who felt the benefits outweigh the risks. Support for genome editing was higher at 52% among those who felt informed compared with 34% of all of those aware, while the increase in support for GM crops was higher at 46% of those who felt informed compared with 36% of those aware. Those with some knowledge about genome editing also had slightly lower levels of opposition towards it, although the same was not true for GM crops.

Figure 12.2: Perceived benefits versus risks of genome editing and GM crops



Q8. From what you know or have heard about [INSERT ISSUE FROM LIST BELOW], which of these statements, if any, most closely reflects your own opinion?
Base (darker bars): All who have heard of the technology (Genome editing 608, GM crops 1,300)
Base (lighter bars): All who feel informed about the technology (Genome editing 233, GM crops 590)

More detailed analysis of the data reveals the following

- Men were more likely than women to say the benefits of GM crops outweigh the risks (44% vs 26%).
- People with degree-level qualifications were more likely than people educated to below degree level to feel the benefits of GM crops outweigh the risks (40% vs 31%).
- People with high science capital were more likely than those with low science capital to feel that the benefits of GM crops outweigh the risks (48% vs 20%).

Awareness of specific applications of genome editing

The remainder of this chapter explores familiarity with and attitudes towards different applications of genome editing and genetic modification of plants. These questions were asked of around a third of the main sample. When presented to the public these questions referred to gene editing rather than genome editing because the term genome editing was not widely recognised when tested with the public.

Survey respondents were asked to consider how much they had heard or read about four different scenarios, presented in the grey box below, in which genome editing could be used.

Genome editing in humans to treat or eliminate disease

Scientists are currently looking into how we can change someone's DNA to treat or eliminate certain diseases. This is known as gene editing.

Genome editing in non-human animals to prevent human disease

The next few questions are about your views on using gene editing techniques in animals as a way to prevent human disease.

For example, scientists have worked out how to change the genetic code of a mosquito that, if introduced into the wild, could wipe out malaria-carrying mosquitos in some areas.

Genome editing in animals for food production

The next few questions are about your views on using gene editing in animals for food production. For example, editing the genes in cattle so that they grow larger to produce more meat or editing the genes in pigs to make them resistant to diseases.

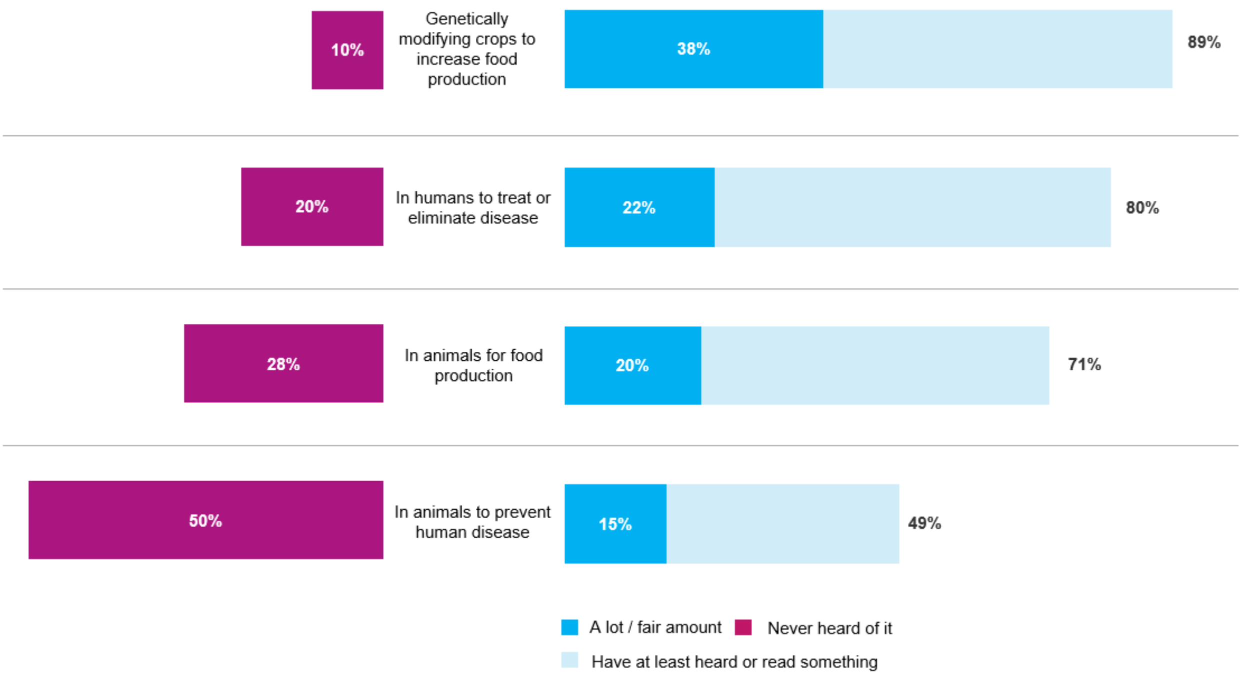
Genetically modifying crops to increase food production

The next few questions are about your views on genetically modifying crops to increase food production. Genetically modified crops refer to plants such as vegetables in which the genetic makeup has been altered.

A majority of the public had at least heard or read something about three of the four different applications of genome editing explored in the survey. Awareness of GM crops was the highest (89% had at least heard of it), while genome editing in animals to prevent human disease had the lowest levels of awareness (49% - see Figure 12.3).

Although most people had heard or read something about these applications, few people reported being informed about them (defined as having heard or read ‘a lot’ or a ‘fair amount’). The application the most people felt informed about was GM crops, which 38% of the public had heard or read ‘a lot’ or ‘a fair amount’ about. Understanding of genome editing in animals to prevent human disease was the application the public felt least informed about with only 15% saying they had heard or read either ‘a lot’ or a ‘fair amount’.

Figure 12.3: Awareness of specific applications of genome editing



Q. Before today, how much had you heard or read about [APPLICATION]?
Base: All respondents, module C (553)

There were differences in awareness by gender, again reflecting the wider gender imbalance in science seen elsewhere in this report.

- Men were more likely than women to feel informed about all four of the different gene editing applications.
- Women were more likely than men to have never heard about gene editing in mosquitos, in animals for food production and for GM plants or crops.

Do people support or oppose different applications of genome editing?

Survey respondents were asked whether they support or oppose a range of different applications of genome editing, presented in the grey box below:

Genome editing in humans to treat or eliminate disease

Using gene editing to correct a genetic condition so that the correction passes on to a person's children**.**

Using gene editing to correct a genetic condition in a way that the correction does not pass on to a person's children.

Genome editing in non-human animals to prevent human disease

The introduction of mosquitos with an edited gene into the wild, even if this results in changes to the local ecosystem.

Genome editing in animals for food production

To increase the efficiency of food production, for example so cattle or salmon grow larger or reach their target weight quicker.

To ensure that animals such as pigs become resistant to disease.

To modify animal products, for example editing the genes in cows to reduce allergic reactions to cow's milk.

Genetically modifying crops to increase food production

To increase the health benefits, for example broccoli with higher anti-oxidant levels.

To increase levels of vegetable production.

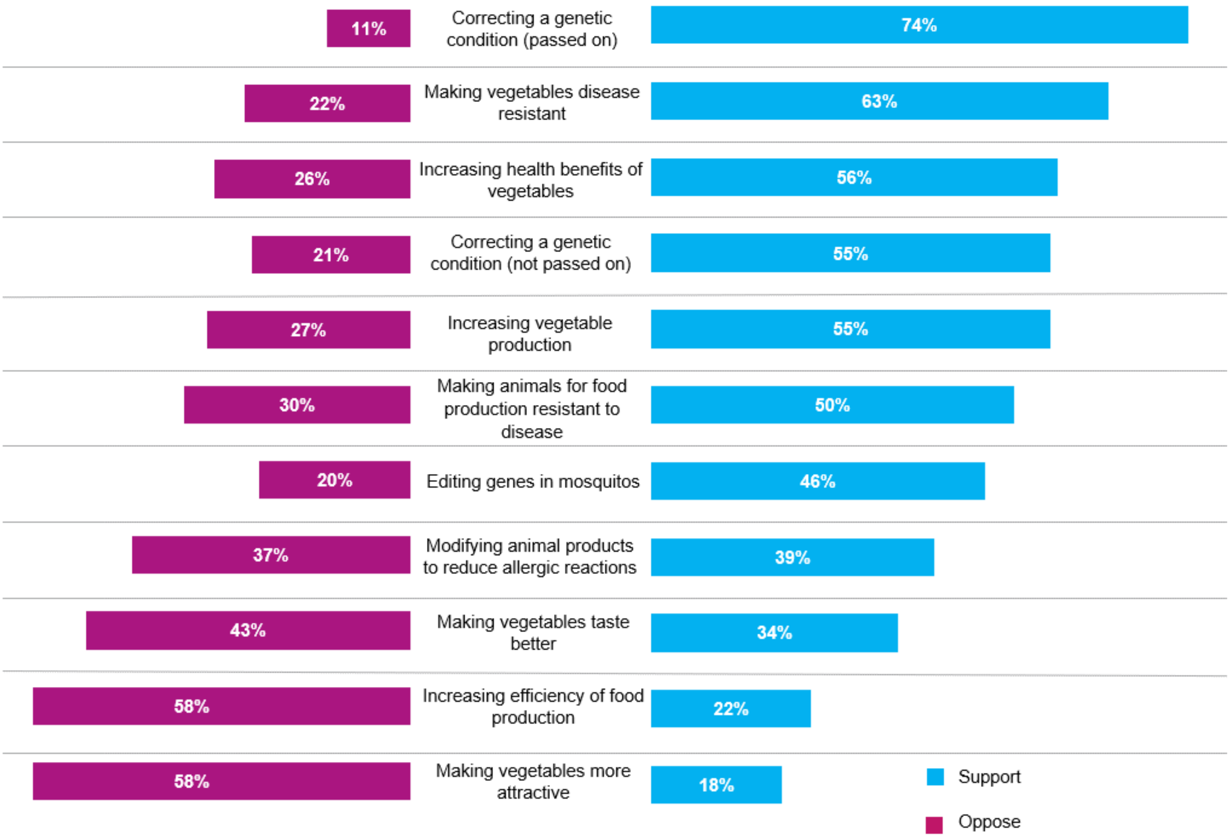
To make vegetables more attractive to the consumer.

To make vegetables taste better.

To make vegetables more disease resistant.

Opinion was sought from all participants, whether or not they had heard of each application, meaning that in many cases responses represented 'top of mind' opinion rather than anything more considered. Levels of support for each application varied considerably as shown in Figure 12.4.

Figure 12.4: Support or opposition towards difference applications of genome editing



Q. To what extent do you support or oppose [APPLICATION]?
Base: All respondents, module C (553)

Applications offering a clear benefit to human health were generally more widely supported compared with those where the health benefit was less clear. The application receiving most support was genome editing to correct a genetic condition that is passed down, which was supported by three-quarters (74%) of the public. Support for this was considerably higher compared with similar techniques where the genetic correction is not passed on, which were supported by 55% of the public.

Applications involving the genomic editing of vegetables to increase or improve food production generally had higher public support than applications involving the genomic editing of animals for the same purpose. For example, 63% of the public supported genetic techniques to make vegetables more disease resistant compared with 50% who supported genetic techniques to make animals more resistant to disease.

Although the level of support varied across different applications public support was significantly higher than opposition for most of the techniques. For example, while less than half of the public supported gene-editing in mosquitos to prevent human disease it was still notable that over twice as many people supported the technique as opposed it (46% support vs 20% oppose).

In contrast, the public were less supportive of techniques which might be considered to have primarily cosmetic benefits rather than health benefits. Around a third (34%) of the public supported the use of gene editing to make vegetables taste better while only around two in ten (18%) supported using gene editing to make vegetables more attractive to the consumer. For both techniques the public was much more likely to oppose than support them, especially making vegetables look more attractive, which was opposed by 58%.

The public were also less supportive of techniques that might be considered to negatively affect animals, as illustrated by the fact that only 22% of the public supported more efficient food production through genetic techniques which make animals grow larger and faster compared with 58% who opposed the technique.

These findings are consistent with other research which has shown that hypothetical scenarios which offer improvements to human health are ranked as more worthwhile than those which offer improvements in food production efficiency or cosmetic enhancements.

For example, the Royal Society (Van Mil et al, 2017) found that genome editing techniques that directly improve human health are viewed as positive developments for society: three quarters (76%) of the public thought that using genome editing to correct a genetic disorder so that the correction would also be inherited is a positive development for society and 72% thought that using genome editing to correct a genetic disorder in a way that would not be inherited was a positive development, while, only 23% of people agreed that genome editing should be used in plants for cosmetic reasons, while 68% disagreed.

While distinct cultural values exist between different cultures in relation to biotechnology (Felt, 2013, Jasanoff, 2005), Pew (2018) found that Americans' views on the appropriateness of changing a baby's genetic characteristics depend in large part on the intended purpose and on whether or not human embryos would be used in testing these techniques. A majority of Americans support the idea of using gene editing with the goal of delivering direct health benefits for babies, but at the same time, a majority considers the use of such techniques to boost a baby's intelligence something that takes technology too far.

As already noted, participants were asked about their support or opposition for different applications irrespective of how informed they felt about a technique or even whether they had heard about it before now. Although not universal across all applications, on balance those who felt informed about a particular genetic technique tended to express higher levels of support for it compared with those who either were not well informed or who had never heard of it before now. However, those who felt well informed about genetically modifying crops to increase food production were less likely than those who had never heard of the technique, to support making vegetables more attractive or tastier.

More detailed analysis of the data reveals the following:

Men were more inclined than women to support most of the applications of gene editing considered in the survey. Specifically, men were more likely than women to support the following uses:

- Correcting a genetic condition so that the correction passes on to a person's children (80% vs 69%).
- Making animals for food production more resistant to disease (58% vs 41%), modifying animal products to reduce allergic reactions (46% vs 32%) and increasing the efficiency of food production (30% vs 14%).
- Genetically modifying vegetables. Men were more likely than women to support all applications relating to genetically modifying vegetables asked about in the survey.

There were also some differences by age, again focusing on support:

- Younger people aged 16-34 were more likely than older age groups (the specific age group varies depending on the application) to support genetically modifying vegetables, except for cosmetic purposes (where there were no significant differences by age) and to support all applications of genome editing in animals for food production.
- Older people aged 65+ were more likely to support using genome editing to correct for a genetic disease so that the correction passes on. Eight in ten (83%) people aged 65 or over supported this use compared with 65% of 35-54 year olds and seven in ten (70%) 16-34 year olds.

There is also evidence to suggest that wider beliefs may affect support. Those who agreed with the statement ‘people shouldn’t tamper with nature’ were less likely than those who disagreed to support most applications of genome editing explored in the survey.

Wave 4: Public attitudes to the use of genome editing and other technological solutions to the issue of food security

The third digital dialogue (33 participants) and focus groups (29 digitally excluded participants) found that people tend to favour the food security solutions they perceive as less complex and more ‘natural’. Dietary changes and using satellite data to maximise crop yields are particularly popular while editing genes across species, and lab grown meat are less popular solutions. There is a sceptical view of editing genes within a species, but it is more widely accepted than growth hormones or editing across species once specific examples were presented.

> “If it was just a case of bad genes being removed […] then that can’t be a bad thing and if it is protecting the supply of crops so that the food supply is enough for everyone then I'm comfortable with it.” *(Female, digital dialogue)*

Five key factors drive the acceptability of genome editing for food production:

Greater understanding of existing farming practices (e.g. selective breeding) helped participants see the outcomes of genome editing as less frightening, and more familiar.

Genome editing involving removing rather than adding characteristics to an organism was seen as less likely to create something unprecedented that could upset the natural order.

> “The idea of foreign DNA not being used is reassuring and I certainly feel more comfortable now with this approach.” *(Male, digital dialogue)*

A similar process is (naturally) possible without human intervention. Those more interested in science and who understood about natural mutations were more likely to voice this.

The subject of the genome editing is biologically further from a human being i.e. plants rather than animals. Some felt an instinctive discomfort about animals’ genomes being edited, but less so plants’.

A tangible and clear example of genome editing is presented. Often this helped participants see that the reality of genome editing is less scary than imagined and reduces their associations with sci-fi examples, such as animals with extra limbs. It also provided clear benefits and costs for people to engage with on a more rational level.

MOST ACCEPTABLE	**Changing our diets**	**Use of satellite data**	**Editing genes within a single species**	
	Benefits: Acknowledged the increased sustainability of a plant-based diet, and welcomed the reduction in cost of living without buying meat	**Benefits:** Welcomed the use of existing technology, and recognised that this would drive efficient practices	**Benefits:** Welcomed the increase in disease resistance and environmental adaptability. Positive that no ‘foreign’ DNA introduced	
	Concerns: Some concerns over diet being dictated, and how possible this would be to achieve at global level	**Concerns:** Minority concerned about this practice promoting continued pesticide use	**Concerns:** Uncertainty over long term impacts, and satisfactory regulation	
	Growth hormones and antibiotics	**Editing genes across species**	**Lab grown meat**	LEAST ACCEPTABLE
	Benefits: Welcomed greater levels of disease resistance in animals	**Benefits:** Recognised that this method would improve yields of crops	**Benefits:** Reduces animal welfare concerns and seen by some as an alternative, sustainable meat production	
	Concerns: Health implications for consumers, and animal welfare issues over increases in muscle mass	**Concerns:** Worried about this leading to a ‘slippery slope’ of the technology being used on humans. Commonly associated with creating ‘alien’ species	**Concerns:** Emotional responses that the concept did not feel ‘natural’	

13. Micro-pollution and plastics

This chapter explores the UK public's familiarity with different causes of micro-pollution, support for a government ban on their use and responsibilities for reducing micro-pollution. It also looks at support for a government ban on common sources of plastic waste.

The survey questions covered in this chapter were asked of around a third of the main sample (553 adults), who were randomly selected. While the findings are still representative of the UK public, margins of error are higher.

Key findings

The public did not have in-depth knowledge about the different causes of micro-pollution explored in the survey, particularly the use of silver particles in sports clothes and socks. However, they were overwhelmingly supportive of a government ban of these causes of micro-pollution. People generally felt the government should have most responsibility in making sure micro-pollution is reduced, which perhaps suggests people are unlikely to take the initiative in doing anything about micro-pollution themselves. Public support for a government ban on plastic waste was also high, particularly for a ban on unrecyclable packaging in supermarkets.

- Most people had at least heard of the use of microbeads in soaps, facial scrubs and toothpaste (76%) and micro-plastics in clothes (67%); the use of silver particles in sports clothes and socks was, in comparison, relatively unknown (43% had at least heard of it).
- However, few people had more in-depth knowledge. Microbeads in soaps, facial scrubs and toothpaste were the most well-known source (40% had heard or read a lot or a fair amount), while silver particles in sports clothing and socks were the least well-known (12% had heard or read a lot or a fair amount).
- Despite the public being poorly informed there was overwhelming support for a government ban on these causes of micro-pollution (between 75% and 81%).
- Public support was also high for a ban on unrecyclable packaging in supermarkets (90%), plastic straws (82%) and cotton buds (81%).
- While everyone can take some responsibility, the public felt the government should have most responsibility for making sure that micro-pollution is reduced.
- In general men and people aged 65+ had more in-depth knowledge (had heard or read a lot or a fair amount).
- Those who felt informed were more likely to support a government ban on sources of micro-pollution and plastic waste (but men were no more likely than women to support a ban).

Context

In the UK it is estimated that we use five million tonnes of plastic every year, nearly half of which is packaging, and demand is rising.[61] Plastic waste often does not decompose and can last centuries in landfill, or else end up as litter in the natural environment, which in turn can pollute soils, rivers and oceans, and harm the creatures that inhabit them.

Scientists have found tiny bits of degraded plastic, along with fibres shed from synthetic fabric, and microbeads from cosmetics throughout the oceans, lakes, soil and even the air.[62] Creatures from plankton to earthworms to humans are eating them, posing a potentially serious health threat to animals and ecosystems. The problem is only expected to expand as plastic production increases exponentially.

As a result, concern about microplastic pollution and its impact on the environment and human health is increasing among scientists, policy makers and the general public.

The upsurge of action on marine plastics has been a success story thanks, in part, to the film 'A Plastic Ocean', described by David Attenborough as one of the most important films of all time, and the BBC series Blue Planet II, the public has become more aware of the damage caused when plastic is dumped in the world's oceans, especially when it breaks down into microplastic particles.

In 2017 the government committed to a 25-year plan that would phase out disposable packaging by 2042. This includes a ban on the distribution and/or sale of plastic straws, plastic - stemmed cotton buds and plastic drink stirrers in England starting from April 2020 (HM Government; A Green Future: Our 25 Year Plan to Improve the Environment.[63])

This chapter explores: public awareness of difference sources of micro-pollution, support for a government ban on difference sources of micro-pollution and plastic waste and views on who should have the most responsibility for reducing micro-pollution.

Awareness of different sources of micro-pollution

Survey respondents were read a brief description of micro-pollution and then asked to consider how much they had heard or read about three different sources of micro-pollution, the description and sources of micro -pollution asked about are presented in the grey box below:

> Micro-pollution refers to plastics and other materials that can break down into tiny pieces and enter the food chain or harm marine life.
>
> Before today, how much have you heard or read about the following as a cause of micro-pollution in the environment?

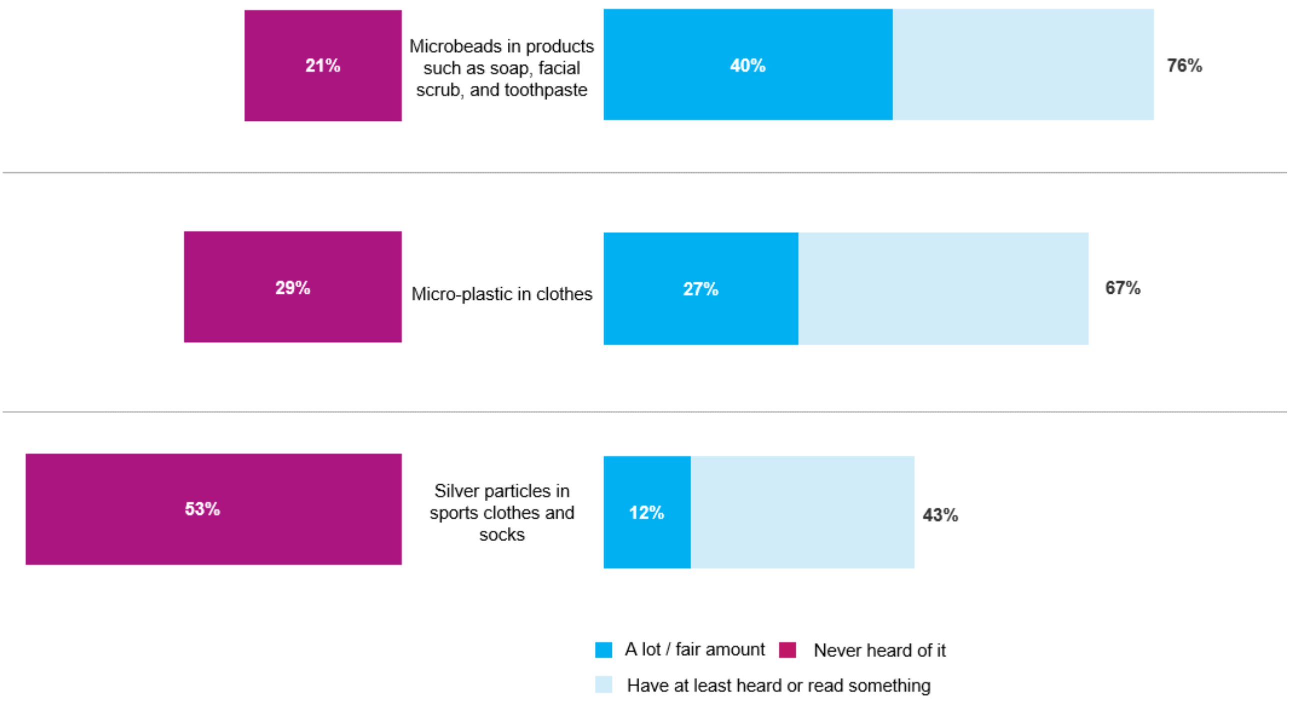
[61] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/765914/resources-waste-strategy-dec-2018.pdf
[62] https://www.scientificamerican.com/article/solving-microplastic-pollution-means-reducing-recycling-mdash-and-fundamental-rethinking1/

[63] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693158/25-year-environment-plan.pdf

1) Silver particles in sports clothing and socks
2) Microbeads in products such as soap, facial scrub, and toothpaste
3) Micro-plastic in clothes

Despite media attention driven by Blue Planet II, people were, on the whole, not well informed about difference sources of micro-pollution (Figure 13.1).

Figure 13.1: Awareness of different sources of micro-pollution



QC10. How much have you heard or read about [SOURCE OF MICRO POLLUTION]?
Base: All respondents, module C (553)

The use of microbeads in products such as soap, facial scrubs and toothpaste was the most well-known form of micro-pollution, with four in ten (40%) having heard or read ‘a lot’ or ‘a fair amount’ about it. This was followed by micro-plastic in clothes (27% having read at least a fair amount). The use of silver in sport clothes and socks as a cause of micro-pollution was the least well known, with only 12% having read at least a fair amount about this.

Indeed, while most people had at least heard of the use of microbeads in soap, facial scrubs and toothpaste (76%) and micro-plastics in clothes (67%), only a minority of the public had heard of silver particles in sports clothes and socks (43% had heard of it). This is likely to reflect the fact that silver nanoparticles have had less publicity than micro-plastics as a source of pollution.

More detailed analysis shows that being informed about difference sources of micro-pollution was highest in the following groups:

- Men - Men were more likely than women to feel informed about the use of micro-plastic in clothes (35% vs 19%).

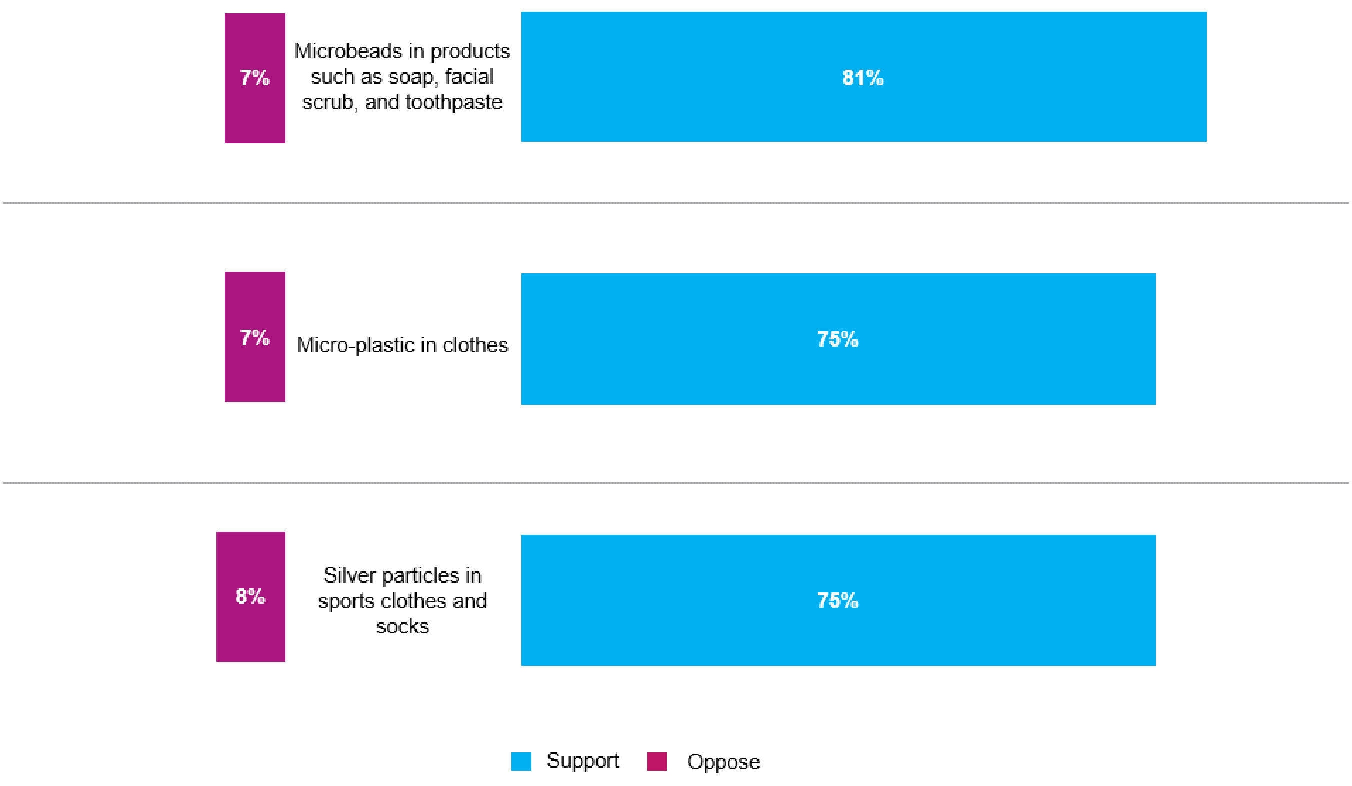
- Older people – people aged 65+ were more likely than younger people aged 16-34 to feel informed about all three sources of micro-pollution.

Support for a government ban on different sources of micro-pollution and plastic waste

As might be expected when it comes to environmental issues that are subject to social desirability bias[64], the public were overwhelmingly in support of a ban on all sources of micro-pollution asked about in the survey, with few opposed to a ban (Figure 13.2).

Three quarters (75%) supported a government ban on the use of silver in sport clothing and socks; the same proportion (75%) supported a government ban on the use of micro-plastic in clothes and a slightly higher proportion (81%) supported a government ban on microbeads in soaps, facial scrubs and toothpaste.

Figure 13.2: Support or opposition for a government ban on different sources of micro-pollution



QC12. To what extent would you support or oppose a government ban on [SOURCE OF MICRO POLLUTION]?
Base: All respondents, module C (553)

Further analysis shows that:

[64] Social desirability bias is a type of response bias that is the tendency of survey respondents to answer questions in a manner that will be viewed favourably by others. It can take the form of over-reporting "good behaviour" or under-reporting "bad," or undesirable behaviour

- Younger people aged 16-34 were less likely than older age groups to support a government ban on all three sources of micro-pollution.
- People who felt informed were more likely than those who had never heard of each source of micro-pollution to support a government ban on microbeads in soap, facial scrubs and toothpaste (92% vs 65%), micro-plastics in clothes (87% vs 59%) and silver in sports clothes and socks (87% vs 72%).

Support for a government ban on plastic waste

Survey respondents were also asked to what extent they support or oppose a government ban on different sources of plastic waste. Again, there was overwhelming support for a ban. Nine in ten (90%) supported a government ban on unrecyclable plastic packaging used in supermarkets, eight in ten (82%) supported a ban on plastic straws and a similar proportion (81%) supported a ban on plastic cotton buds.

This supports findings from a 2018 YouGov survey[65] which found that the public are overwhelmingly supportive of banning 'problem plastics' including plastic straws (77% supported a ban), plastic bags used in supermarkets for fresh produce and pastries (73% support) and plastic cotton buds (70% support). Though not directly comparable to PAS 2019 this does imply that support for banning problem plastics has been increasing over the last year. Indeed, more recent findings from a 2019 YouGov poll conducted in May 2019[66] found that 80% of the public support the restriction on the use of plastic straws and plastic cotton buds that is due to be introduced in England from April 2020.

Interestingly Ipsos MORI (2018)[67] found that while people are generally concerned about plastic waste, few are willing to take action if it costs them money. Less than half (43%) said they would be willing to stop buying goods that have packaging that cannot be recycled, and fewer still were willing to stop visiting supermarkets and shops which use a lot of unrecyclable packaging (18%) or pay extra for goods that only use recyclable packaging (12%). This suggests that while it is easy to support the general principle of reducing plastic waste through government action perceptions may shift if this action affects consumers in a way which they see as negative such as increased prices or changing their shopping habits.

Following a similar pattern to micro-pollution, young people aged 16-34 were generally less likely than older age groups to support a government ban on the three sources of plastic waste explored in the survey.

By way of context, evidence from other recent surveys also found that younger people were less concerned than older people about the effects of unrecyclable plastic on the environment. Across all 17 products asked about in the 2018 YouGov survey younger people were less likely to support a ban than older people, generally this was because they more likely to have answered 'don't know' than because they specifically oppose a ban.[68] 2018 research by Ipsos

[65] https://yougov.co.uk/topics/politics/articles-reports/2018/05/29/yougov-finds-overwhelming-support-banning-problem-
[66] https://yougov.co.uk/opi/surveys/results#/survey/3f10726b-7df6-11e9-a273-edd0466c74c2
[67] https://www.ipsos.com/ipsos-mori/en-uk/public-concern-about-plastic-and-packaging-waste-not-backed-willingness-act
[68] https://yougov.co.uk/topics/politics/articles-reports/2018/05/29/yougov-finds-overwhelming-support-banning-problem-

MORI [69] also found that younger generations are much less concerned than older generations about the effects on the environment of unrecyclable plastic.

Who should have the most responsibility for reducing micro-pollution?

While everyone can take some responsibility to reduce micro-pollution, survey respondents were asked who should have the most responsibility. Half (52%) felt that most responsibility should be taken on by government, and a third (33%) by industry and businesses. A smaller proportion felt the public should have most responsibility by choosing to buy non-polluting products (11%), perhaps suggesting that people are unlikely to take the initiative in doing anything about micro-pollution themselves.

PAS 2019 did not capture public perceptions on who should have the most responsibility for reducing plastic waste. However the 2018 Ipsos MORI research[70] found that most people do not feel that consumers should take most responsibility for finding a way to reduce the amount of unnecessary packaging which is sold: four in ten (40%) believed responsibility should be shared equally among consumers, goods producers, retailers and government (this option was not included in the PAS 2019 survey question about micro-pollution), while 27% put the responsibility on companies producing packaged goods, 13% on the companies that sell them and 11% on government. and just 3% felt that consumers should take most responsibility. However, when prompted many of the public did say that they would be prepared to take some steps towards solving the problem of plastic waste (for example 75% said they would re-use plastic bags and bottles), but far fewer said they would do things to help that would cost them money.

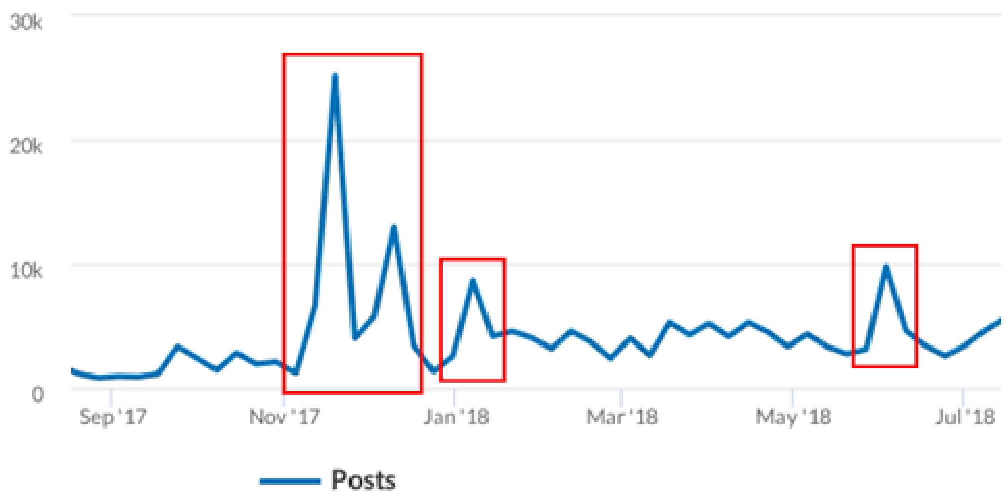
[69] https://www.ipsos.com/ipsos-mori/en-uk/public-concern-about-plastic-and-packaging-waste-not-backed-willingness-act
[70] https://www.ipsos.com/ipsos-mori/en-uk/public-concern-about-plastic-and-packaging-waste-not-backed-willingness-act

Wave 4 Social Media Analysis: Public attitudes to ocean plastic pollution

Social media analysis was conducted at wave 4 to explore the online conversation surrounding ocean plastic pollution. The purpose of the analysis was to uncover the volume of discussion on this topic and to identify the key characteristics of influential users and posts.

The peaks of discussion were event led, driven mainly by the BBC's Blue Planet II and trusted expert, David Attenborough. Following the release of Blue Planet II in November 2017, there was a spike in levels of discussion about ocean plastics, with posts rising from 2000 to 25,000 per week (see Figure 1).

Figure 1: Timeline showing spikes in posts about ocean plastics on social media



Online conversation on this topic was further galvanised by trusted scientific expert, David Attenborough. Although there are numerous celebrities generating conversation about ocean plastics (e.g. lifestyle influencers and sportspeople), Attenborough is more influential and garners deeper public engagement due to a combination of key character traits, being seen as:

Having specialist knowledge
Being passionate and having confliction
Having a point of view and being personally invested
Acting selflessly and not being motivated by profit or power

"Sir David shows the way."

The Blue Planet II series was a national event that helped to raise awareness, advance a cause and engage users by telling an emotional story. Visual material and stories about plastics (for example of a dying whale) were more engaging than posts on reports and statistics; they also increased momentum by motivating users to share their experiences and opinions.

"When Attenborough speaks, we should sit up and take

"I expect his heart breaks after what he's seen in his lifetime."

"Wisdom and heart, compassion and intelligence, what a wonder David Attenborough is."

References

Archer, L., DeWitt, J., Osborne, J., Dillon, J. & Wong, B. (2013). ASPIRES: Young people's science and career aspirations, age 10-14. London: King's College London.https://www.kcl.ac.uk/ecs/research/aspires/aspires-final-report-december-2013.pdf

Bauer, M., Hall, M.HowardS. and B. Franks (2016) Do we like TINA: a growing tolerance of technocracy in Britain?, Science and Democracy Network 15th Annual Meeting, June 23-25, 2016, London.

Bauer, M. (2017) No time for experts? Trust in science after the BREXIT vote of 23 June 2016, in Schiele, B. and LeMarec, J., (eds.) Cultures de Science. Montreal, Canada : Acfas, 2017, pp. 91-99, http://eprints.lse.ac.uk/78047/

BEIS (2019) BEIS Public Attitudes Tracker: March 2019 (Wave 29), London: BEIS. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/800429/BEIS_Public_Attitudes_Tracker_-_Wave_29_-_key_findings.pdf

BIS (2014) Charter for Science and Society, London. https://scienceandsociety.blog.gov.uk/uk-charter-for-society/

Bodmer, W. (1985) The Public Understanding of Science (London: Royal Society).

Bourdieu, P. (1984). Distinction: A social critique of the judgement of taste. Cambridge, MA: Harvard University Press

Brossard, D., & Nisbet, M. C. (2007). Deference to scientific authority among a low information public: Understanding U.S. opinion on agricultural biotechnology. International Journal of Public Opinion Research, 19(1), 24-52

Burchell, K. (2015) Factors affecting public engagement by researchers: literature review. London: Policy Studies Institute. https://wellcome.ac.uk/sites/default/files/wtp060036.pdf

Burchell, K (2019) (2019 PAS literature review)

Curtice, J., Clery, E., Perry, J., Phillips M. and Rahim, N. (eds.) (2019), British Social Attitudes: The 36th Report, London: The National Centre for Social Research

DIUS (2008) A Vision for Science and Society, London: Department for Innovation, Universities and Skills.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/36747/49-08-S_b.pdf

DMA (2018) Data privacy: What the consumer really thinks, London: DMA.
https://dma.org.uk/uploads/misc/5a857c4fdf846-data-privacy---what-the-consumer-really-thinks-final_5a857c4fdf799.pdf

Engdahl, E. and R. Lidskog (2014) Risk, communication and trust: Towards an emotional understanding of trust, Public Understanding of Science, 23(6): 703–717.

European Commission (2013) Special Eurobarometer 401: Responsible Research and Innovation (RRI), Science and Technology.
https://ec.europa.eu/commfrontoffice/publicopinion/archives/ebs/ebs_401_en.pdf

European Commission (2017) Special Eurobarometer 460: Attitudes towards the impact of digitisation and automation on daily life, EU.
https://ec.europa.eu/jrc/communities/sites/jrccties/files/ebs_460_en.pdf
http://ec.europa.eu/commfrontoffice/publicopinion/index.cfm/Survey/getSurveyDetail/instruments/SPECIAL/surveyKy/2160

Felt (2013) Keeping Technologies Out: Sociotechnical imaginaries and the formation of Austrian national technopolitical identity; In: Jasanoff, S and Kim, S (2013) Dreamscapes of Modernity, Chicago pp.103-125

Fenech, M, Elliston, C and Buston, O (2017) The Impact of AI in UK Constituencies: Where will automation hit hardest? London, Future Advocacy. http://futureadvocacy.com/wp-content/uploads/2018/04/FutureAdvocacy-GeographicalAI.pdf

Hamlyn, R, Shanahan, M, Lewis, H, O'Donoghue, E, Hanson, T and Burchell, K (2015) Factors affecting public engagement by researchers, London: Wellcome Trust.
https://wellcome.ac.uk/sites/default/files/wtp060033_0.pdf

Hamlyn, R, Matthews, P and Shanahan, M (2017) Young people's views on science education: Science Education Tracker Research Report February 2017, London: Wellcome Trust.
https://wellcome.ac.uk/sites/default/files/science-education-tracker-report-feb17.pdf

Harris Interactive (2018) Information Rights Strategic Plan: Trust and Confidence, Wilmslow: Information Commissioner's Office. https://ico.org.uk/media/about-the-ico/documents/2259732/annual-track-2018.pdf

IET (2017) Skills and Demand in Industry: 2017 Survey, London: Institute of Engineering and Technology. https://www.theiet.org/media/1350/skills17.pdf

Ipsos Mori (2016) Wellcome Trust Monitor, Wave 3. London: Wellcome Trust
https://wellcome.ac.uk/sites/default/files/monitor-wave3-full-wellcome-apr16.pdf

Ipsos Mori (2017) Public views of Machine Learning: Findings from public research and engagement conducted on behalf of the Royal Society, London: Royal Society.
https://royalsociety.org/-/media/policy/projects/machine-learning/publications/public-views-of-machine-learning-ipsos-mori.pdf

Ipsos Mori (2018) Veracity Index, London: Ipsos Mori.
https://www.ipsos.com/sites/default/files/ct/news/documents/2018-11/veracity_index_2018_v1_161118_public.pdf

Ipsos Mori (2018b) Public attitudes to animal research in 2018, London: BEIS.
https://www.gov.uk/government/publications/attitudes-to-animal-research-in-2018

Jasanoff, S. (2005) Designs on Nature: Science and Democracy in Europe and the United States, Princeton.

Kantar Public (2018) Transport and Technology: Public Attitudes Tracker, Waves 1 and 2 summary report, London: DfT.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/

file/752240/transport-and-transport-technology-public-attitudes-tracker-wave-1-and-2-report.pdf

Macnaghten, P. and J. Chilvers (2014) The future of science governance: publics, policies, practices, Environment and Planning C: Government and Policy, 32: 530 – 548.

Neave, S, Wood, G, May, T, Tortis, M, Kähärä, M, Mellors-Bourne, R, Morgan, R, Desai, M, Halej, J and Talbot, M (2018) The state of engineering. London: Engineering UK https://www.engineeringuk.com/media/156187/state-of-engineering-report-2018.pdf

Newman, N, Fletcher, R, Kalogeropoulos, A, and Nielsen, R (2019) Reuters Institute Digital News Report 2019, Oxford: Reuters Institute https://reutersinstitute.politics.ox.ac.uk/sites/default/files/2019-06/DNR_2019_FINAL_1.pdf

Ofcom (2018) Communications Market Report, London: Ofcom. https://www.ofcom.org.uk/data/assets/pdf_file/0022/117256/CMR-2018-narrative-report.pdf

Pew Research Center (2013) Living to 120 and Beyond: Americans' Views on Aging, Medical Advances and Radical Life Extension, Washington DC: Pew. https://www.pewforum.org/2013/08/06/living-to-120-and-beyond-americans-views-on-aging-medical-advances-and-radical-life-extension/

Pew Research Center (2016) U.S. Public Way of Biomedical Technologies to 'Enhance' Human Abilities, Washington DC: Pew. https://www.pewinternet.org/wp-content/uploads/sites/9/2016/07/PS_2016.07.26_Human-Enhancement-Survey_FINAL.pdf

Pew Research Center (2017) Automation in everyday life, Washington DC: Pew. https://www.pewinternet.org/2017/10/04/americans-attitudes-toward-robot-caregivers/

Pew Research Center (2018) Public Views of Gene Editing for Babies Depend on How It Would Be Used, Washington DC: Pew. https://www.pewresearch.org/science/2018/07/26/public-views-of-gene-editing-for-babies-depend-on-how-it-would-be-used/

Populus (2018) Trust in Charities, 2018: How the public views charities, what this means for the sector, and how trust can be increased, London: Charity Commission for England and Wales. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/723566/Charity_Commission_-_Trust_in_Charities_2018_-_Report.pdf

PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation, London: PwC. https://www.pwc.co.uk/economic-services/assets/international-impact-of-automation-feb-2018.pdf

QEPE (2017) Create The Future report 2017, London: Queen Elizabeth Prize for Engineering. http://qeprize.org/research/

Reuters (2019) Digital News Report 2019, Reuters Institute for the Study of Journalism, Oxford University https://reutersinstitute.politics.ox.ac.uk/sites/default/files/2019-06/DNR_2019_FINAL_0.pdf

RSPH (2019) Moving the Needle: Promoting vaccination uptake across the life course, London: RSPH. https://www.rsph.org.uk/our-work/policy/vaccinations/moving-the-needle-promoting-vaccination-uptake-across-the-life-course.html

Slovic, P. (1997) Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield, Risk Analysis, 19(4): 689-701.

Smallman, M. (2018) Science to the rescue or contingent progress? Comparing 10 years of public, expert and policy discourses on new and emerging science and technology in the United Kingdom, Public Understanding of Science, 27(6): 655–673URSUS (2018) Report to the Royal Society: Evaluation of Genetic Technologies Public Dialogue and Opinion Survey, London: Royal Society. https://royalsociety.org/~/media/policy/projects/gene-tech/genetic-technologies-public-dialogue-ursus-evaluation.pdf

Van Mil, A, Hopkins, H, and Kinsella, S (2017) Potential uses for genetic technologies: dialogue and engagement research conducted on behalf of the Royal Society, London: Royal Society. https://royalsociety.org/~/media/policy/projects/gene-tech/genetic-technologies-public-dialogue-hvm-full-report.pdf

WES (2018) Statistics on Women in Engineering, Stevenage: Women's Engineering Society. https://www.wes.org.uk/sites/default/files/2018-01/Women%20in%20Engineering%20Statistics%20-%20January%202018%20-%20created%20by%20Sarah%20Peers_0.pdf

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