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The effect of seeing scientists as intellectually humble on trust in scientists and their research

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Public trust in scientists is critical to our ability to face societal threats. Here, across five pre-registered studies ($N = 2{,}034$), we assessed whether perceptions of scientists' intellectual humility affect perceived trustworthiness of scientists and their research. In study 1, we found that seeing scientists as higher in intellectual humility was associated with greater perceived trustworthiness of scientists and support for science-based beliefs. We then demonstrated that describing a scientist as high (versus low) in intellectual humility increased perceived trustworthiness of the scientist (studies 2–4), belief in their research (studies 2–4), intentions to follow their research-based recommendations (study 3) and information-seeking behaviour (study 4). We further demonstrated that these effects were not moderated by the scientist's gender (study 3) or race/ethnicity (study 4). In study 5, we experimentally tested communication approaches that scientists can use to convey intellectual humility. These studies reveal the benefits of seeing scientists as intellectually humble across medical, psychological and climate science topics.

Public trust in science and scientists is critically important to scientific endeavours and evidence-based social policy. While trust in science and scientists is generally high[1], in 2021 the percentage of US residents who reported a great deal of confidence in scientists dropped to 29% (a 10% decrease from 2020)[2]. Lower levels of trust are more prevalent for polarizing topics and among certain groups of the population (for example, US conservatives)[3,4], indicating heterogeneity in how people perceive scientists and their recommendations. During the COVID-19 pandemic, for instance, we witnessed the deleterious effects that lower trust can have on people's tendency to follow public health guidelines. People with lower levels of trust in science reported weaker intentions to comply with recommendations to socially distance[5] despite social distancing being identified as one of the most effective practices for stopping the spread of COVID-19 (ref. 6). Moreover, evidence from 12 countries demonstrated that people with lower trust in science are less likely to vaccinate against COVID-19 (ref. 7). Looking beyond the COVID-19 pandemic, lower trust in science decreases belief in threats such as climate change[8] and reduces people's willingness to engage in pro-environmental behaviours[9]. As such, lower trust in science often has personal and societal costs and can even result in the loss of human lives.

Given the costs of lower trust in science and scientists, it is important that we understand its origins. Researchers have identified many separable but overlapping paths that can lead to lower trust in science[10,11]. Certain political and religious beliefs can undermine trust in science[10–15], and people sometimes have lower trust in scientists because they believe scientific findings or values conflict with their own worldviews[16–18]. People may even assume that scientists are not primarily focused on finding objective truths, but instead are biased and politically motivated[19]. Other belief systems and worldviews, including conspiracy beliefs, can also give rise to lower trust in science and advance suspicions that scientists do not have the public's best interests at heart or are lying to the public[20–22].

People may also have lower trust in science because of the shortcomings and uncertainties inherent in the scientific process. Namely, new and socially relevant scientific evidence is often tentative,

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uncertain or conflicting[23]. Scientific research understandably cannot reach complete or unequivocal conclusions because of the complexity of what is being studied, contextual influences or measurement error (among other reasons)[24,25]. Scientists themselves are also limited. Scientists can make mistakes or incorrect predictions[26,27] and can develop methods or theories that perpetuate prejudice and bias[28]. Furthermore, although the scientific process provides a safeguard against confirmation bias, 'researcher degrees of freedom' can lead even the most well-intentioned scientists to conduct different statistical analyses, leading to different results and scientific conclusions[29], ultimately resulting in broader problems such as the replication crisis. Therefore, blind trust in all scientific findings is not ideal and remaining sceptical is an important feature of scientific thinking. Nevertheless, considering science as a trustworthy source of knowledge is fundamental for evidence-based thinking, learning and information evaluation for both scientists and non-scientists[30].

Notwithstanding valid reasons for qualified trust in science and scientists, the aim of the present work is to understand factors that legitimately promote or hinder trust. Prior research makes the distinction between trust as a perception (for example, seeing a scientist as worthy of being trusted) and as a behaviour (for example, following a scientist's recommendations)[31]. In the current study, we were interested in perceived trustworthiness—conceptualized as having the qualities of expertise (that is, seeing the scientist as epistemically competent), benevolence (that is, seeing the scientist as concerned for the wellbeing of others) and integrity (that is, seeing the scientist as honest)[32]—as well as whether this perceived trust spills over into actual behavioural willingness to follow recommendations.

We argue that certain features of scientists might exert powerful influences on how trustworthy they appear to be. Recently, scholars[33,34] have called for scientists to act and communicate with greater intellectual humility (IH)—the awareness that one's knowledge and beliefs might be limited or wrong[35]. While IH is most often defined as an intrapersonal or meta-cognitive trait, other definitions include interpersonal and context-specific manifestations[35,36]. In the current research, we similarly define IH as the intrapersonal awareness of the limitations of one's knowledge, which can in turn have interpersonal and perceivable aspects (for example, respectfulness). IH is distinct from other similar traits, such as general humility, in that it specifically focuses on the limitations of one's knowledge, as opposed to one's general limitations[35,37]. In this way, IH is uniquely relevant to the domain of science relative to general humility, as being aware of the limitations inherent to the scientific enterprise and communicating transparently about them is critical for improving the scientific process[33]. As such, IH may be perceived as the expression of following the norms of science[33]. As scientific norms so closely resemble what it means to be intellectually humble, when scientists fail to behave in ways that reflect IH, it might be especially detrimental and jarring as it goes against both the fundamental norms of science and people's expectations for how a responsible scientist should act. Just because scientists understand that the scientific process entails these features, they may not always behave in ways that reflect IH. We therefore ask: how do people's perceptions of scientists' IH influence their perceived trustworthiness of scientists and willingness to follow research-based recommendations?

To our knowledge, no one has yet examined the impact of perceptions of scientists' IH on perceived trustworthiness of them and their research. Prior work has examined how someone's trait levels of IH predict their trust in science[5,38] and how a scientist's communication of topic complexity can impact someone's trust and levels of IH about a scientific topic[39]. Other work has demonstrated that certain behavioural qualities of scientists that might map onto high IH are associated with positive outcomes. For example, scientists who admit to mistakes and support open science practices are perceived as more trustworthy[40,41], and expressing uncertainty and complexity as part of scientific communication can sometimes foster trust[39,42,43]. While these studies focus on specific methods of conducting or communicating about science, they do not directly assess more global perceptions of scientists' IH. One study on physician humility demonstrated that participants reported greater trust and willingness to adhere to the recommendations of fictitious physicians who were ostensibly described by a prior patient as 'very humble (versus 'not humble') in (their) approach to patient care'[44]. These studies, however, focused on patients' perceptions of physicians' humility towards their patients and did not assess characteristics of IH or perceived trustworthiness of scientists and their research.

We argue that perceptions of scientists' IH may be an especially important predictor of people's perceived trustworthiness of scientists because IH uniquely focuses on admitting the limitations of one's knowledge and beliefs. As science is inherently uncertain and limited, being willing to recognize when one is wrong, rely on others' knowledge or update one's beliefs is critical for the scientific process[33]. We therefore hypothesized that these characteristics of IH render it particularly relevant to the perceived trustworthiness of scientists.

More specifically, we reasoned that perceiving a scientist as having low IH should feed into lower perceived trustworthiness because being unwilling to recognize one's fallibility can decrease the quality of one's research. That is, low IH may impede aspects of the scientific process that make it valuable and rigorous (for example, avoiding confirmation bias, separating one's ego from one's research programme, being willing to update beliefs based on data, recognizing when one has made an error, recognizing limitations of the science, continuously learning and leaning on the knowledge of others). Indeed, people who are lower in IH are less scrutinizing of information that confirms their worldviews[45], are less effective at recognizing gaps in their knowledge[46], are more overconfident in their knowledge[47], are less motivated by learning[48], use less effective learning strategies[49] and are less open to exposing themselves to different perspectives[50]. Although it may be difficult for participants to understand how low IH is related to specific questionable scientific practices, scientists who express an insight into the limits of their own knowledge and their continuous learning and updating of beliefs would be perceived as trustworthy in their general approach to research and science[40].

By contrast, we reasoned that perceiving a scientist as having higher (versus lower) IH should foster perceived trustworthiness because being willing to recognize one's fallibility supports learning-oriented approaches and rigorous scientific practices such as those listed above, leading to perceptions of expertise. Moreover, because people higher (versus lower) in IH are more likely to endorse prosocial values[51] and are perceived as having more prosocial characteristics[52,53], people might believe that scientists with higher IH have the public's best interests at heart, leading to perceptions of benevolence. Finally, IH may also imply that the scientist is less motivated by personal or political agendas because they are more focused on pursuing knowledge, leading to perceptions of integrity. We therefore predicted that people would report greater perceived trustworthiness of scientists—in the form of greater perceived expertise, benevolence and integrity—who they perceive as having high (versus low) IH. Further, we aimed to examine whether, in addition to perceiving scientists as trustworthy, participants would exhibit more behavioural trust—operationalized as seeing the scientist's research findings as trustworthy and being interested in receiving more information about how to follow their research-based recommendations.

Overview

In the current study, we assessed perceptions and outcomes of seeing scientists as intellectually humble in five pre-registered studies ($N = 2{,}034$). In study 1, we examined the correlates of seeing scientists as intellectually humble and found that those who saw scientists as higher in IH indicated higher perceived trustworthiness of scientists and support for science-based beliefs. In study 2, we experimentally

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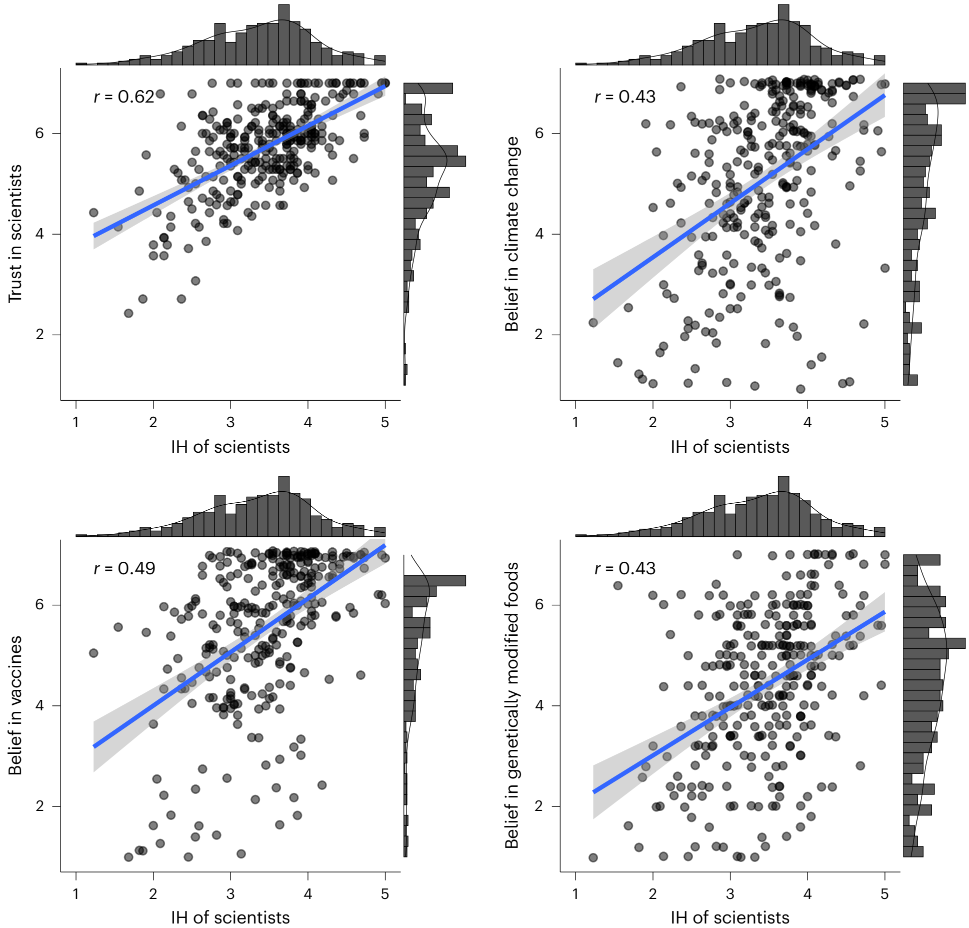

Fig. 1 | The association of perceived IH of scientists and outcomes. Scatter plots showing the association between perceived IH and four outcomes from study 1. The error bands represent the 95% CI. $N = 298$. Correlation tests are two sided.

manipulated the IH of an ostensible scientist, demonstrating that describing a scientist as high (versus low) in IH increases their perceived trustworthiness and trust in their research findings. In studies 3 and 4, we replicated this finding while also testing for moderation by the gender (study 3) and race/ethnicity (study 4) of the scientist, and further demonstrated effects of a scientist's IH on intentions to follow their research-based recommendations (study 3) and information-seeking behaviour aimed at learning more about the scientist's recommendations (study 4). In a final study, we tested tangible communication approaches scientists might use to convey their IH to the public in a census-matched representative experiment. In all studies, we show the benefits of seeing scientists as intellectually humble across a variety of polarized scientific domains including medical science (studies 1 and 2), psychological science (studies 3 and 5) and climate science (studies 1 and 4). For all studies, we also present exploratory Bayes factors for null effects using JASP version 0.18.3 and JASP's default priors[54,55]. Bayesian results did not substantially differ when testing robustness with different priors (see OSF). All descriptive information and plots of posterior distributions are available on OSF.

While not pre-registered, we also explored the influence of perceived IH on each dimension of perceived trustworthiness (that is, expertise, benevolence and integrity), as measured by the Muenster Epistemic Trustworthiness Inventory[32]. Further, while there are many IH scales that conceptualize IH in slightly different ways, in the current work we focus on the conceptualization of IH captured by the Comprehensive Intellectual Humility Scale[36,56]. We chose this scale because it contains subscales that assess both the more intrapersonal dimensions of IH (lack of intellectual overconfidence and independence of intellect and ego) as well as subscales that have some interpersonal components and are therefore more observable (openness to revising one's views and respect for others' views). Prior work shows that this scale shows similar associations with various outcomes as other IH scales that focus on purely meta-cognitive aspects[57,58]. While this scale is not normally used to measure perceptions of someone else's IH, throughout all studies we found that the adapted version of the scale was affected by our manipulations of IH, suggesting that it was picking up on signals of scientists' IH as we had intended it to. We present exploratory analyses using the separate IH subscales here and in the Supplementary Information.

Results

Study 1

Study 1 was a correlational test of the association between seeing scientists as intellectually humble and trustworthy. We asked participants ($N = 298$) to think of a broad range of scientists and rate them on perceived IH[56]. Participants also provided ratings of their perceived trustworthiness of scientists[32] and indicated their belief in polarizing science topics (climate change, vaccinations and genetically modified foods)[21].

Perceived IH of scientists was strongly associated with perceived trustworthiness of scientists ($r_{(296)} = 0.62$, $P < 0.001$) and belief in anthropogenic climate change ($r_{(296)} = 0.43$, $P < 0.001$), support for vaccinations ($r_{(296)} = 0.49$, $P < 0.001$) and support for genetically modified food ($r_{(296)} = 0.43$, $P < 0.001$; Fig. 1), with effect sizes ranging from medium–large to large[59]. While all subscales of IH of scientists were associated with perceived trustworthiness, they varied in magnitude (openness to revising one's views, $r_{(296)} = 0.54$, $P < 0.001$; respect for

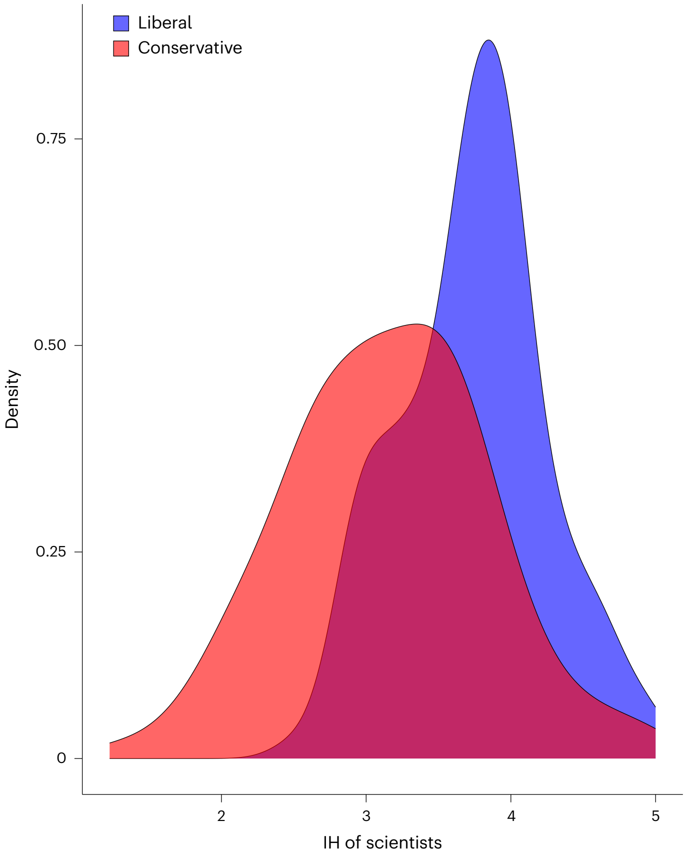

Fig. 2 | Perceived IH of scientists separated by political orientation. Density plot showing the perceived IH of scientists grouped by the political orientations of participants from study 1. $N = 298$.

other's views, $r_{(296)} = 0.62$, $P < 0.001$; lack of intellectual overconfidence, $r_{(296)} = 0.46$, $P < 0.001$; and independence of intellect and ego, $r_{(296)} = 0.43$, $P < 0.001$). Similarly, while IH of scientists was associated with all three dimensions of perceived trustworthiness, they varied in magnitude (integrity, $r_{(296)} = 0.62$, $P < 0.001$; benevolence, $r_{(296)} = 0.57$, $P < 0.001$; and expertise, $r_{(296)} = 0.47$, $P < 0.001$). Importantly, perceived IH of scientists did differ by political orientation with a large effect size, with liberal participants perceiving more IH in scientists (mean (M) = 3.74, s.d. of 0.51) than conservative participants ($M = 3.15$, s.d. of 0.70; $F_{(1, 296)} = 70.24$, $P < 0.001$, partial eta squared (η^2_p) = 0.19, 95% confidence interval (CI) for η^2_p of 0.12–0.27; Fig. 2). However, associations between perceived IH of scientists and perceived trustworthiness, and between perceived IH of scientists and belief in polarizing science topics, were robust to including simultaneous covariates of political orientation, political conviction, interest in science, science knowledge and conspiracy mentality (all $P < 0.021$; Supplementary Table 3). Finally, perceived IH of scientists was still significant when also including cognitive reflection and participants' own level of IH to these models (all $P < 0.001$), with the exception of the belief in climate change model ($P = 0.083$).

Overall, study 1 provided correlational evidence that people who see scientists as intellectually humble also tend to see those scientists as more trustworthy and hold evidence-based scientific beliefs.

Study 2

In study 2, we tested our hypothesis using an experimental design. We randomly assigned participants ($N = 317$) to read one of three articles about an ostensible scientist, Susan Moore, researching new treatments for long COVID-19 symptoms. Participants in the control condition read about Susan Moore's research and findings. Participants in the low-IH condition read this same article but with cues of low IH (for example, "… according to one colleague, 'Dr Moore is not afraid to assert what she knows'"). Finally, participants in the high-IH condition read the same control article but with cues of high IH (for example, "…according to one colleague, 'Dr Moore is not afraid to admit when she doesn't yet know something'", see OSF for manipulations).

We found a large effect of our manipulation on perceived IH of the scientist, $F_{(2, 314)} = 172.84$, $P < 0.001$, $\eta^2_p = 0.52$, 95% CI for η^2_p of 0.45 to 0.58). Using a Tukey test to adjust for multiple comparisons, participants saw the scientist as significantly more intellectually humble in the high-IH condition ($M = 4.19$, s.d. of 0.57), than in either of the other conditions ($M_{\text{control condition}} = 3.61$, s.d.$_{\text{control condition}}$ of 0.51; $M_{\text{low IH condition}} = 2.70$, s.d.$_{\text{low IH condition}}$ of 0.69; all $P < 0.001$). Participants saw the scientist as significantly less intellectually humble in the low-IH condition than in the control condition ($P < 0.001$). The strength of the effect of condition varied by subscale of IH (lack of intellectual overconfidence, $\eta^2_p = 0.57$, 95% CI for η^2_p of 0.51 to 0.63; openness to revising one's views, $\eta^2_p = 0.51$, 95% CI for η^2_p of 0.44 to 0.57; respect for other's views, $\eta^2_p = 0.31$, 95% CI for η^2_p of 0.23 to 0.38; and independence of intellect and ego, $\eta^2_p = 0.25$, 95% CI for η^2_p of 0.17 to 0.33).

We also found a large effect on perceived trustworthiness, $F_{(2, 314)} = 25.50$, $P < 0.001$, $\eta^2_p = 0.14$, 95% CI for η^2_p of 0.07 to 0.21 (Fig. 3). Participants saw the scientist as significantly more trustworthy in the high-IH condition ($M = 6.43$, s.d. of 0.64) than in the low-IH condition ($M = 5.62$, s.d. of 1.10; $P < 0.001$). Participants saw the scientists as significantly less trustworthy in the low-IH condition than in the control condition ($M = 6.17$, s.d. of 0.76; $P < 0.001$). The difference between the high-IH and control conditions did not reach significance ($P = 0.078$), though a Bayes factor analysis indicated some evidence against the null (that group means do not differ, BF_{01} of 0.27). The strength of the effect of condition differed by perceived trustworthiness subscale (integrity, $\eta^2_p = 0.13$, 95% CI for η^2_p of 0.07 to 0.20; benevolence, $\eta^2_p = 0.19$, 95% CI for η^2_p of 0.11 to 0.26; and expertise, $\eta^2_p = 0.06$, 95% CI for η^2_p of 0.02 to 0.12).

Finally, we found a small-to-medium effect on belief in the scientist's research on the new long COVID-19 treatment, $F_{(2, 314)} = 6.56$, $P = 0.002$, $\eta^2_p = 0.04$, 95% CI for η^2_p of 0.01 to 0.09. Participants believed the scientist's research more in the high-IH condition ($M = 4.85$, s.d. of 1.07) than in the low-IH condition ($M = 4.45$, s.d. of 1.14; $P = 0.025$). Participants believed the scientist's research less in the low-IH condition than in the control condition ($M = 5.00$, s.d. of 1.16; $P = 0.002$). The difference between the high-IH and control condition did not reach significance ($P = 0.589$) and the Bayes factor provided evidence in favour of the null hypothesis (BF_{01} of 4.23).

All results remained significant after controlling for participants' baseline belief in vaccines (all $P < 0.002$; Supplementary Tables 16–18).

Study 2 revealed that a description of a scientist as having characteristics reflective of higher IH (versus lower IH) led to greater perceived trustworthiness of the scientist and belief in her scientific research. A description of a scientist with lower IH also led to lower perceived trustworthiness and belief in research than the control scientist, implying that low IH in scientists might be especially detrimental. However, because we described a woman scientist, we were not able to examine whether the effects were in part driven by the scientist's gender. Prior work has argued that the positive outcomes of expressing humility might differ based on social power, such that expressing humility may be less beneficial or even harmful for people of lower social power[60–62]. In particular, others have argued and shown that humility may be harmful if its expression does not adhere to gender norms[60,63]. In addition, there is evidence that people tend to be biased against women in science. For example, faculty rate women candidates for a STEM position as less competent and less hirable than men candidates[64,65]. It is therefore possible that low IH was viewed less positively in this study simply because it was perceived as

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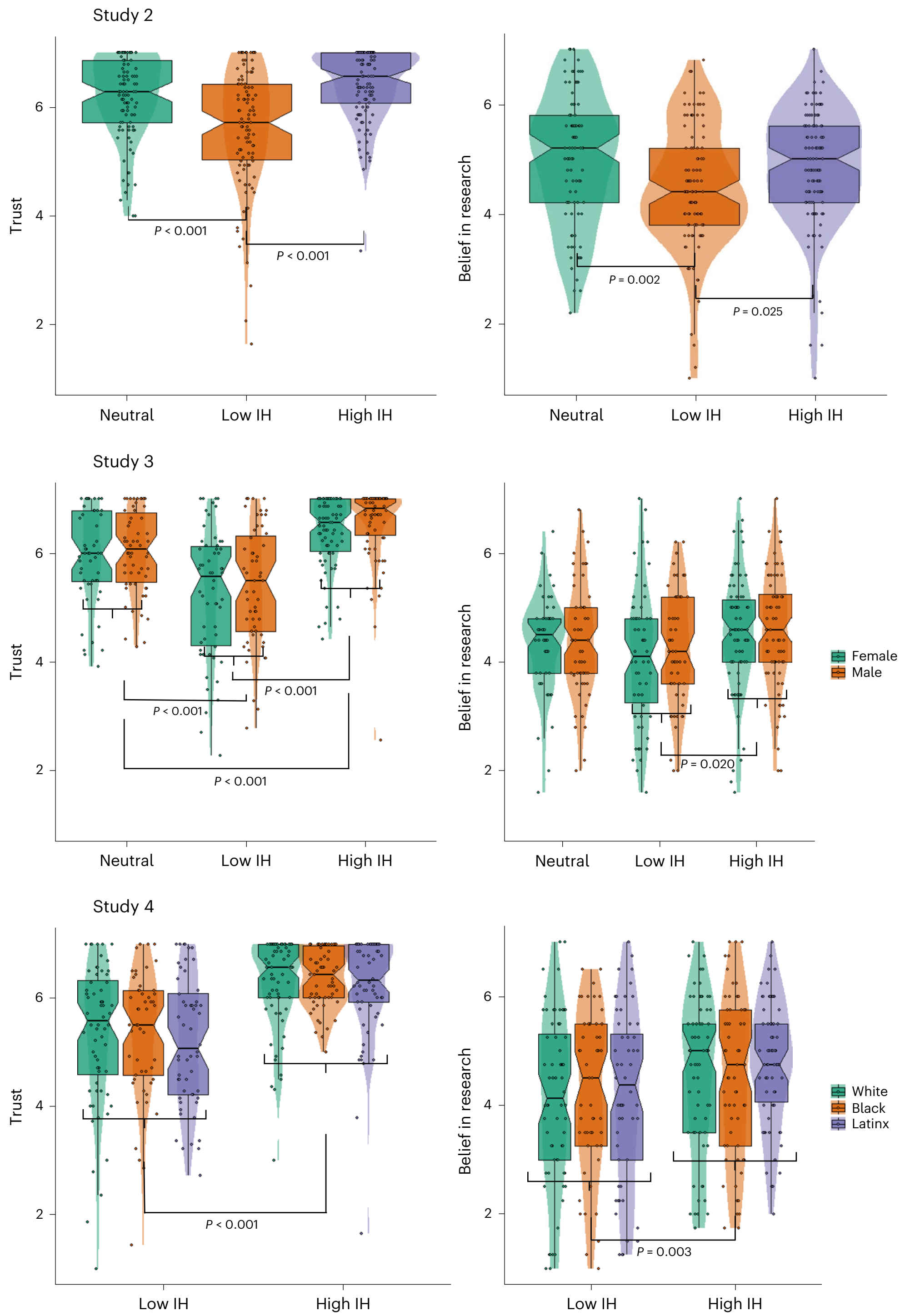

Fig. 3 | Differences in perceived trustworthiness and belief in research for studies 2–4. Violin and box plots showing the effect of IH on differences in trust (left) and belief in research (right) (studies 2–4) and including the effects of the scientist's gender (study 3) and race (study 4). The lines indicates median values, notches indicate 95% CIs around the median, upper and lower hinges indicate 75th and 25th percentiles, respectively, and whiskers indicate 1.5× the interquartile range. All significant differences are labelled. $N_{\text{study 2}} = 317$, $N_{\text{study 3}} = 369$ and $N_{\text{study 4}} = 371$.

counterstereotypical for a woman scientist. We therefore examined the effect of scientist gender in study 3.

Study 3

In study 3, we aimed to test the effect of scientist gender and replicate the results of study 2 in a new scientific context. We randomly assigned participants ($N = 369$) to read an article about an ostensible psychological scientist researching why people should talk across political divides. As in study 2, there was a control condition as well as conditions describing the scientist as high in IH or low in IH. We crossed this with the described gender of the scientist (woman: Sandra Wilson, she/her pronouns; man: Robert Wilson, he/him pronouns).

We found a large effect of IH condition on perceived IH of the scientist, $F_{(2,363)} = 167.11$, $P < 0.001$, $\eta^2_p = 0.48$, 95% CI for η^2_p of 0.41 to 0.54. Using a Tukey test to adjust for multiple comparisons, participants saw the scientist as significantly more intellectually humble in the high-IH condition ($M = 4.30$, s.d. of 0.50), than in either of the other conditions ($M_{\text{control condition}} = 3.81$, s.d.$_{\text{control condition}}$ of 0.55; $M_{\text{low IH condition}} = 2.96$, s.d.$_{\text{low IH condition}}$ of 0.71; all $P < 0.001$). Participants saw the scientist as significantly less intellectually humble in the low-IH condition than in the control condition ($P < 0.001$). There was an absence of evidence for an effect of ($P = 0.129$) or interaction with ($P = 0.548$) the gender of the scientist. The Bayes factor indicated evidence in favour of the null model that only included IH condition (model with gender, BF_{01} of 3.46; model with gender and its interaction, BF_{01} of 38.02). Again, the strength of the effect of condition varied by IH subscale (lack of intellectual overconfidence, $\eta^2_p = 0.53$, 95% CI for η^2_p of 0.46 to 0.58; openness to revising one's views, $\eta^2_p = 0.48$, 95% CI for η^2_p of 0.41 to 0.54; respect for other's views, $\eta^2_p = 0.28$, 95% CI for η^2_p of 0.21 to 0.35; and independence of intellect and ego, $\eta^2_p = 0.16$, 95% CI for η^2_p of 0.09 to 0.22).

We found a large effect of IH condition on perceived trustworthiness, $F_{(2, 363)} = 52.70$, $P < 0.001$, $\eta^2_p = 0.23$, 95% CI for η^2_p of 0.15 to 0.29. Participants saw the scientist as significantly more trustworthy in the high-IH condition ($M = 6.46$, s.d. of 0.69) than in either of the other conditions ($M_{\text{control condition}} = 5.98$, s.d.$_{\text{control condition}}$ of 0.81; $M_{\text{low IH condition}} = 5.33$, s.d.$_{\text{low IH condition}}$ of 1.13; all $P < 0.001$). Participants saw the scientist as significantly less trustworthy in the low-IH condition than in the control condition ($P < 0.001$). There was an absence of evidence for an effect of ($P = 0.165$) or interaction with ($P = 0.957$) the gender of the scientist. The Bayes factor indicated evidence in favour of the null model that only included IH condition (model with gender, BF_{01} of 3.22; model with gender and its interaction, BF_{01} of 57.45). Again, the strength of the effect of condition differed by perceived trustworthiness subscale (integrity, $\eta^2_p = 0.23$, 95% CI for η^2_p of 0.16 to 0.30; benevolence, $\eta^2_p = 0.26$, 95% CI for η^2_p of 0.19 to 0.33; and expertise, $\eta^2_p = 0.14$, 95% CI for η^2_p of 0.08 to 0.20).

We found a small-to-medium effect of IH condition on belief in the scientist's research on the benefits of talking across political divides, $F_{(2, 363)} = 3.63$, $P = 0.028$, $\eta^2_p = 0.02$, 95% CI for η^2_p of 0.00 to 0.05. Participants believed the scientist's research more in the high-IH condition ($M = 4.54$, s.d. of 1.07), than in the low-IH condition ($M = 4.17$, s.d. of 1.16; $P = 0.020$). There was an absence of evidence for the difference between the high-IH and control conditions ($M = 4.36$, s.d. of 0.97; $P = 0.401$). The Bayes factor also indicated some evidence in favour of the null (that group means do not differ; BF_{01} of 3.06). There was also an absence of evidence for the difference between the low-IH and control conditions ($P = 0.392$). The Bayes factor also indicated some evidence in favour of the null (BF_{01} of 3.04). Finally, there was an absence of evidence for an effect of ($P = 0.414$) or interaction with ($P = 0.930$) the gender of the scientist. The Bayes factor indicated evidence in favour of the null model that only included IH condition (model with gender, BF_{01} of 6.59; model with gender and its interaction, BF_{01} of 110.31).

Finally, we found a small–medium effect of IH condition on intention to follow the scientist's research, $F_{(2, 363)} = 5.71$, $P = 0.004$, $\eta^2_p = 0.03$, 95% CI for η^2_p of 0.00 to 0.07. Participants indicated higher intention to follow the scientist's research in the high-IH condition ($M = 5.03$, s.d. of 1.69), than in the low-IH condition ($M = 4.29$, s.d. of 1.96; $P = 0.003$). There was an absence of evidence for a difference between the high-IH and control conditions ($M = 4.50$, s.d. of 1.83; $P = 0.058$), and the Bayes factor indicated weak evidence against the null (that group means do not differ; BF_{01} of 0.50). There was also an absence of evidence for a difference between the low-IH and control conditions ($P = 0.647$). The Bayes factor indicated evidence in favour of the null (BF_{01} of 4.85). There was an absence of evidence for an effect of ($P = 0.701$) or interaction with ($P = 0.642$) the gender of the scientist. The Bayes factor indicated evidence in favour of the null model that only included IH condition (model with gender, BF_{01} of 7.99; model with gender and its interaction, BF_{01} of 101.55).

Study 3 replicated the experimental effects of scientists expressing IH in a different science domain (psychological science) and did not detect a difference by scientist gender. However, in studies 1–3 we did not explicitly assess perceptions of the scientist's race/ethnicity. Prior research has shown that people tend to presume the racial identity of others based on their implicit stereotypes, and often assume that those in leadership positions are white[66]. It is therefore possible that participants in studies 2 and 3 presumed that the presented scientists were white, absent of explicit cues. While it is unknown whether there are differential benefits of perceived IH across racial identities, there is substantial evidence for bias against scientists of colour. For example, faculty rate Black and Latinx candidates as less competent and hirable for STEM positions[64]. It is therefore possible that scientists of colour who exhibit high (versus low) IH might be viewed as less confident in their knowledge or less competent. To ensure that the benefits of perceived IH generalize to scientists of colour, in study 4 we tested whether the effects of IH were affected by the racial identity of the scientist.

Study 4

Study 4 aimed to replicate the results of studies 2 and 3 in a new scientific context, while also experimentally varying the described race/ethnicity of the scientist. We randomly assigned participants ($N = 371$) to read an article about an ostensible climate scientist researching the benefits of a plant-rich diet for reducing global carbon emissions. We again described the scientist as either high or low in IH, dropping the neutral control condition to increase power. We crossed the manipulation of IH with the described race/ethnicity of the scientist using a name manipulation from prior work (white: Claire Miller; Black: Shanice Banks; Latinx: Maria Rodriguez)[64].

We found a large effect of IH condition on perceived IH of the scientist, $F_{(1, 365)} = 468.63$, $P < 0.001$, $\eta^2_p = 0.56$, 95% CI for η^2_p of 0.50 to 0.61. Participants saw the scientist as significantly more intellectually humble in the high-IH condition ($M = 4.08$, s.d. of 0.61), than in the low-IH condition ($M = 2.64$, s.d. of 0.69). There was an absence of evidence for an effect of ($P = 0.594$) or interaction with ($P = 0.223$) the race/ethnicity of the scientist. Further, the Bayes factor indicated strong evidence in favour of the null model that only included IH condition (model with race/ethnicity, BF_{01} of 19.88; model with race/ethnicity and its interaction, BF_{01} of 95.88). Again, the strength of the effect of condition varied by IH subscale (lack of intellectual overconfidence, $\eta^2_p = 0.56$, 95% CI for η^2_p of 0.50 to 0.61; openness to revising one's views, $\eta^2_p = 0.51$, 95% CI for η^2_p of 0.44 to 0.57; respect for other's views, $\eta^2_p = 0.43$, 95% CI for η^2_p of 0.35 to 0.49; and independence of intellect and ego, $\eta^2_p = 0.30$, 95% CI for η^2_p of 0.22 to 0.37).

We found a large effect of IH condition on perceived trustworthiness, $F_{(1, 365)} = 84.14$, $P < 0.001$, $\eta^2_p = 0.19$, 95% CI for η^2_p of 0.12 to 0.26. Participants saw the scientist as significantly more trustworthy in the high-IH condition ($M = 6.28$, s.d. of 0.80), than in the low-IH condition ($M = 5.30$, s.d. of 1.24). There was an absence of evidence for an effect of ($P = 0.539$) or interaction with ($P = 0.928$) the race/ethnicity of the scientist. Further, the Bayes factor indicated strong evidence in favour of the null model that only included IH condition (model with race/ethnicity, BF_{01} of 19.96; model with race/ethnicity and its interaction, BF_{01} of 337.36). Again, the strength of the effect of condition varied by perceived trustworthiness subscale (integrity, $\eta^2_p = 0.20$, 95% CI for η^2_p of 0.13 to 0.27; benevolence, $\eta^2_p = 0.23$, 95% CI for η^2_p of 0.16 to 0.30; and expertise, $\eta^2_p = 0.10$, 95% CI for η^2_p of 0.05 to 0.16).

We found a small–medium effect of IH condition on belief in the scientist's research on the benefits of plant-rich diets, $F_{(1, 365)} = 8.88$, $P = 0.003$, $\eta^2_p = 0.02$, 95% CI for η^2_p of 0.00 to 0.06. Participants believed the scientist's research more in the high-IH condition ($M = 4.62$, s.d. of 1.35), than in the low-IH condition ($M = 4.17$, s.d. of 1.54). There was an absence of evidence for an effect of ($P = 0.670$) or interaction with ($P = 0.722$) the race/ethnicity of the scientist. The Bayes factor indicated evidence in favour of the null model that only included IH condition (model with race/ethnicity, BF_{01} of 23.47; model with race/ethnicity and its interaction, BF_{01} of 316.90).

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Finally, we found a small–medium effect of IH condition on participants' information-seeking behaviour, odds ratio (OR) of 1.46, 95% CI for OR of 1.16 to 1.86; $P = 0.002$, such that a higher percentage of people chose to receive information about switching to a plant-rich diet in the high-IH condition (36%) than in the low condition (21%). There was an absence of evidence for an effect of or interaction with the race/ethnicity of the scientist (all $P > 0.312$).

Study 4 provided additional evidence of the benefits of expressed IH in a different (and politically polarized) science domain (climate science) and also across scientist races/ethnicities.

Study 5

Studies 1–4 showed that seeing a scientist as more intellectually humble increases perceived trustworthiness of them and their findings compared with seeing them as less intellectually humble. These results raise an important question: how can scientists most effectively express their IH? To answer this question, we first reached out to experts in the field of IH to identify ways that scientists can communicate with IH to the public. We organized the most commonly reported communication approaches into three categories: personal IH (for example, updating beliefs and willingness to share credit with others), limits of methods (for example, describing specific methodological limitations and methodological constraints of the current research) and limits of results (for example, describing the nuances and weaknesses in the results of the current research or describing limits to the generalizability of the findings). In study 5, we randomly assigned participants from a census-matched sample ($N = 679$), to read one of four (three IH communication conditions and one neutral control) interviews with a scientist discussing the psychological benefits of taking a break from social media[67]. Critically, this was a subtle manipulation of communicating IH (versus a neutral control) about a non-polarizing topic.

We found a small-to-medium effect on perceived IH of the scientist, $F_{(3,675)} = 8.93$, $P < 0.001$, $\eta^2_p = 0.04$, 95% CI for η^2_p of 0.01 to 0.07 (Fig. 4). Using a Tukey test, participants saw the scientist as more intellectually humble in the personal IH condition ($M = 3.97$, s.d. of 0.47) and the limitations of results condition ($M = 3.93$, s.d. of 0.50) than the control condition ($M = 3.70$, s.d. of 0.53; all $P < 0.001$). Perceived IH was also significantly higher in the personal IH condition than the limitations of methods condition ($M = 3.82$, s.d. of 0.55; $P = 0.033$). There was an absence of evidence for a difference between the limitations of methods condition and the control ($P = 0.173$). The Bayes factor indicated that the data were insensitive to detect this difference (BF_{01} of 1.38). The effect of condition was very similar across all subscales ($\eta^2_p = 0.02$–0.03).

Counter to our expectations, there was no effect of condition on perceived trustworthiness, $F_{(3,675)} = 2.59$, $P = 0.052$, $\eta^2_p = 0.01$, 95% CI for η^2_p of 0.00 to 0.03. The Bayes factor also indicated evidence in support for the null hypothesis (BF_{01} of 5.45). This may be due to a ceiling effect, with all conditions having a mean of over six on a seven-point scale ($M_{control} = 6.05$, $s.d._{control}$ of 0.83; $M_{limits\ of\ methods} = 6.15$, $s.d._{limits\ of\ methods}$ of 0.79; $M_{limits\ of\ results} = 6.28$, $s.d._{limits\ of\ results}$ of 0.65; $M_{personal\ IH} = 6.17$, $s.d._{personal\ IH}$ of 0.77). Interestingly, the effect of condition was significant when looking at the individual subscales of integrity, $F_{(3,675)} = 2.81$, $P = 0.039$, $\eta^2_p = 0.01$, 95% CI for η^2_p of 0.00 to 0.03, and benevolence, $F_{(3,675)} = 3.27$, $P = 0.021$, $\eta^2_p = 0.01$, 95% CI for η^2_p of 0.00 to 0.03, but not expertise, $F_{(3,675)} = 1.30$, $P = 0.274$, $\eta^2_p = 0.01$, 95% CI for η^2_p of 0.00 to 0.02. In a secondary mediation analysis, we found a significant indirect effect on perceived trustworthiness from both limits of results ($b = 0.18$, s.e.m. of 0.05, 95% CI for b of 0.09 to 0.28) and personal IH ($b = 0.22$, s.e.m. of 0.05, 95% CI for b of 0.13–0.31) conditions through perceived IH using 10,000 bootstrapped samples (compared with the control). There was no indirect effect from the limits of methods condition ($b = 0.09$, s.e.m. of 0.05, 95% CI for b of −0.00 to 0.19); Supplementary Fig. 9).

We found a small-to-medium effect of IH condition on belief in the scientist's research on taking a break from social media, $F_{(3,675)} = 9.26$, $P < 0.001$, $\eta^2_p = 0.04$, 95% CI for η^2_p of 0.01 to 0.07. Using a Tukey test, participants believed the research more in the personal IH condition ($M = 5.32$, s.d. of 0.97) than in the limits of results condition ($M = 4.89$, s.d. of 1.07; $P < 0.001$) and the limits of methods condition ($M = 5.02$, s.d. of 1.08; $P = 0.033$). Participants believed the research more in the control condition ($M = 5.39$, s.d. of 0.97) than in the limits of results condition ($P < 0.001$) and the limits of methods condition ($P = 0.005$).

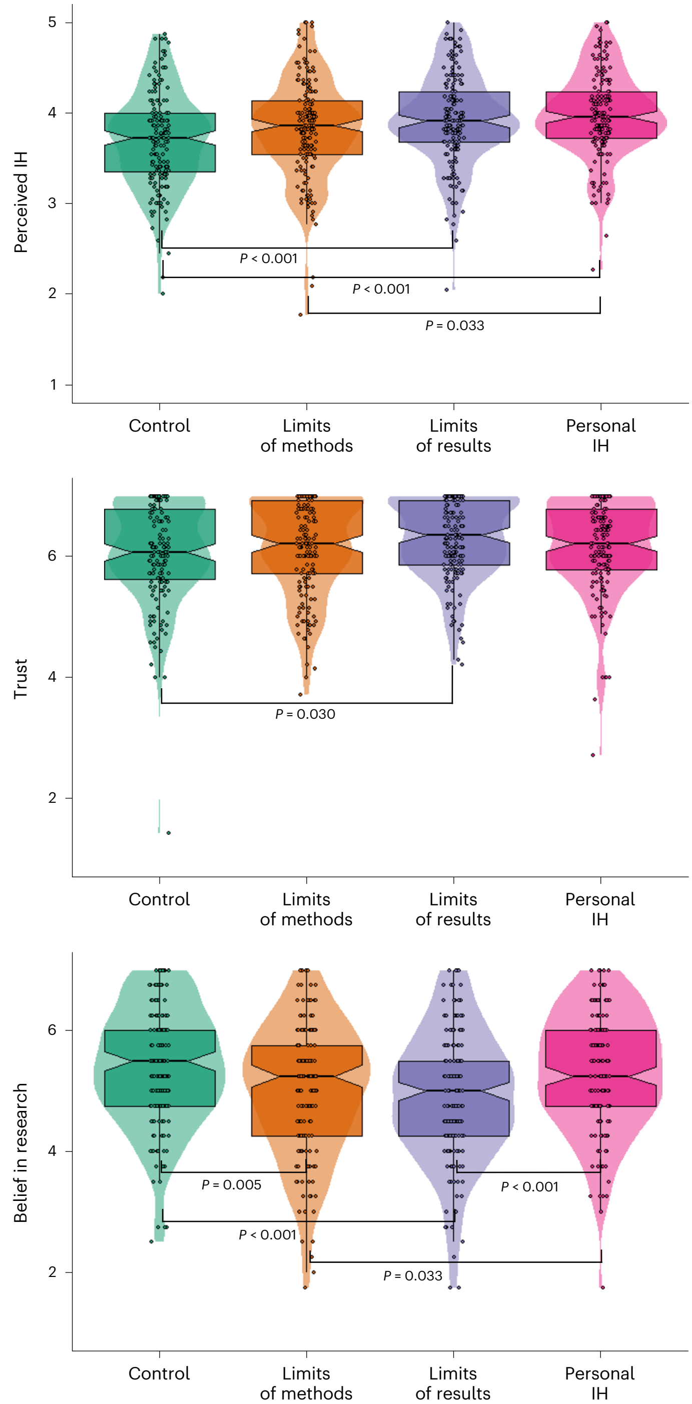

Fig. 4 | Differences in perceived IH, trust and belief in research by condition. Violin and box plots showing the effect of IH communication approaches on perceived IH (top), trust (middle) and belief in research (bottom) from study 5. The lines indicate the median value, notches indicate 95% CIs around the median, upper and lower hinges indicate 75th and 25th percentiles, respectively, and whiskers indicate 1.5× the interquartile range. All significant contrasts are labelled. $N = 679$.

The personal IH condition and the control condition did not differ ($P = 0.927$). For the latter contrast, the Bayes factor also indicated support for the null hypothesis (BF_{01} of 6.69). We ran the same mediation model on belief in the scientists' research and found significant indirect effects from both limits of results ($b = 0.10$, s.e.m. of 0.03, 95% CI for b of 0.05 to 0.17) and personal IH ($b = 0.13$, s.e.m. of 0.03, 95% CI for b of 0.07 to 0.20) conditions (compared with the control) through perceived IH. There was no indirect effect from the limits of methods condition ($b = 0.05$, s.e.m. of 0.03, 95% CI for b of −0.00 to 0.11).

Finally, we found non-significant effects on participants' information-seeking behaviour relative to the control (personal IH condition, OR of 0.65, 95% CI for b of 0.40 to 1.04; $P = 0.073$; limitations of methods condition, OR of 0.67, 95% CI for b of 0.42 to 1.07; $P = 0.093$; and limitations of results condition, OR of 0.82, 95% CI for b of 0.52 to 1.28; $P = 0.383$).

Study 5 provided mixed evidence for the effectiveness of the expert-recommended approaches to communicating IH. We found that two of the three approaches effectively increased perceptions of IH of the ostensible scientist (personal IH and limitations of results). Further, perceptions of IH significantly predicted perceived trustworthiness as in prior studies ($r_{(677)} = 0.56$, $P < 0.001$). However, only personal IH successfully increased perceptions of IH without backfiring, and even this approach had only indirect effects on perceived trustworthiness and belief in the scientist's research.

Discussion

In the current research, we aimed to test the effects of seeing scientists as intellectually humble on trust in scientists and intentions to follow scientific evidence. In line with our predictions and prior theorizing[33], we found that perceiving scientists as high in IH is reliably associated with perceiving them as trustworthy and believing their research (study 1). We also tested this experimentally and found that describing a scientist as high (versus low) in IH increases perceptions of their trustworthiness and belief in their research (studies 2–4). Critically, this effect was consistent across scientists with different gender (study 2) and racial/ethnic (study 3) identities. We also found that perceptions of IH contribute to more perceived trustworthiness in scientists across different topics including medical, climate and psychological science. Finally, we found that perceptions of IH contribute to intentions to follow the scientist's research-based recommendations and information-seeking behaviour aimed at learning more about the scientist's recommendations. Together, these four studies offer compelling evidence that perceptions of scientists' IH play an important role in both trust in scientists and willingness to follow their research-based recommendations.

In study 5, we tested three communication approaches to increase perceptions of IH and perceived trustworthiness. Of the approaches tested, personal IH was the most successful. This is perhaps unsurprising as people might pay closest attention to expressions that reflect a scientist's personal character (rather than limitations of the research) when making judgements of their trustworthiness. However, even this approach was limited in its direct benefits on perceived trustworthiness and intentions to follow scientific evidence, perhaps due in part to its subtlety and its comparison to a neutral (rather than low IH) control. Future work is needed to provide a deeper understanding of how scientists can authentically express IH when communicating about their science with the public and whether such communication enhances perceived trustworthiness.

We would be remiss to not acknowledge that two of the IH communication approaches backfired in the domain of believing a scientist's research. This finding raises the question of how perceived trustworthiness in the scientist as a person might differ from trust in the scientist's results. It is possible that conveying limitations about a particular study might signal that the scientist is more honest and intellectually humble but might simultaneously reduce trust in the research or recommendations that follow from it[68]. This is perhaps why prior research has found mixed effects of expressing limitations of research[40,42,43,69]. Future research should therefore seek to understand other ways to convey IH, while paying close attention to potential backfire effects. If certain expressions of IH are found to be helpful in increasing trust without decreasing belief in the science, it may be important to consider how to enhance the culture of intellectually humble communication within scientific institutions as well as between scientists and the public.

This research was characterized by several strengths distinguishing it from other studies in this domain (for example, use of experimental design, crowdsourcing of IH researchers and behavioural information-seeking measures) and it is, to our knowledge, the first set of studies to examine how participants perceive IH in scientists. Nevertheless, this research is also characterized by several important limitations. First, all studies used convenience samples collected from online pools. While this does make them more diverse than typical university pools[70], it also limits their generalizability (for example, all participants chose to opt in to academic research websites and therefore may have more positive attitudes towards science). Similarly, while we collected a census-matched sample in study 5, the samples for studies 1–4 were notably less diverse in terms of race/ethnicity. Second, this research did not test whether there are specific underlying mechanisms for why perceptions of IH increase perceived trustworthiness. It will be fruitful to identify what precisely it is about IH that leads to more trust and whether these effects are unique to IH as opposed to other correlated traits/processes (for example, prosociality and agreeableness; Supplementary Figs. 3, 5 and 8). Future research should also directly test whether perceived IH combats common drivers of lower perceived trustworthiness, such as conspiracy beliefs[17,21] or perceptions of ideological motives[19]. It would also be advantageous to examine whether seeing a scientist model IH boosts the perceiver's IH, thereby motivating people to seek out accurate scientific knowledge themselves. Third, while we chose scientific disciplines that vary in their methods and topics of study, the current research can only speak to the effect of IH in these specific disciplines (medical science, climate science and psychological science). Future research should replicate this work in other disciplines (for example, economics, engineering and political science), as such work would clarify the generalizability of the relations identified in the present investigation. Finally, we used samples from the United States and cannot speak to how these results generalize to other geographic or cultural contexts.

In conclusion, this research builds on an emerging literature revealing the importance of IH in helping to solve major societal problems. IH is undoubtedly critical to the scientific process[33]. The current studies are some of the first to investigate how perceptions of people's IH impact their judgements, and we examined this question in a context that has paramount consequences for the wellbeing of society and its members: perceived trustworthiness of scientists and willingness to follow their research-based recommendations. Our work suggests that participants understand that IH is a beneficial characteristic for scientists to possess in these disciplines. At a practical level, this work suggests that scientists embracing and conveying IH is beneficial. Across three studies in different scientific domains, we found that scientists who are described as possessing intellectually humble characteristics—such as being willing to admit gaps in their knowledge, listening to the input of others and revising their beliefs in the face of new evidence—were more trusted than scientists who were described as possessing characteristics consistent with lower IH. Moreover, in study 5, we found that expressions of personal IH (for example, admitting that one's original predictions were wrong and updating one's thinking) promote perceptions of scientist IH, with downstream benefits for perceived trustworthiness of the scientist and their research. Although more work is needed to identify specific communication strategies that scientists can use to effectively convey IH, the current set of studies speaks to the benefits of scientists approaching their science and their public communications in ways that reflect high rather than low IH. In particular, given that we saw few differences between the high-IH and neutral control conditions in studies 2 and 3, this may suggest that the default perception of scientists is that they possess relatively high levels of IH and may especially dislike it when scientists display low IH or even arrogance. While future research should continue to disentangle valuing IH from disvaluing intellectual overconfidence or arrogance, we encourage scientists to be particularly mindful of displaying low IH, such as by expressing overconfidence, being unwilling to course correct or disrespecting others' views. These results also suggest that the field of science might more deliberately discourage low IH practices and reward scientists who approach their research and scientific communication with IH (as suggested in ref. 33).

Methods

Ethics statement

All studies were approved by the University of Pittsburgh Institutional Review Board and determined to be exempt from requiring consent. All participants for each study read an information script before participating that informed them of the procedure, risks/benefits and compensation.

Study 1

The goal of study 1 was to examine the public's perception of scientists' IH, and to test what these perceptions predict. Study 1 was pre-registered on 5 June 2022 at OSF. This and all studies were conducted in Qualtrics.

Participants. An a priori power analysis in G*Power[71] recommended a sample of 134 to detect a medium effect (r = 0.30)[59] using a correlational design (95% power, α = 0.05, two tailed). We aimed to collect data from 300 participants to allow for tests for moderation by political orientation. We collected a sample of 300 participants from Prolific Academic. Of these, two failed our pre-registered attention check, leaving a sample of 298 (47.65% female, 49.66% male, 2.35% non-binary/third gender, 0.34% prefer not to say; 2.01% Native American, 9.73% Asian or Asian American, 1.68% Black or African American, 0.67% Native Hawaiian or other Pacific Islander, 10.07% Hispanic or Latina/Latino/Latinx, 84.90% white, 2.01% Middle Eastern or North African; M_{age} = 39.40, s.d.$_{age}$ of 14.78). We collected equal numbers of liberals and conservatives in the sample (both N = 149).

Materials and procedure. *Perceived IH of scientists*. We instructed participants to 'consider a broad range of scientists, such as medical scientists (for example, scientists who study human health conditions and diseases and how to treat them), social scientists (for example, psychologists and archaeologists) and natural scientists (for example, physicists and biologists)'. Participants then completed an adapted version of the Comprehensive Intellectual Humility Scale[56]. This is a validated 22-item measure containing four subscales—independence of intellect and ego (for example, "When someone disagrees with ideas that are important to a scientist, it makes the scientist feel insignificant"), openness to revising one's viewpoint ("Scientists are open to revising their important beliefs in the face of new information"), respect for others' viewpoints ("Scientists respect that there are ways of making important decisions that are different from the way they make decisions") and lack of intellectual overconfidence ("Scientists believe that their ideas are usually better than other people's ideas")—on a scale from 1 (strongly disagree) to 5 (strongly agree; α = 0.94). See Supplementary Table 7 for the results broken up by subscales across all studies.

Perceived trustworthiness of scientists. Participants then indicated their perceived trustworthiness of scientists on the Muenster Epistemic Trustworthiness Inventory[32]. This is a validated measure containing three subscales of 14 bipolar items—expertise (for example, incompetent to competent), integrity (for example, unjust to just) and benevolence (for example, immoral to moral)—on seven-point scales (α = 0.95). See Supplementary Table 8 for the results broken up by subscales across all studies.

Belief in polarizing science topics. Participants next completed three scales assessing beliefs in polarizing science topics in a randomized order. Participants completed five-item measures assessing each belief in climate change (for example, "Human CO2 emissions cause climate change", α = 0.94), support for vaccinations (for example, "I believe that vaccines are a safe and reliable way to help avert the spread of preventable diseases", α = 0.91) and support for genetically modified foods (for example, "I believe that genetic modification is an important and viable contribution to help feed the world's rapidly growing population", α = 0.93) on scales from 1 (strongly disagree) to 7 (strongly agree)[21].

Exploratory measures. Participants completed exploratory measures of conspiracist ideation[72] (α = 0.87), science knowledge[73], cognitive reflection[74] and participants' own IH[56] (α = 0.88). Finally, participants completed political (political identity, political orientation, political conviction, political interest and moralization of politics), science-related (interest in science and views of scientists in politics) and demographic (race/ethnicity, age, gender, education, religion and religiosity) measures. See Supplementary Tables 2 and 3–6 for analyses with exploratory measures.

Study 2

The goal of study 2 was to examine the experimental impacts of scientist IH on perceived trustworthiness. Study 2 was pre-registered on 8 August 2022 at OSF.

Participants. An a priori power analysis in G*Power[71] recommended a sample of 252 to detect a medium effect (f = 0.25)[59] using a three-condition design (95% power, α = 0.05). We aimed to double this and collect 520 to test for moderation by political orientation. We collected a sample of 517 from Prolific Academic. Of these, 152 failed the first attention check, 9 failed the second attention check and 76 failed the manipulation check, leaving a sample of 317 (47.95% female, 49.53% male, 2.21% non-binary/third gender, 0.32% prefer to self-describe; 1.58% Native American, 8.20% Asian or Asian American, 6.31% Black or African American, 0.32% Native Hawaiian or other Pacific Islander, 10.41% Hispanic or Latina/Latino/Latinx, 78.55% white, 0.63% Middle Eastern or North African, 0.95% 'Other'; M_{age} = 40.05, s.d.$_{age}$ of 15.10). We collected roughly equal numbers of liberals (N = 160) and conservatives (N = 157).

Materials and procedure. *Manipulation*. We randomly assigned participants to one of three conditions. All participants read an article about an ostensible scientist (Susan Moore) at the University of Michigan researching a new anti-viral treatment for long COVID-19 symptoms. We described Susan Moore as high in IH (for example, "…according to one colleague, 'Dr Moore is not afraid to admit when she doesn't yet know something'", N = 115), low in IH (for example, "…according to one colleague, 'Dr Moore is not afraid to assert what she knows'", N = 103) or no information about IH (N = 99). We modelled the manipulations using the IH behaviours expressed in the Comprehensive Intellectual Humility Scale.

Big five inventory of the scientist. As a filler scale, we asked participants to report on their perceptions of the scientist's personality[75] using a 15-item measure with subscales of extraversion (for example, "Dr Moore is someone who is dominant, acts as a leader", α = 0.57), openness (for example, "Dr Moore is someone who is original, comes up with new ideas", α = 0.61), neuroticism (for example, "Dr Moore is someone who worries a lot", $\alpha = 0.54$), conscientiousness (for example, "Dr Moore is someone who is reliable, can always be counted on", $\alpha = 0.65$) and agreeableness (for example, "Dr Moore is compassionate, has a soft heart", $\alpha = 0.81$) on a scale from 1 (strongly disagree) to 5 (strongly agree; Supplementary Tables 9 and 19–21).

Perceived IH of the scientist. As a manipulation check, participants completed the same IH scale from study 1, now adapted to be about Dr Moore (for example, "Dr Moore believes that her ideas are usually better than other people's ideas", $\alpha = 0.97$).

Likability of the scientist. Participants also completed an adapted four-item likability scale[76] (for example, "Dr Moore is friendly") on a scale from 1 (very strongly disagree) to 7 (very strongly agree, $\alpha = 0.94$; Supplementary Tables 9 and 13–15).

Perceived trustworthiness of the scientist. Participants completed the same Muenster Epistemic Trustworthiness Inventory, now focused on Dr Moore ($\alpha = 0.96$).

Belief in the scientist's research. Participants completed a five-item measure assessing belief in the scientist's anti-viral treatment (for example, "I believe that this new anti-viral treatment is a safe and reliable way to help avert long COVID-19 symptoms", adapted from ref. 21, $\alpha = 0.88$).

Exploratory measures. As an exploratory covariate, participants completed the same support for vaccinations scale ($\alpha = 0.94$) and interest in science scale (inter-item $r_{(315)} = 0.39$) as in study 1. Participants completed the same demographic measures as in study 1. See Supplementary Tables 9 and 16–18 for analyses on exploratory measures.

Study 3

The goal of study 3 was to replicate the results of study 2, while also testing the impacts of scientist gender on perceived IH. Study 3 was pre-registered on 8 March 2023 at OSF.

Participants. An a priori power analysis in G*Power[71] recommended a sample of 374 to detect a small–medium effect ($f = 0.20$)[59] using a 3 × 2 between-subjects design (95% power, $\alpha = 0.05$). We collected a sample of 450 from Prolific Academic to account for potential low-quality data. Of these, 3 failed the first attention check and 79 failed the second attention check, leaving a sample of 369 (49.86% female, 48.24% male, 1.90% non-binary/third gender; 2.17% Native American, 5.96% Asian or Asian American, 7.05% Black or African American, 0.54% Native Hawaiian or other Pacific Islander, 8.67% Hispanic or Latina/Latino/Latinx, 82.66% white, 0.27% Middle Eastern or North African, 0.27% 'Other'; $M_{age} = 42.63$, s.d.$_{age}$ of 14.40). We collected roughly equal numbers of liberals ($N = 195$) and conservatives ($N = 174$).

Materials and procedure. *Manipulation*. As in study 2, we randomly assigned participants to one of three IH conditions (high, $N = 146$; low, $N = 113$; control, $N = 110$). The IH part of the manipulation was identical to study 2. Unlike study 2, all articles were about an ostensible psychological scientist at the University of Pittsburgh researching the benefits of talking to people across the political divide in the United States. We crossed IH condition with the gender of the scientist, who was either a woman (Sandra Wilson, $N = 184$) or a man (Robert Wilson, $N = 185$).

Perceived IH of the scientist. Participants completed the same IH scale from studies 1 and 2, now adapted to be about Robert Wilson ($\alpha = 0.96$).

Perceived trustworthiness in the scientist. Participants completed the Muenster Epistemic Trustworthiness Inventory about the scientist ($\alpha = 0.97$).

Belief in the scientist's research. Participants completed a five-item measure assessing belief in the scientist's research on the benefits of talking across the political divide (for example, "I believe that talking to people from the opposing political party makes people feel happier", adapted from ref. 21, $\alpha = 0.72$).

Intention to follow research. Participants completed two items about their intentions to learn more about how to follow the scientist's research recommendations ("I would be interested in receiving information about how to have productive conversations with people from other political parties", "I would be interested in learning more about Dr Wilson's suggestions for productive conversations", inter-item $r_{(366)} = 0.86$).

Stereotype content of the scientist. As an exploratory outcome, participants completed two items assessing the warmth ('warm', 'friendly', inter-item $r_{(366)} = 0.91$) and two items assessing the competence ('competent', 'capable', inter-item $r_{(365)} = 0.88$) of the scientist (adapted from ref. 77; see Supplementary Tables 36–50 for results). It should be noted that the 'competent' item from the competence scale overlaps with one item from the Muenster Epistemic Trustworthiness Inventory (incompetent to competent). We therefore recommend caution when interpreting models that include both these scales.

Demographic measures. Participants completed the same demographic measures as in prior studies.

Study 4

The goal of study 4 was to replicate the results of studies 2 and 3 and ensure the effects of perceived IH were consistent across scientists with different race/ethnic identities. Study 4 was pre-registered on 15 June 2023 at: OSF.

Participants. An a priori power analysis in G*Power[71] recommended a sample of 374 to detect a small–medium effect ($f = 0.20$)[59] using a 3 × 2 between participant design (95% power, $\alpha = 0.05$). We collected a sample of 450 from Prolific Academic to account for potential low-quality data. Of these, 9 failed the first attention check and 74 failed the second attention check, leaving a sample of 371 (51.21% female, 47.17% male, 1.35% non-binary/third gender, 0.27% prefer to self-describe; 0.54% Native American, 8.63% Asian or Asian American, 6.47% Black or African American, 8.63% Hispanic or Latina/Latino/Latinx, 83.02% white, 0.54% Middle Eastern or North African, 0.27% 'Other'; $M_{age} = 43.07$, s.d.$_{age}$ of 14.85). We collected roughly equal numbers of liberals ($N = 187$) and conservatives ($N = 184$).

Materials and procedure. *Manipulation*. We randomly assigned participants to one of two IH conditions (high, $N = 198$; low, $N = 173$). We removed the neutral control condition to maximize power. The IH part of the manipulation was identical to studies 2 and 3. Unlike studies 2 and 3, participants read about an ostensible climate scientist researching why people should switch to plant-rich diets to reduce global emissions. We modelled the reasoning and results off real research done by Project Drawdown. We crossed IH condition with the race/ethnicity of the scientist. We used a name manipulation from prior work[64]; the scientist was Claire Miller (white condition, $N = 133$), Shanice Banks (Black condition, $N = 116$) or Maria Rodriguez (Latinx condition, $N = 122$). It should be noted that despite using a manipulation from prior work, 98 participants misidentified the race/ethnicity of the scientist. Removing these participants did not change any of the results with race/ethnicity condition.

Perceived IH of the scientist. Participants completed the same IH scale from prior studies ($\alpha = 0.97$).

Perceived trustworthiness of the scientist. Participants completed the Muenster Epistemic Trustworthiness ($\alpha = 0.97$).

Belief in the scientist's research. Participants completed a four-item measure assessing belief in the scientist's research on the benefits of switching to a plant-rich diet to reduce emissions (for example, "I believe that adopting a plant-rich diet will reduce climate change", adapted from ref. 21, $\alpha = 0.83$).

Information-seeking behaviour. Participants had the option to opt into ostensibly being sent information and tips for switching to a plant-rich diet with answer options of no (0) and yes (1). Participants also reported on their current level of meat consumption ("How many days per week do you currently eat meat (on average)", "What percentage of your current meals are plant-rich", data from this measure are available on OSF).

Stereotype content of the scientist. Participants completed the same measure of warmth (inter-item $r_{(369)} = 0.93$) and competence (inter-item $r_{(368)} = 0.87$) of the scientist (see Supplementary Tables 64 and 69–78 for results).

Demographic measures. Participants completed the same demographic measures as in prior studies.

Study 5

The goal of study 5 was to test communication approaches scientists might use to effectively express IH when communicating to the public. Study 5 was pre-registered on 8 December 2023 at OSF.

Participants. An a priori power analysis in G*Power[71] recommended a sample of 768 to detect a small–medium effect ($f = 0.20$)[59] using a four-condition design (95% power, $\alpha = 0.05$). We collected a census-matched sample of 775 from CloudResearch Connect. We removed one participant who completed the survey twice. Following our pre-registered exclusion criteria, we removed 66 participants who spent less than 5 s on the manipulation, 25 participants who failed the first attention check and 13 participants who failed the second attention check. This left a final sample of 679 (49.19% female, 49.63% male, 0.29% non-binary or transgender; 2.65% Native American, 5.30% Asian or Asian American, 13.11% Black or African American, 0.29% Native Hawaiian or other Pacific Islander, 14.73% Hispanic or Latina/Latino/Latinx, 75.85% white, 0.15% Middle Eastern or North African, 0.88% 'Other'; $M_{age} = 46.51$, s.d.$_{age}$ of 15.94). We also screened to include a sample that was on average politically moderate ($M_{political\ orientation} = 3.86$, s.d.$_{political\ orientation}$ of 2.06 on a seven-point scale).

Materials and procedure. *Manipulation*. To determine what communication approaches scientists might use to convey IH when describing their research, we reached out to experts in the field of IH via email to ask them how they convey IH to the public, or how they think others might. In all, 11 experts provided a total of 34 recommendations. We then grouped these together into three different approaches. The first, personal levels of humility, was operationalized as admitting that one's initial predictions were wrong or incorrect/updating beliefs and by giving credit to graduate students. The second, limits of methods, was operationalized as explicitly stating that there are methodological limitations and by acknowledging that one study cannot prove something is universally true. The third, limits of results, was operationalized as acknowledging that there are inconsistent findings and being cautious not to overgeneralize.

We randomly assigned participants to read one of four short interviews with a psychological scientist, Susan Moore at the University of Pittsburgh, who was researching why it is beneficial to take breaks from social media (modelled off real research[67]). One condition was a neutral control and the other three conditions contained one of each of the IH communication approaches ($N_{control} = 164$, $N_{limits\ of\ methods} = 174$, $N_{limits\ of\ results} = 178$ and $N_{personal\ IH} = 163$).

Perceived IH of the scientist. Participants completed the same IH scale from prior studies ($\alpha = 0.93$).

Perceived trustworthiness of the scientist. Participants completed the Muenster Epistemic Trustworthiness Inventory ($\alpha = 0.96$).

Belief in the scientist's research. Participants completed a four-item measure assessing belief in the scientist's research on the benefits of taking a break from social media (for example, "I believe taking a break from social media makes people happier and less stressed", adapted from ref. 21, $\alpha = 0.68$).

Information-seeking behaviour. Participants indicated if they would like to be sent information and tips for taking a social media break with answer options of no (0), yes (1) and "I don't use social media". Participants who indicated the latter were removed from analyses on this measure.

Stereotype content of the scientist. Participants also completed the same measure of warmth (inter-item $r_{(676)} = 0.91$) and competence (inter-item $r_{(675)} = 0.85$) of the scientist (see Supplementary Table 92 for results).

Ratings of individual statements. As an exploratory measure, we presented all participants with six different IH statements included in the manipulations. We asked participants how much each statement conveyed IH, would increase their perceived trustworthiness in the scientist and would increase their trust in the scientist's research (see Supplementary Fig. 11 and Supplementary Tables 104–106 for results).

Demographic measures. Participants completed the same demographic measures as in prior studies.

Reporting summary

Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Data Availability

Anonymized data are available at OSF (https://osf.io/d3xua/?view_only=0ebe5366331f497da7c78a7c874c2961).

Code Availability

Code is available at OSF (https://osf.io/d3xua/?view_only=0ebe5366331f497da7c78a7c874c2961).

References

1. Krause, N. M., Brossard, D., Scheufele, D. A., Xenos, M. A. & Franke, K. Trends—Americans' trust in science and scientists. *Public Opin. Q.* **83**, 817–836 (2019).
2. Kennedy, B., Tyson, A. & Funk, C. Americans' trust in scientists, other groups declines. *Pew Research Center* https://www.pewresearch.org/science/2022/02/15/americans-trust-in-scientists-other-groups-declines/ (2022).
3. Funk, C. Key findings about Americans' confidence in science and their views on scientists' role in society. *Pew Research Center* https://www.pewresearch.org/fact-tank/2020/02/12/key-findings-about-americans-confidence-in-science-and-their-views-on-scientists-role-in-society/ (2020).
4. Gauchat, G. Politicization of science in the public sphere: a study of public trust in the United States, 1974 to 2010. *Am. Sociol. Rev.* **77**, 167–187 (2012).
5. Koetke, J., Schumann, K. & Porter, T. Trust in science increases conservative support for social distancing. *Group Process. Intergr. Relat.* **24**, 680–697 (2021).

6. Fazio, R. H. et al. Social distancing decreases an individual's likelihood of contracting COVID-19. *Proc. Natl Acad. Sci. USA* **118**, e2023131118 (2021).
7. Algan, Y., Cohen, D., Davoine, E., Foucault, M. & Stantcheva, S. Trust in scientists in times of pandemic: panel evidence from 12 countries. *Proc. Natl Acad. Sci. USA* **118**, e2108576118 (2021).
8. Hornsey, M. J., Harris, E. A., Bain, P. G. & Fielding, K. S. Meta-analyses of the determinants and outcomes of belief in climate change. *Nat. Clim. Change* **6**, 622–626 (2016).
9. Cologna, V., Berthold, A. & Siegrist, M. Knowledge, perceived potential and trust as determinants of low-and high-impact pro-environmental behaviours. *J. Environ. Psychol.* **79**, 101741 (2022).
10. Hornsey, M. J. Why facts are not enough: understanding and managing the motivated rejection of science. *Curr. Dir. Psychol. Sci.* **29**, 583–591 (2020).
11. Lewandowsky, S. & Oberauer, K. Motivated rejection of science. *Curr. Dir. Psychol. Sci.* **25**, 217–222 (2016).
12. Fielding, K. S. & Hornsey, M. J. A social identity analysis of climate change and environmental attitudes and behaviors: Insights and opportunities. *Front. Psychol.* https://doi.org/10.3389/fpsyg.2016.00121 (2016).
13. van der Linden, S. The social-psychological determinants of climate change risk perceptions: towards a comprehensive model. *J. Environ. Psychol.* **41**, 112–124 (2015).
14. Washburn, A. N. & Skitka, L. J. Science denial across the political divide: liberals and conservatives are similarly motivated to deny attitude-inconsistent science. *Soc. Psychol. Pers. Sci.* **9**, 972–980 (2018).
15. Upenieks, L., Ford-Robertson, J. & Robertson, J. E. Trust in God and/or science? Sociodemographic differences in the effects of beliefs in an engaged god and mistrust of the COVID-19 vaccine. *J. Relig. Health* **61**, 657–686 (2022).
16. Jamieson, K. H., McNutt, M., Kiermer, V. & Sever, R. Signaling the trustworthiness of science. *Proc. Natl Acad. Sci. USA* **116**, 19231–19236 (2019).
17. Lewandowsky, S. & Oberauer, K. Worldview-motivated rejection of science and the norms of science. *Cognition* **215**, 104820 (2021).
18. Rutjens, B. T. & Heine, S. J. The immoral landscape? Scientists are associated with violations of morality. *PLoS ONE* **11**, e0152798 (2016).
19. Hannikainen, I. R. Ideology between the lines: lay inferences about scientists' values and motives. *Soc. Psychol. Pers. Sci.* **10**, 832–841 (2019).
20. Hornsey, M. J., Harris, E. A. & Fielding, K. S. Relationships among conspiratorial beliefs, conservatism and climate scepticism across nations. *Nat. Clim. Change* **8**, 614–620 (2018).
21. Lewandowsky, S., Gignac, G. E. & Oberauer, K. The role of conspiracist ideation and worldviews in predicting rejection of science. *PLoS ONE* **8**, e75637 (2013).
22. van der Linden, S. The conspiracy-effect: exposure to conspiracy theories (about global warming) decreases pro-social behavior and science acceptance. *Pers. Individ. Differ.* **87**, 171–173 (2015).
23. Kampourakis, K. & McCain, K. *Uncertainty: How It Makes Science Advance* (Oxford Univ. Press, 2019).
24. Latour, B. & Woolgar, S. *Laboratory Life: The Construction of Scientific Facts* (Princeton Univ. Press, 2013).
25. Van Der Bles, A. M., van der Linden, S., Freeman, A. L. & Spiegelhalter, D. J. The effects of communicating uncertainty on public trust in facts and numbers. *Proc. Natl Acad. Sci. USA* **117**, 7672–7683 (2020).
26. Hutcherson, C. A. et al. On the accuracy, media representation, and public perception of psychological scientists' judgments of societal change. *Am. Psychol* **78**, 968–981 (2023).
27. The Forecasting Collaborative. Insights into the accuracy of social scientists' forecasts of societal change. *Nat. Hum. Behav.* **7**, 484–50 (2023).
28. Roberts, S. O., Bareket-Shavit, C., Dollins, F. A., Goldie, P. D. & Mortenson, E. Racial inequality in psychological research: trends of the past and recommendations for the future. *Perspect. Psychol. Sci.* **15**, 1295–1309 (2020).
29. Breznau, N. et al. Observing many researchers using the same data and hypothesis reveals a hidden universe of uncertainty. *Proc. Natl Acad. Sci. USA* **119**, e2203150119 (2022).
30. Hardwig, J. The role of trust in knowledge. *J. Philos.* **88**, 693–708 (1991).
31. Besley, J. C. & Tiffany, L. A. What are you assessing when you measure "trust" in scientists with a direct measure? *Public Underst. Sci.* **32**, 709–726 (2023).
32. Hendriks, F., Kienhues, D. & Bromme, R. Measuring laypeople's trust in experts in a digital age: the Muenster Epistemic Trustworthiness Inventory (METI). *PLoS ONE* **10**, e0139309 (2015).
33. Hoekstra, R. & Vazire, S. Aspiring to greater intellectual humility in science. *Nat. Hum. Behav.* **5**, 1602–1607 (2021).
34. Nosek, B. A. et al. Preregistration is hard, and worthwhile. *Trends Cogn. Sci.* **23**, 815–818 (2019).
35. Porter, T. et al. Predictors and consequences of intellectual humility. *Nat. Rev. Psychol.* **1**, 524–536 (2022).
36. Porter, T. et al. Clarifying the content of intellectual humility: a systematic review and integrative framework. *J. Pers. Assess* **104**, 573–585 (2021).
37. Davis, D. E. et al. Distinguishing intellectual humility and general humility. *J. Posit. Psychol.* **11**, 215–224 (2016).
38. Plohl, N. & Musil, B. Assessing the incremental value of intellectual humility and cognitive reflection in predicting trust in science. *Pers. Individ. Differ.* **214**, 112340 (2023).
39. Vaupotič, N., Kienhues, D. & Jucks, R. Complexity appreciated: how the communication of complexity impacts topic-specific intellectual humility and epistemic trustworthiness. *Public Underst. Sci.* **33**, 740–756 (2024).
40. Altenmüller, M. S., Nuding, S. & Gollwitzer, M. No harm in being self-corrective: self-criticism and reform intentions increase researchers' epistemic trustworthiness and credibility in the eyes of the public. *Public Underst. Sci.* **30**, 962–976 (2021).
41. Schneider, J., Rosman, T., Kelava, A. & Merk, S. Do open-science badges increase trust in scientists among undergraduates, scientists, and the public? *Psychol. Sci.* **33**, 1588–1604 (2020).
42. Gustafson, A. & Rice, R. E. A review of the effects of uncertainty in public science communication. *Public Underst. Sci.* **29**, 614–633 (2020).
43. Howe, L. C., MacInnis, B., Krosnick, J. A., Markowitz, E. M. & Socolow, R. Acknowledging uncertainty impacts public acceptance of climate scientists' predictions. *Nat. Clim. Change* **9**, 863–867 (2019).
44. Huynh, H. P., Dicke-Bohmann, A. & Nelson, C. What do humble doctors do? A conceptualization of clinician humility from the patient's perspective. *Patient Educ. Couns.* **104**, 3066–3071 (2021).
45. Koetke, J., Schumann, K. & Porter, T. Intellectual humility predicts scrutiny of COVID-19 misinformation. *Soc. Psychol. Pers. Sci.* **13**, 277–284 (2022).
46. Krumrei-Mancuso, E. J., Haggard, M. C., LaBouff, J. P. & Rowatt, W. C. Links between intellectual humility and acquiring knowledge. *J. Posit. Psychol.* **15**, 155–170 (2020).
47. Bowes, S. M., Ringwood, A. & Tasimi, A. Is intellectual humility related to more accuracy and less overconfidence? *J. Posit. Psychol.* **19**, 538–553 (2023).
48. Wong, I. H. & Wong, T. T. Exploring the relationship between intellectual humility and academic performance among post-secondary students: The mediating roles of learning motivation and receptivity to feedback. *Learn. Individ. Differ.* **88**, 102012 (2021).

49. Porter, T., Schumann, K., Selmeczy, D. & Trzesniewski, K. Intellectual humility predicts mastery behaviors when learning. *Learn. Individ. Differ.* **80**, 101888 (2020).
50. Porter, T. & Schumann, K. Intellectual humility and openness to the opposing view. *Self Identity* **17**, 139–162 (2018).
51. Krumrei-Mancuso, E. J. Intellectual humility and prosocial values: direct and mediated effects. *J. Posit. Psychol.* **12**, 13–28 (2017).
52. Hagá, S. & Olson, K. R. 'If I only had a little humility, I would be perfect': children's and adults' perceptions of intellectually arrogant, humble, and diffident people. *J. Posit. Psychol.* **12**, 87–98 (2017).
53. Meagher, B. R., Leman, J. C., Heidenga, C. A., Ringquist, M. R. & Rowatt, W. C. Intellectual humility in conversation: distinct behavioral indicators of self and peer ratings. *J. Posit. Psychol.* **16**, 417–429 (2021).
54. van den Bergh, D. et al. A tutorial on conducting and interpreting a Bayesian ANOVA in JASP. *L'Année Psychol.* **120**, 73–96 (2020).
55. Van Doorn, J. et al. The JASP guidelines for conducting and reporting a Bayesian analysis. *Psychon. Bull. Rev.* **28**, 813–826 (2021).
56. Krumrei-Mancuso, E. J. & Rouse, S. V. The development and validation of the comprehensive intellectual humility scale. *J. Pers. Assess.* **98**, 209–221 (2016).
57. Bowes, S. M., Blanchard, M. C., Costello, T. H., Abramowitz, A. I. & Lilienfeld, S. O. Intellectual humility and between-party animus: implications for affective polarization in two community samples. *J. Res. Pers.* **88**, 103992 (2020).
58. Koetke, J. & Schumann, K. Is intellectual humility polarized too? A systematic examination of intellectual humility, political orientation, and strength of political belief. *J. Posit. Psychol.* https://doi.org/10.1080/17439760.2024.2352739 (2024).
59. Cohen, J. *Statistical Power Analysis for the Behavioral Sciences* (Routledge, 2013).
60. D'Errico, F., Bull, P., Lamponi, E. & Leone, G. Humility expression and its effects on moral suasion: an empirical study of Ocasio-Cortez's communication. *Hum. Aff.* **32**, 101–117 (2022).
61. Moon, S. H. & Sandage, S. J. Cultural humility for people of color: critique of current theory and practice. *J. Psychol. Theol.* **47**, 76–86 (2019).
62. Sandage, S. J. & Hee An, C. Intellectual humility in applied sociocultural contexts: a reply to Ballantyne. *J. Posit. Psychol.* **18**, 280–283 (2023).
63. Priebe, C. & Van Tongeren, D. R. Women pay a steeper price for arrogance: examining presentation style, gender, and humility. *J. Posit. Psychol.* **18**, 121–129 (2023).
64. Eaton, A. A., Saunders, J. F., Jacobson, R. K. & West, K. How gender and race stereotypes impact the advancement of scholars in STEM: professors' biased evaluations of physics and biology post-doctoral candidates. *Sex. Roles* **82**, 127–141 (2020).
65. Moss-Racusin, C. A., Dovidio, J. F., Brescoll, V. L., Graham, M. J. & Handelsman, J. Science faculty's subtle gender biases favor male students. *Proc. Natl Acad. Sci. USA* **109**, 16474–16479 (2012).
66. Petsko, C. D. & Rosette, A. S. Are leaders still presumed white by default? Racial bias in leader categorization revisited. *J. Appl. Psychol.* **108**, 330–340 (2023).
67. Allcott, H., Braghieri, L., Eichmeyer, S. & Gentzkow, M. The welfare effects of social media. *Am. Econ. Rev.* **110**, 629–676 (2020).
68. Petersen, M. B., Bor, A., Jørgensen, F. & Lindholt, M. F. Transparent communication about negative features of COVID-19 vaccines decreases acceptance but increases trust. *Proc. Natl Acad. Sci. USA* **118**, e2024597118 (2021).
69. Kerr, J. R., Schneider, C. R., Freeman, A. L., Marteau, T. & van der Linden, S. Transparent communication of evidence does not undermine public trust in evidence. *Proc. Natl Acad. Sci. USA Nexus* **1**, pgac280 (2022).
70. Hanel, P. H. & Vione, K. C. Do student samples provide an accurate estimate of the general public? *PLoS ONE* **11**, e0168354 (2016).
71. Faul, F., Erdfelder, E., Lang, A.-G. & Buchner, A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav. Res. Methods* **39**, 175–191 (2007).
72. Bruder, M., Haffke, P., Neave, N., Nouripanah, N. & Imhoff, R. Measuring individual differences in generic beliefs in conspiracy theories across cultures: conspiracy mentality questionnaire. *Front. Psychol.* https://doi.org/10.3389/fpsyg.2013.00225 (2013).
73. Rutjens, B. T., Sutton, R. M. & van der Lee, R. Not all skepticism is equal: exploring the ideological antecedents of science acceptance and rejection. *Personal. Soc. Psychol. Bull.* **44**, 384–405 (2018).
74. Patel, N., Baker, S. G. & Scherer, L. D. Evaluating the cognitive reflection test as a measure of intuition/reflection, numeracy, and insight problem solving, and the implications for understanding real-world judgments and beliefs. *J. Exp. Psychol. Gen.* **148**, 2129–2153 (2019).
75. Soto, C. J. & John, O. P. Short and extra-short forms of the Big Five Inventory 2: the BFI-2-S and BFI-2-XS. *J. Res. Personal.* **68**, 69–81 (2017).
76. Reysen, S. Construction of a new scale: the Reysen likability scale. *Soc. Behav. Pers. Int. J.* **33**, 201–208 (2005).
77. Cuddy, A. J., Fiske, S. T. & Glick, P. The BIAS map: behaviors from intergroup affect and stereotypes. *J. Pers. Soc. Psychol.* **92**, 631–648 (2007).

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Author contributions

J.K., K.S., S.M.B. and N.V. designed the studies. J.K. and K.S. collected the data. J.K. analysed the data. J.K. and K.S. wrote the first draft of the manuscript. N.V. and S.M.B. provided comments on and edited the manuscript.

Competing interests

The authors have no competing interests to declare.

Additional information

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Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	Data was collected with Qualtrics (Versions June 2022, August 2022, March 2023, June 2023, and December 2023).
Data analysis	Data was analyzed in R version 4.3.2 and JASP version 0.18.3. Code is available at https://osf.io/d3xua/?view_only=0ebe5366331f497da7c78a7c874c2961.

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Research involving human participants, their data, or biological material

Policy information about studies with human participants or human data. See also policy information about sex, gender (identity/presentation), and sexual orientation and race, ethnicity and racism.

Reporting on sex and gender	We collected self-reported gender identity in all studies. We did not test for moderation by gender identity because we did not anticipate theoretical reasons for the results to differ by gender identity.
Reporting on race, ethnicity, or other socially relevant groupings	We collected self-reported racial/ethnic identification in all studies. We did not test for moderation or controlling for race/ethnicity because we did not anticipate theoretical reasons for the results to differ by race/ethnicity.
Population characteristics	See behavioural & social sciences study design section.
Recruitment	Participants were recruited from Prolific Academic (Studies 1-4) and CloudResearch (Study 5). All studies were described similarly as about perceptions of scientists. It is therefore possible that participants selectively opted into the survey based on preheld beliefs about scientists.
Ethics oversight	All studies were approved by the University of Pittsburgh IRB and determined to be exempt from requiring consent. All participants for each study read an information script prior to participating that informed them of the procedure, risks/benefits, and compensation.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

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Behavioural & social sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	Study 1 was a quantitative correlation study. Study 2 was a 3-condition between participants quantitative experiment. Study 3 was a 6-condition (3 X 2 factorial design) between participants quantitative experiment. Study 4 was a 6-condition (3 X 2 factorial design) between participants quantitative experiment. Study 5 was a 4-condition between participants quantitative experiment.
Research sample	Studies 1-4 were collected from Prolific Academic using screeners to recruit roughly equal numbers of participants identifying as male and female and liberal and conservative (Study 1: 47.65% Female, 49.66% Male, 2.35% Non-binary/third gender, 0.34% Prefer not to say; 2.01% Native American, 9.73% Asian or Asian American, 1.68% Black or African American, 0.67% Native Hawaiian or other Pacific Islander, 10.07% Hispanic or Latina/Latino/Latinx, 84.90% White, 2.01% Middle Eastern or North African; Mage = 39.40, SDage = 14.78; Study 2: 47.95% Female, 49.53% Male, 2.21% Non-binary/third gender, 0.32% Prefer to self-describe; 1.58% Native American, 8.20% Asian or Asian American, 6.31% Black or African American, 0.32% Native Hawaiian or other Pacific Islander, 10.41% Hispanic or Latina/Latino/Latinx, 78.55% White, 0.63% Middle Eastern or North African, 0.95% “Other”; Mage = 40.05, SDage = 15.10; Study 3: 49.86% Female, 48.24% Male, 1.90% Non-binary/third gender; 2.17% Native American, 5.96% Asian or Asian American, 7.05% Black or African American, 0.54% Native Hawaiian or other Pacific Islander, 8.67% Hispanic or Latina/Latino/Latinx, 82.66% White, 0.27% Middle Eastern or North African, 0.27% “Other”; Mage = 42.63, SDage = 14.40; Study 4: 51.21% Female, 47.17% Male, 1.35% Non-binary/third gender, 0.27% Prefer to self-describe; 0.54% Native American, 8.63% Asian or Asian American, 6.47% Black or African American, 8.63% Hispanic or Latina/Latino/Latinx, 83.02% White, 0.54% Middle Eastern or North African, 0.27% “Other”; Mage = 43.07, SDage = 14.85). Study 5 was collected from Cloud Research Connect screening to include roughly equal numbers of liberals and conservatives, and quota sampled to be census matched on gender, age, and race/ethnicity (49.19% Female, 49.63% Male, 0.29% Non-binary or Transgender; 2.65% Native American, 5.30% Asian or Asian American, 13.11% Black or African American, 0.29% Native Hawaiian or other Pacific Islander, 14.73% Hispanic or Latina/Latino/Latinx, 75.85% White, 0.15% Middle Eastern or North African, 0.88% “Other”; Mage = 46.51, SDage = 15.94). All samples were from the United States. Studies 1-4 were not representative. Study 5 used quota sampling to be representative on gender, age, and race/ethnicity. All studies used online sample out of convenience and to obtain samples more diverse than typical student samples.
Sampling strategy	All samples were convenience. All samples sizes were determined prior to data collection using a power analysis as detailed in our preregistrations.
Data collection	All data was collected online using Qualtrics. Participants did not directly interact with the researchers as part of the study. Participants were blind to condition.
Timing	Study 1 was run on June 5, 2022; Study 2 was run August 8-9, 2022; Study 3 was run on March 8, 2023; Study 4 was run June 15-16, 2023; Study 5 was run December 10-19, 2023.
Data exclusions	All data exclusions were preregistered. In Study 1 we removed 2 who failed the attention check. In Study 2, we removed 152 who

Data exclusions	failed the first attention check, 9 who failed the second attention check, and 76 who failed the manipulation check. In Study 3 we removed 3 who failed the first attention check and 79 who failed the second attention check. In Study 4 we removed 9 who failed the first attention check and 74 who failed the second attention check. In Study 5, we removed 1 participant who completed the survey twice, 66 participants who spent less than five seconds on the manipulation, 25 participants who failed the first attention check, and 6 participants who failed the second attention check.
Non-participation	In Study 1, 10 participants started but did not complete the study. In Study 2, 43 participants started but did not complete the study (including one participant who started but did not complete the survey twice). In Study 3, 17 participants started but did not complete the study (including one participant who started the study once, then re-started it and completed the second time). In Study 4, 20 participants started but did not complete the study (including two participants who started the study once, then re-started it and completed the second time). In Study 5, 74 participants started but did not complete the study (including 12 participants who started the study once and completed it the second time, and 1 participant who started the survey twice and completed it the third time).
Randomization	Participants were randomly assigned to condition in all experimental studies (Studies 2-5) through Qualtrics.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern
☒	☐ Plants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Plants

Seed stocks	*Report on the source of all seed stocks or other plant material used. If applicable, state the seed stock centre and catalogue number. If plant specimens were collected from the field, describe the collection location, date and sampling procedures.*
Novel plant genotypes	*Describe the methods by which all novel plant genotypes were produced. This includes those generated by transgenic approaches, gene editing, chemical/radiation-based mutagenesis and hybridization. For transgenic lines, describe the transformation method, the number of independent lines analyzed and the generation upon which experiments were performed. For gene-edited lines, describe the editor used, the endogenous sequence targeted for editing, the targeting guide RNA sequence (if applicable) and how the editor was applied.*
Authentication	*Describe any authentication procedures for each seed stock used or novel genotype generated. Describe any experiments used to assess the effect of a mutation and, where applicable, how potential secondary effects (e.g. second site T-DNA insertions, mosiacism, off-target gene editing) were examined.*