levels of progress.

If researchers in a field are concerned about flaws in individual papers, we can measure their prevalence by analysing a sample of papers. But it is hard to find smoking-gun evidence that scientific communities as a whole are overemphasizing predictive accuracy at the expense of understanding, because it is not possible to access the counterfactual world. That said, historically, there have been many examples of fields getting stuck in a rut even as they excelled at producing individual findings. Among them are alchemy before chemistry, astronomy before the Copernican revolution and geology before plate tectonics.

The story of astronomy is particularly relevant to AI. The model of the Universe with Earth at its centre was extremely accurate at predicting planetary motions, because of tricks such as 'epicycles' — the assumption that planets move in circles whose centres revolve around Earth along a larger circular path. In fact, many modern planetarium projectors use this method to compute trajectories.

Today, AI excels at producing the equivalent of epicycles. All else being equal, being able to squeeze more predictive juice out of flawed theories and inadequate paradigms will help them to stick around for longer, impeding true scientific progress.

The paths forward

We have pointed out two main problems with the use of AI in science: flaws in individual studies and epistemological issues with the broad adoption of AI.

The following are tentative ideas to improve the credibility of machine-learning-based scientific studies and avoid illusions of progress. We offer these as starting points for discussion, rather than proven solutions.

Training, tools and incentives. Machine learning is not a plug-and-play technology for scientists but a set of methods that require deep expertise and continual training. Courses on quantitative methods should train researchers in machine learning alongside statistics, and ensure that common pitfalls and mitigations are studied.

There are tools that authors can use to make it easier to spot or avoid flaws, such as leakage, in their work. For example, we brought together a group of 19 authors from computer science, mathematics, social science and health research, and introduced REFORMS, a set of consensus-based recommendations for machine-learning-based science in the form of a checklist and accompanying set of guidelines[6].

The common task method, which ensures that researchers don't grade their own work when evaluating models — sometimes by using a secret evaluation data set — could help in some cases.

Incentives for better computational-science practices can go a long way. Such changes could involve ensuring the availability of code and data to make verification easier, or deeper ones, such as greater collaboration between domain experts and machine-learning specialists.

Separating production from progress. For addressing the epistemological challenges, deeper changes are necessary. These should be guided by a clear distinction between the production of individual findings and progress in the state of scientific understanding.

As the avalanche of AI-based findings continues, one approach that could help to fill the gap is to expand evidence-synthesis efforts that collate evidence from individual findings. Systematic reviews can aggregate evidence and catch known flaws. There is also an important need for less-systematic, more-critical syntheses that question accepted methods, embrace diverse forms of evidence, confront seemingly incompatible claims and theorize existing findings.

Resetting expectations. Scientific claims from machine-learning-based research should be treated tentatively until they can be rigorously reproduced. Although this applies to all other methods in science, extra caution is warranted in this area.

In AI research, unlike in machine-learning-based science, the models themselves are the topics of study, not the phenomena that underlie the data sets. The goal is prediction, and explanation has usually been a distant secondary goal. By making relatively little contact with the real world, AI research enjoys frictionless reproducibility.

In scientific fields in which explanation is the main goal, we should not expect to be able to mimic the speed and nature of progress in AI, in which researchers can rapidly verify and build on one another's findings. In most scientific fields, AI is unlikely to be the solution to concerns about slowing progress.

Funding quality over quantity. Funding agencies have a lot of power and responsibility to change how AI is adopted in science. Funders should aim for quality over quantity. Specifically, AI-for-science funding programmes should allocate a portion of resources to the activities we recommend here, such as improving training, incentivizing reproducibility efforts and expanding evidence-synthesis initiatives.

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Science's big problem is loss of influence, not trust

Heidi J. Larson & David M. Bersoff

Evidence shows that science and scientists remain highly trusted. But genuine scientific voices are not shouting loud enough over the noise to hold sway.

Science has a trust problem — at least, that is the common perception. If only, the argument goes, we could get people to 'trust' or 'follow' the science, we, as a society, would be doing more about climate change, childhood vaccination rates would be increasing rather than decreasing and fewer people would have died during the COVID-19 pandemic. Characterizing the problem as 'science denialism', however, is misleading and wrongly suggests that the

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People who have high trust in their health-care system are more likely to be fully vaccinated against COVID-19.

solution is to build greater trust between scientists and the public.

Indeed, the research produced by our organizations — the Edelman Trust Institute think tank and the Global Listening Project non-profit organization — suggests that trust in science and scientists remains high globally. But scientists and scientific information exist in an increasingly complex ecosystem in which people's perception of what counts as reliable evidence or proof is influenced by myriad other people and factors, including politics, religion, culture and personal belief. In the face of this complexity, the public are turning to friends, family, journalists and others to help them filter and interpret the vast amounts of information available.

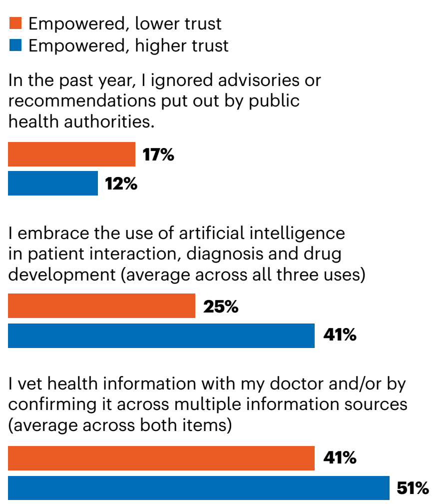
Our work suggests that the crux of science's current challenge is not lost trust, but rather misplaced trust in untrustworthy sources. High trust levels can be dangerous when they are invested in institutions and individuals that are misinformed or not well-intentioned. In this regard, it is especially problematic when societal institutions become politicized and advocate policies and behaviours that are at odds with scientific consensus.

Misplaced trust can drive behaviours that put people's lives at risk[1,2]. For example, during the COVID-19 pandemic, cases and deaths were higher in nations, such as the United States and Brazil, that had political leaders who dismissed the severity or even existence of the pandemic, undermined the need for masks and questioned the safety of the vaccines[2–4].

In what follows, we share data on trust in science and strategies to help scientists compete with non-credentialed sources for influence.

TRUST IN HEALTH

High self-confidence, or empowerment, in medical matters combined with low trust in the health system is problematic.



SOURCE: REF. 9

Unpacking the real challenges

Trust in science is generally high. A survey, conducted in 68 countries between November 2022 and August 2023, found that 75% of respondents said that they trusted scientists[5]. In a separate study across 70 countries, conducted by the Global Listening Project between July and September 2023, 71% of respondents said that they had high trust in science (see go.nature.com/3qyawpb). And the 2024 Edelman Trust Barometer, an annual online survey of 28 countries conducted by the Edelman Trust Institute in November 2023, found that 74% of respondents trust scientists to tell the truth about new innovations and technologies[6].

By contrast, our research revealed concern over the sanctity and independence of science, especially for certain topics, such as COVID-19 and climate change. More than half of Trust

Barometer respondents (53%) said that science had become politicized in their country, and 59% said that governments and other large funding organizations have too much influence on how science is done[6]. One by-product of these perceptions has been an increase in aggression towards scientists[7].

Another damaging consequence of this politicization is that it makes people more open to alternative narratives that might not be evidence-based and are often rooted in political ideologies, on topics such as climate and vaccines. This ideological schism is not defined by a pro-science versus anti-science antipathy but by a 'my science' versus 'your science' or a 'my evidence' versus 'your evidence' polarization.

Often, this tension stems from the fact that scientists seek truth in experiments and data analyses, and focus on effects that manifest across large numbers of people. By contrast, the public is often focused on, and driven by, the experiences of people they know personally or vicariously. These experiences are taken as evidence and often carry more weight than peer-reviewed research.

All sides claim respect for science and evidence, hence the generally high numbers for trust in scientists across ideological groups; but each side has its own version of the 'truth' based on its own evidence and its own interpretation of what actions the evidence dictates[6].

For example, parental concerns about the potential of vaccines to cause autism have been refuted by many scientific studies[8]; nevertheless, a parent's experience with their own child or witnessing what has happened to others can be taken as direct and compelling evidence of a causal rather than a coincidental link between the timing of a measles, mumps and rubella vaccine and the onset of autism. Sometimes a sample of one, when you know that person, is more powerful emotionally, if not statistically, than a sample of 10,000.

Competing narratives around topics such as vaccines or climate change can also breed confusion, which manifests as doubt or misguided beliefs about the best actions to take, for oneself and for wider society. Doubt can weaken people's resolve to support and follow scientific advice, especially when doing so requires effort, risk and sacrifice. Misguided beliefs, meanwhile, can lead people to act against their own or society's best interests.

Another challenge is that many people trust non-scientists to tell them the truth about scientific matters. According to the 2024 Edelman Trust Barometer report, those with most influence include 'someone like me' (74%) and 'friends and family' (78%). Even celebrities (39%) and religious leaders (43%) enjoy substantial amounts of trust on technology and innovation matters[6]. Participants in the Global Listening Project study ranked family members higher than scientists when it came to who they would go to for truthful information in a crisis (see go.nature.com/3qyawpb and 'Local influences').

> **"The scientific community needs to recognize that people focus on information that is emotionally stirring."**

Although these other sources generally lack scientific credentials, they exhibit other characteristics that people associate with legitimacy. In particular, respondents to the 2025 Edelman Trust Barometer survey conducted between October and November last year indicated that relevant personal experience (70%) is more strongly associated with source legitimacy than are formal training and academic credentials (65%; see go.nature.com/4jpparb). Although this might not affect the world of theoretical physics, it does matter in domains such as health and climate.

Legitimacy based on personal experience is something that people extend to themselves. The 2024 Edelman Trust Barometer Special Report: Trust and Health survey[9], which involved 16 countries and was conducted in March last year, found that 65% of people are confident in their own judgement, information acumen and personal efficacy when it comes to health matters (see 'Trust in health'). Of these 'high health self-confidence' individuals, 43% have relatively low trust in the health-care system[9]. High health self-confidence coupled with trust in health-care systems generally drives better health outcomes, but when there is a high level of self-confidence accompanied by low levels of trust, things can be problematic.

This is especially true when it comes to complying with public-health mandates, acceptance of medical-care innovations and being a positive influence on the health decisions of others. In the case of vaccines, those who reported themselves as being self-confident with high trust in the health-care system were more likely to be fully vaccinated (including all boosters) against COVID-19 (54%) than were those who felt equally self-confident but had lower trust (40%)[9].

The threat posed by high levels of trust in non-credentialed sources is exacerbated by where and how people get their scientific information. Most often, it is through online searches, which return a mix of credentialed and non-credentialed information. Because of how people judge credibility, it cannot be assumed that they will discount non-credentialed information in favour of evidence-based, peer-reviewed findings. In fact, those with high self-confidence and little trust in official sources are often drawn to non-credentialed voices and sources[8].

Because the information ecosystem contains misinformation disseminated by sources who lack scientific training but are trusted at similar levels to those who have had training, scientists need to communicate better – with more relevance, emotional resonance and empathy – if they are going to compete with other sources that are increasingly influential.

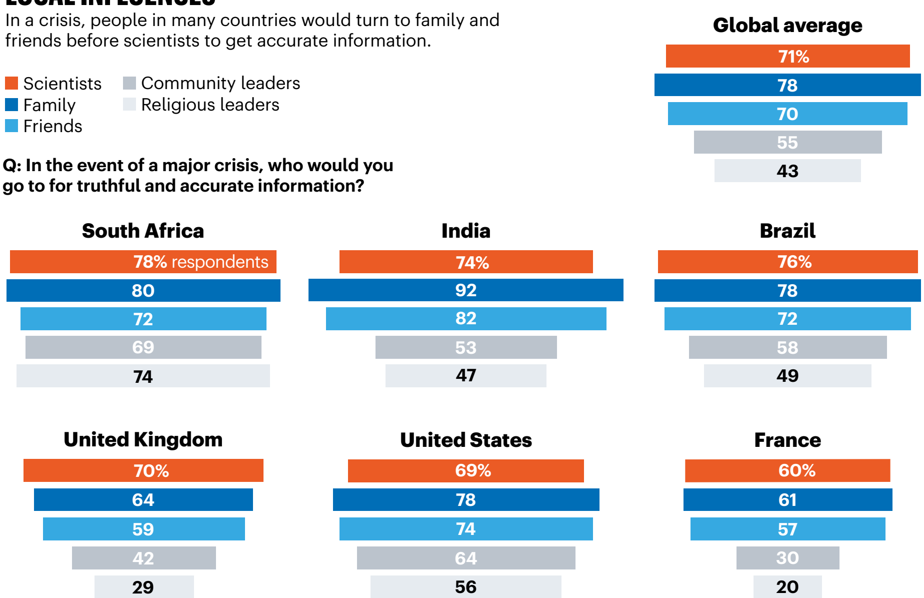
Three strategies to build trust

We recommend three strategies for scientists to enhance the influence of evidence-based, peer-reviewed information.

First, work with locally trusted sources to disseminate information. Beyond their credibility, respected individuals such as physicians and religious leaders are often in the best position to make information relevant to people's lives and their values. Public-health authorities that issue scientific information, as well as academic and research institutions,

LOCAL INFLUENCES

In a crisis, people in many countries would turn to family and friends before scientists to get accurate information.



SOURCE: GLOBAL LISTENING PROJECT

JORGE MANTILLA/NURPHOTO/SHUTTERSTOCK

People in some countries put more trust in community leaders than scientists.

should identify and work with such partners, and provide them with training to become trusted sources of information armed with accurate and compelling arguments to address misconceptions.

For example, people trust family physicians more than they do scientists in some settings, and religious leaders are more influential than scientists in many countries. Employers are another potential partner: 68% of respondents said they trust their employer to do what is right when it comes to addressing their health-related needs and concerns[9]. This trust was higher than for government, media, business and non-governmental organizations.

Second, cultivate greater science and media literacy. Last year, almost one-third (32%) of Trust Barometer respondents said that when scientists or experts change their recommendations, people start to doubt whether those experts really know the correct thing to do. For example, during the COVID-19 pandemic, this lack of understanding regarding how scientific knowledge evolves undermined people's trust in some pandemic-control policies and mandates.

Correcting such misunderstandings about the scientific process means strengthening and broadening the reach of science education and critical-thinking programmes[10]. Such programmes can enhance media literacy more broadly, teaching people how to spot misinformation and fake news. Finland is often cited as having one of the best science-literacy programmes, reaching young people in schools but also older people through community centres and other venues.

Third, make scientific communications more resonant with lay audiences. The scientific community needs to recognize that people are predisposed to focus on information that is visceral and emotionally stirring, rather than abstract and emotionally impoverished, such as a data point on a chart. Such information includes the personal experience of someone they know, either directly or through one-sided relationships with media personalities and celebrities.

Researchers need to bring their data to life – making them more compelling to those they are trying to reach if they hope to compete for attention with influencers who play on people's emotions or with whom a person feels a personal connection. There are many guidelines available, such as the American Society for Cell Biology's Best Practices in Science Communication (see go.nature.com/3tysevs). In January, *Nature Medicine* launched a commission[11] that aims to develop a digital health curriculum for science communicators and a battery of tactics to manage the effect of misinformation.

It is also important that science-based recommendations and mandates are communicated with an understanding of people's everyday lives. One of the top reasons people gave for why they followed medical advice from a friend or family member, or information that they found on social media, instead of following the advice of their health-care provider, was because the recommendation was easier to fit into their lifestyle[9].

If inconvenience cannot be avoided, then scientific representatives must speak with empathy, acknowledging the sacrifices that they are asking people to make, and linking those sacrifices to things people value. For example, scientists should have given greater consideration to the disruptions caused by social distancing and quarantining during the COVID-19 pandemic. Rather than using data or even social responsibility to motivate compliance, a more emotionally compelling approach would have been to talk about keeping loved ones safe from COVID-19 and ultimately getting to the other side of the pandemic and returning to normal as quickly as possible. This was the strategy adopted by a joint initiative between the Vaccine Confidence Project – a resource that was set up to address concerns about vaccinations – and YouTube, which created a series of short videos that attracted more than 20 million viewers (see go.nature.com/4m3qff6).

The scientific community cannot stop the dissemination and amplification of misinformation, but that does not mean it is powerless. It can improve the information ecosystem by making reliable sources easier to find and recognize. By collaborating with trusted local voices and influencers, it can help people to avoid falling prey to misinformation, especially that which is spouted by institutional authorities and government leaders. The community can elevate the perception of science as a non-partisan endeavour not driven by political ideology. And it has the ability to improve the effectiveness of science communications, especially when telling the public things they might not want to hear.

The answer to science's influence problem is not trust building but rather aiding better-placed confidence and communicating the truth in a more compelling way, one that does not assume a lack of competing sources or that everyone is playing by the same rules of evidence.

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