

# How aggregated opinions shape beliefs

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## Abstract

In today's online world, the beliefs of people are shaped by aggregated opinions: the elicited, quantified and summarized judgements of many strangers. Ratings guide purchases, likes guide shares, and polls guide votes. In this Review, we consolidate cross-disciplinary research to clarify how individuals draw inductive inferences about the world based on the opinions of others. We draw on philosophy to clarify what conceptually distinguishes aggregated opinion from other forms of evidence, draw on political science to describe its functional origins in collective judgement and decision-making, and draw on psychology to shed light on the mechanisms that drive how individuals conform to, learn from and ignore the collected opinions of others. Finally, we highlight future directions to address important gaps in the literature, such as exploring how the causal history of opinion shapes the inferences that people draw, and how the mechanisms that drive responses to aggregated opinion can be leveraged in tailored interventions that are responsive to people's individual reasons for maintaining their beliefs.

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Responding to aggregated opinion

Mechanisms that drive responses to aggregated opinion

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## Introduction

Social learning canonically takes the form of face-to-face, qualitatively rich interactions among familiar individuals. For instance, children learn about the world through the testimony of their parents<sup>1-3</sup>, social animals reach collective decisions by sharing information in small groups<sup>4-6</sup>, and societies accumulate culture through stories exchanged among kin<sup>7-9</sup>. Humans and other social animals are therefore equipped with cognitive mechanisms that enable such learning, including the capacity to track the accuracy<sup>10-12</sup> and intentions<sup>13-16</sup> of others. However, with the advent of voting in ancient Greece, humanity was introduced to a distinctively impersonal form of social information: the elicited, quantified and summarized judgements of arbitrarily large groups of individuals<sup>17,18</sup>. We call such information ‘aggregated opinion’ (Fig. 1). Like personal reports, aggregated opinion can have diverse contents, including summaries of reported beliefs (such as the percentage of Americans who believe the Earth is flat), evaluations (such as the average rating of a particular restaurant) and norms (such as the median agreement with a new dress code). Yet, in contrast to evaluating personal reports, evaluating aggregated opinion can require distinct skills (such as quantitative reasoning), motivations (such as understanding global sentiment) and knowledge (such as sampling methodology).

Aggregated opinion is a defining feature of democratic governance<sup>19,20</sup>, an active driver of electoral outcomes<sup>21-23</sup> and a force that shapes public opinion on key issues such as climate change<sup>24,25</sup>. Developments in media technologies have driven the rapid spread and influence of aggregated opinion<sup>26-28</sup>, including through surveys (for instance, Gallup public opinion polls), repositories (for instance, movie ratings on IMDb) and metrics of opinion (for instance, likes on Facebook), such that daily life is steeped in salient and easily accessible data on the views of others<sup>28,29</sup>. As the prevalence and importance of aggregated opinion have increased, an emerging cross-disciplinary research literature has explored the properties of aggregated opinion.

Statisticians and political scientists have studied how it can be measured<sup>30,31</sup>, social and cognitive psychologists have studied how it is evaluated<sup>32,33</sup>, and economists and philosophers have analysed how it ought to be interpreted<sup>34,35</sup>. This research has focused specifically on aggregated opinion (rather than singular opinion) in part due to its distinctive challenges and affordances. These challenges include the need to scale up the mechanisms involved in evaluating singular opinion (for instance, mechanisms for inferring the reliability of informants<sup>36</sup>), as well as the need to consider mechanisms unique to evaluating aggregated opinion, such as tracking informational dependencies across individuals<sup>37</sup>. A unique affordance of aggregated opinion is its capacity to efficiently convey consolidated social information at scales that are evolutionarily unprecedented.

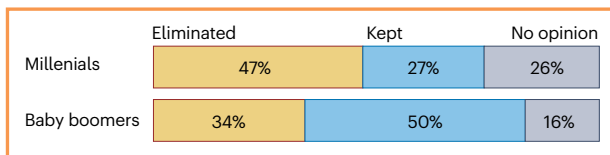
In this Review, we consolidate cross-disciplinary insights on how aggregated opinion shapes beliefs. Throughout, we use ‘beliefs’ to refer to people’s representations of the world<sup>38</sup>, and we examine how learning about aggregated opinions influences these representations. In the first section, we define aggregated opinion, contrast it with other forms of social information, and describe three basic factors that influence its informativeness. In the second section, we review literature on the circumstances in which people conform to, learn from and effectively ignore information from aggregated opinion. In the third section, we describe a unifying framework that clarifies when and why each of these responses to aggregated opinion is likely to emerge. We end by summarizing key points and identifying fruitful directions for future research.

Before proceeding, we note that the vast majority of the empirical evidence in this paper comes from studies conducted in the USA, and should not be assumed to generalize to all people across the globe<sup>39</sup>. For the sake of conciseness and readability, we use the term ‘people’ when referring to the results of these studies, but readers should keep in mind that extensive cross-cultural work is needed to investigate the

### a Opinion poll results

Younger Americans are more in favour of ending daylight savings time than older Americans

Respondents who think daylight savings time should be...



### b Product reviews

Springer’s Potato Crisps. 25 grams



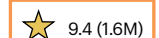
3.5K bought in the past week

### c Movie reviews



It's A Wonderful Life

1946 131 minutes



### d Social media post



User05238

School winter holidays are too short!

565

102

Reply

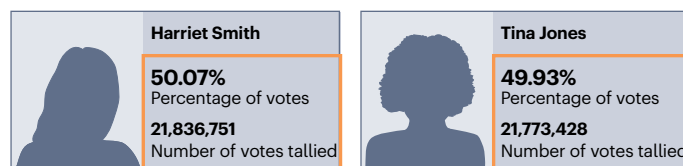
Share

...

### e Election results

Vote tally for parliament seat

Votes tallied (%) 81.2



**Fig. 1 | Aggregated opinion is diverse and prevalent.** Aggregated opinion conveys public opinions on societal issues (part a), product star ratings on shopping websites (part b), movie ratings on websites (part c), likes and

dislikes to social media comments (part d) and vote tallies for elections (part e). The orange boxes highlight different representations of aggregated opinion.

generalizability of these results. Similarly, we will speak of ‘mechanisms’ and ‘inferences’ generically, but it is possible that how people perceive and respond to aggregated opinion is a function of their cultural environment<sup>40</sup>.

## Defining and measuring aggregate opinion

Social scientists have generally approached opinion as either a latent or explicit construct. Early political theorists, for instance, considered public opinion to be the dynamic, emergent and latent sentiment of society regarding a given proposition<sup>41–43</sup>. Later empirical scholars defined public opinion as the elicited, quantified and summarized judgements of the individuals that comprise society regarding a proposition in a given moment<sup>44–46</sup>, in which judgements can refer to any reported evaluations of stimuli, including likelihood, truth or quality. Our definition of aggregated opinion as the elicited, quantified and summarized judgements of arbitrarily large groups of individuals builds on the approach by empirical scholars because it offers a direct link to measurement. The key distinction that we draw between public and aggregated opinion is that aggregated opinion extends beyond judgements of ‘society’ (in that it can cover the judgements of smaller collectives such as the users of a product, as well as larger collectives such as the opinions of everyone in the world).

This definition of aggregated opinion leaves some questions open, such as whether there are different kinds of opinion (for instance, whether judgements formed through deliberation across years and judgements formed rapidly in response to surveys are different kinds<sup>46</sup>). This definition also excludes more qualitative forms of opinion aggregation, such as ethnographies<sup>47</sup>, and cases in which opinions are inferred from behaviour rather than being reported<sup>3,48</sup>. We adopt the explicit, operationalist definition as a provisional tool to facilitate empirical research – one that should be enriched in future work to capture nuances long noted by the latent approach<sup>49</sup>.

Our definition highlights two distinctive properties of aggregated opinion: the complexity of its causal history (including its elicitation, quantification and summarization) and the simplicity of its content (a mere summary of judgements). Understanding these properties is necessary for making sense of the inferences made by people from aggregated opinion.

## Complex causal history

Aggregated opinion is the result of a complex process with five stages: sampling, measurement, collection, summarization and presentation<sup>50</sup>. Each stage uniquely sculpts the final form in which individuals encounter aggregated opinion, with implications for what can be inferred from it.

The process begins with a target population whose opinions are of interest. It is often impractical to collect the opinions of the entire population, so opinions are sampled instead. Samples exist on a continuum from convenience samples (obtained from easily accessible members of the population) to probability samples (obtained randomly from the population)<sup>51</sup>. Ideal samples are representative: their characteristics generalize to the population. For instance, an election poll on a representative sample of Americans would result in an estimate of the popularity of a candidate that approximates the population-level popularity of the candidate.

The attitudes of interest are then measured in the sample through an ‘instrument’. Typically, the instrument is a question accompanied by a response scale. For instance, an election poll might ask “How much do you like the candidate?”. Here the extent of ‘liking’ is the target

judgement, which might be measured through a slider scale from ‘not at all’ (0) to ‘extremely’ (100). Instruments can vary dramatically in the judgement they target (for instance, subjective probability that a claim is true, perceived quality of some product or perceived efficacy of some policy), and in the measurement involved (for instance, a multiple choice question or a verbal response that is mapped on to some response scale)<sup>52</sup>. Ideal measurement is reliable and valid, such that responses are stable, capture judgements of interest and generalize to other judgements and behaviours by the same person<sup>53,54</sup>. For instance, a reliable measure of apple preference would predict whether someone is likely to eat apples when presented with them, and would yield consistent estimates of preference if presented multiple times to a participant over a short time interval.

Once an instrument is crafted for measurement, opinion can be collected – that is, the instrument can be administered to the sample. An important consideration involved in collection is the mode of administration, as different methods entail different trade-offs. For instance, the same instrument can be implemented in a simple anonymous online survey or in a face-to-face interview following a small-group discussion. Online surveys typically produce less desirability bias and more sharing of sensitive information than face-to-face surveys, but are harder to comprehend (for instance, because participants cannot ask clarifying questions in an online survey, whereas they can during in-person interviews) and prone to noisy responding<sup>55–58</sup>. Modes of administration can also influence the extent to which participants offer relatively unreflective versus more deliberative responses. For example, questionnaires with minimal context are less likely to be biased by the researcher but more likely to elicit unconsidered or made-up responses than interviews involving more deliberative components, such as group discussions<sup>59,60</sup>. Moreover, online surveys increasingly run the risk of receiving responses automated through generative artificial intelligence<sup>61</sup>.

Collected opinions are finally summarized and presented. Often, measures of central tendency (such as the mean or median) are used to summarize opinion data<sup>30,62</sup>, even though the same statistics can be consistent with many opinion distributions, which means that a lot of potentially relevant information is left out<sup>63,64</sup>. More nuanced forms of summarization are also possible. For instance, the product ratings on Amazon are the output of a proprietary machine-learning algorithm that takes factors such as recency into account<sup>65</sup>. Aggregated opinions can then be presented quantitatively (Fig. 1c,d,e), through an analogue representation corresponding to that quantity (Fig. 1b) or using both formats (Fig. 1a).

Together, these five stages reveal the many degrees of freedom involved in aggregation: even if each stage was only a choice between three options, there would be 243 varieties of aggregated opinion that one could encounter (Table 1). Thus, aggregated opinion is a form of social information with a complex causal history.

Research in marketing and science communication, as well as political science, has investigated how choices made at each of the five stages described above influence the inferences that people draw from aggregated opinion. For instance, different presentations of ratings can lead to different product quality judgements (as one example, a left-digit bias can make ‘3.8/5’ seem worse than the equivalent rating presented as three fully filled and one mostly filled star out of five stars<sup>66–69</sup>). Presenting scientific consensus in different formats can lead to different degrees of confidence in the extent of consensus<sup>24,70,71</sup>, and in some domains (such as aggregated predictions about future sporting events), people seem more persuaded when claims are

**Table 1 | Two examples of aggregated opinion**

Stage	Key consideration	Examples	
		Amazon product reviews	Gallup opinion polls
Sampling	Whose opinions are included	Any user	Nationally representative probability sample
Measurement	What were people asked	Star rating from 1 to 5	Multiple choice question
Collection	How were opinions solicited	Online, anonymous	Phone call with pollsters
Summarization	How were the data compressed	Proprietary algorithm	Mean response
Presentation	How was the data summary presented	Predicted star value out of 5	Bar chart

accompanied by some measure of uncertainty<sup>72</sup>. All of these choices matter for scholars who aim to understand how people learn from aggregated opinion, as they potentially shape the inferences that people draw. For instance, people with previous knowledge about what representative sampling means are more likely to draw stronger inferences from representative samples than from convenience samples<sup>73</sup>. As this example points out, such causal complexity can lead to substantial individual differences in how people interpret the same instance of aggregated opinion.

### Simplicity of content

Although aggregated opinion is the result of a complex process, its contents are remarkably simple. Regardless of how it is measured or collected, aggregated opinion contains a summary of judgements. This simplicity contrasts with the information contained in testimony, as in a child telling their mother that they did not break a vase. This testimony will not only contain a reported judgement (“It wasn’t me!”), but also reasons, evidence and arguments that support the reported judgement (“I was with dad this afternoon!”)<sup>74</sup>. Moreover, the testimony will be accompanied by dynamic nonverbal information, including the pitch of the child’s voice, their posture, gaze aversion and facial expression<sup>75</sup>. In contrasting individual testimony with aggregated opinion, there are two dimensions to consider: the richness of the data (which is high in most cases of testimony and low for mere reported judgement), and the number of judgements being aggregated (one in the case of individual testimony and an unbounded number in aggregated opinion). Although these dimensions are in principle dissociable, it is not a coincidence that large-scale aggregation tends to lose information: aggregated opinion omits qualitative richness to provide a compressed snapshot of the judgements of many people.

This simplicity of content leads to the observation that, on issues that concern objective matters of fact, aggregated opinion is a fundamentally different kind of evidence from testimony. In the absence of information about the reasons of others for their judgements, aggregated opinion at best offers indirect reasons to doubt one’s own beliefs<sup>76</sup>. For instance, learning that 50% of your friends disagree with you about the answer to a tricky mathematical problem (for instance, whether  $5 + 5 \times 5 = 30$  or 50) might lead you to question

your answer – perhaps others have access to information you lack, or perhaps they engaged in more careful reasoning. However, the fact that others disagree with you is not itself a reason for why one answer is right or wrong. In this example, the truth of the question comes down to the rules of arithmetic and the order of operations.

More generally, aggregated opinion does not typically provide direct evidence concerning the truth of the proposition in question<sup>77–79</sup>. Epistemologists call this indirect kind of evidence higher-order evidence (Box 1). The distinction is important because the kind of evidence in question can affect the inferences that people draw from that evidence. For instance, the inferences drawn from higher-order evidence depend on evaluations of how accurate the sources tend to be (for example, ‘are my friends more or less reliably correct than me when it comes to solving mathematical problems?’). By contrast, the inferences drawn from first-order evidence require evaluations of the link between the evidence and the question (for example, ‘is a particular rule about the order of operations a good reason to think the answer is 30?’)<sup>76</sup>. Thus, when drawing inferences from the mere fact that others disagree with them – a source of higher-order evidence – people need to evaluate the relative expertise of the sampled population<sup>80,81</sup>.

In brief, aggregated opinion is the elicited, quantified and summarized judgements of a collection of individuals, a form of social information that is increasingly prevalent. It has a complex causal history in that purveyors of aggregated opinion make key choices about how to sample, measure, collect, summarize and present opinion, and these choices can shape the inferences that people draw from aggregated opinion (for instance, with probability samples leading to greater trust in the accuracy and objectivity of polls than convenience samples<sup>73</sup>). At the same time, aggregated opinion is a summary that abstracts away from much of the qualitative richness and

### Box 1 | Higher-order evidence

Epistemologists draw a distinction between first-order and higher-order evidence<sup>76,79,810</sup>. To illustrate, consider writing a psychology essay for an examination and learning two things as you exit the testing room: that Skinner, not Watson, wrote *Verbal Behavior*, and that you were drugged before you wrote the essay. Your confidence that you will receive a perfect score on the essay on behaviourism, in which you claimed that Watson wrote *Verbal Behavior*, should take a hit from each revelation, but in different ways. Learning the fact about the authorship offers direct (or first-order) evidence that you made a mistake. Learning that you were drugged should decrease your confidence more indirectly: your intoxication has no bearing on who wrote which psychological treatise, but it might lead you to question whether you accurately processed the information in the essay prompt.

This distinction has implications for how people draw inferences from opinion. For instance, when drawing inferences from first-order evidence, people typically need some expertise in the subject matter itself. When drawing inferences from the mere fact that others disagree with them, people need to evaluate the relative expertise of the sampled population<sup>80,81</sup>. Aggregated opinion, disagreement and similar forms of social information are often better characterized as providing higher-order evidence than first-order evidence, although they often provide a complex blend of the two<sup>78</sup>.

direct evidence characteristic of individual testimony, and it offers a correspondingly different form of evidence.

## Responding to aggregated opinion

Having characterized key properties of aggregated opinion, we turn to empirical evidence on how people respond to it. We review research on when people conform to, learn from and ignore the opinions of others. Conformity involves social pressures to change one's beliefs towards the aggregated opinion<sup>82</sup>; learning involves mechanisms for inferring properties of the world from aggregated opinion<sup>33</sup>, and ignoring involves discounting or failing to process aggregated opinion entirely<sup>83</sup>. To illustrate, imagine an individual who believes in climate change and reads that 87% of the members of a group deny climate change. Moreover, imagine that the believer perceives this group to be systematically unreliable (that is, the aggregated opinions of the group are inaccurate more often than they are accurate). Conforming in this situation could entail adjusting one's beliefs to align with the group (towards denying climate change), learning could entail updating one's beliefs in light of the disagreement (towards believing in climate change, since the group is always wrong), and ignoring opinion could entail not shifting one's beliefs at all.

## Conforming to aggregate opinion

Early social psychological studies of opinion, largely conducted after World War II, focused on the tendency of people to conform to the judgements and behaviour of others<sup>84</sup>. For instance, in landmark studies of the era, a naive participant was placed in a room with six to nine confederates who consecutively reported their judgements in an easy perceptual task, with the participant reporting their judgement last. Their task was to pick, from a set of possible alternative lines, the line from a visual display that best matched a target line in length, and to indicate their choice out loud. In the key experimental condition, confederates unanimously identified a line that was clearly not the one that best matched the target. Most naive participants, on at least one of the relevant trials, reported out loud the inaccurate but unanimously chosen option when it was their turn to provide their response, and a smaller subset of participants later privately reported changing their beliefs as well<sup>85</sup>. Later work extended this paradigm to other domains, group sizes and cultures, and found that many participants provide the inaccurate consensus response across these contexts<sup>82,86–88</sup>.

The conformity paradigm just described is not an example of aggregated opinion as we have defined it (as the opinions of the group are not provided in aggregated form), but it does demonstrate the surprising extent to which people conform to inaccurate judgements, and it inspired later research that examined shifts towards aggregate opinion that plausibly reflect the operation of mechanisms related to conformity. First, research has documented shifts towards aggregate opinions in online preference and judgement tasks, in which the opinions of others are summarized and presented as average ratings<sup>89–91</sup>. Second, political scientists have investigated whether voters become more likely to turn out and vote for candidates whom they are told to be increasingly popular in polls<sup>21,92,93</sup>. Although field studies have shown mixed results, experimental studies have provided evidence of conformity<sup>22,94,95</sup>.

In some cases, the collective opinions of a group are inferred, rather than explicitly provided. In such cases, these perceived group opinions shape beliefs. Research on pluralistic ignorance (in which group members misperceive the distribution of opinions within their own groups<sup>96</sup>) has revealed that people draw diverse, and sometimes

inaccurate, inferences about what others in their community believe and do, and that they conform to these inferred opinions and behaviours. For instance, students in a fraternity overestimated the willingness of others within the group to racially discriminate against people from minority racial backgrounds and discriminated against them, in part to conform to this self-actualizing norm<sup>97,98</sup>. These mistaken inferences are rooted in biased exposure to the judgements of others (such as overexposure to a salient subgroup of a larger population<sup>99,100</sup>) and biased processing of the judgements of others (such as overgeneralization of an individual's own judgements to others<sup>101–103</sup>). Related research has examined the processes underlying misperceptions of the opinions of groups that individuals are not themselves a part of, which are referred to as out-party misperceptions (for instance, the inaccurate beliefs that Democrats have about the opinions of Republicans). This research has shown that such misperceptions are not only prevalent<sup>104</sup> but impactful, potentially driving ideological polarization in the USA (that is, partisans developing increasingly disparate political beliefs). For instance, partisans overestimate the proportion of out-party members who hold extreme political beliefs, and correcting these misperceptions by providing partisans with the actual proportion of out-party members that hold extreme beliefs results in partisans' own beliefs becoming more moderate<sup>105</sup>. Related research has also explored the relationship between affective polarization and misperceptions, and reached mixed conclusions<sup>106–109</sup>.

Theorists often emphasize social influence as a causal factor that drives conformity within and across social groups. For instance, social impact theory posits that conformity is driven by a multiplicative function of the strength (power and status), immediacy (proximity) and quantity of the members of a group<sup>110,111</sup>. These factors are thought to influence judgements because attitudes have a social function as signals of group affiliation<sup>112,113</sup>. By aligning their beliefs with those of their in-group, individuals can enjoy the benefits of social integration while avoiding the drawbacks of social exclusion<sup>114–116</sup>. Other theories of conformity share the same mechanistic logic that people are attracted to or repulsed by the beliefs of others as a function of social factors such as power and similarity<sup>117–119</sup>. These mechanisms of conformity have been implemented in agent-based models of societal opinion dynamics, which seek to simulate or explain the evolution of opinion in populations over time<sup>120–123</sup>.

Social factors clearly have a role in driving conformity – more powerful individuals, for instance, conform less than the powerless<sup>124–126</sup>, and conformity is less prevalent when judgements are made privately<sup>85,127,128</sup>. Yet, they are not the sole drivers of how people evaluate and respond to aggregated opinions. Theories of conformity typically acknowledge that opinion can have an informational role beyond the affiliative, where the informational role refers to the capacity of opinion to provide useful evidence about the world, whereas the affiliative role refers to the capacity of opinion to signal group membership<sup>82,129,130</sup>. We address this informational role in the next section on learning from aggregated opinion.

## Learning from aggregate opinion

In some cases, people can use aggregated opinion to learn not only about the opinions of others but also about the world itself, such as the answer to a mathematical problem or the quality of a product. As a concrete example, consider early research on the 'wisdom of crowds', which demonstrated that the aggregated opinion of a crowd of judges evaluating the weight of an ox was highly accurate (the median judgement was within 1% of the actual value), whereas the judgements of

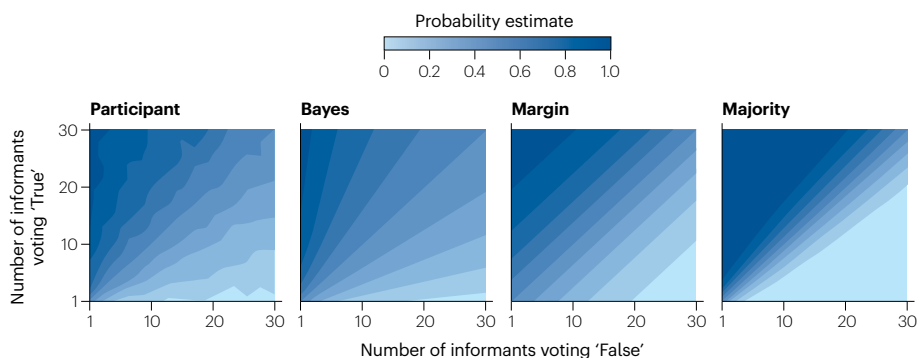
individual judges were highly variable (only half of the judges were within 7% of the actual weight of the ox)<sup>131</sup>. In this case, an individual could use aggregated opinion to learn about a property of the world: the weight of the ox. Work in cognitive and computational psychology has focused on how three basic features of aggregated opinion shape the inductive inferences made by people about the world. These features are the quantity of people whose opinions were sampled and summarized, the reliability of the sampled group (that is, their likelihood of providing accurate judgements about the world<sup>36,132,133</sup>) and the dependence of the judgements of the individuals constituting the sample (that is, the causal dependence or correlation between their judgements<sup>35,37,134</sup>, which is itself influenced by many factors, such as the amount of shared information between informants<sup>135</sup>, the extent of communication between them<sup>136</sup> and the similarity of informants' previous knowledge<sup>137</sup>). These features have been studied in part because formal analyses across multiple literatures (including Bayesian epistemology, jury theorems and wisdom of crowds) have shown that they shape the probability with which following aggregated opinion is likely to lead to accurate inferences about the world<sup>35,132,138</sup>. In other words, these factors determine the informativeness of aggregated opinion. Intuitively, the aggregated opinion of a small group of unreliable informants who copy the judgements of each other is much less likely to lead to accurate inferences about the world than the aggregated opinion of a large group of informants who provide independent judgements<sup>139</sup>.

When it comes to quantity, evidence has suggested that people change their beliefs more when provided with the opinions of larger groups – for conspiratorial beliefs<sup>140</sup>, consumer ratings<sup>141,142</sup>, polls<sup>143</sup> and in collective reinforcement learning tasks<sup>144</sup>. Moreover, using computational models, the extent of belief change can be quantitatively predicted. For instance, one study explored how participants drew inferences about the likely truth of statements when shown a large set of aggregated opinions in a game-show setting. These statements included masked statements (that is, statements that were only identified with a label such as 'Statement 2') and trivia statements (for instance, that 'Bismarck was the name of a German ship sunk in World War II'). The predictions of a Bayesian model (which assumes that the distribution of opinions matches the probability with which propositions are true) closely aligned with the inferences of participants for both masked statements (Fig. 2) and for trivia statements. This model was sensitive to both the prior beliefs of participants and the proportion of judges that identified statements as true, and it performed better than alternative models<sup>33</sup>. That the Bayesian model performs well suggests that people are not merely conforming to aggregated opinion in these cases, but that they are in fact learning. Conformity does not

provide a precise prescription for how to adjust the beliefs of an individual towards aggregated opinion, whereas learning does (in the form of the precise inductive inference specified by the Bayesian model).

When it comes to reliability, people are more likely to change their beliefs concerning key issues such as climate change upon learning about scientific consensus if they perceive scientists as competent and trustworthy versus incompetent or unreliable<sup>62,145–147</sup>. More generally, children, adults and even great apes are sensitive to the reliability of informants across many contexts<sup>12,148–151</sup>. For instance, in one study, adults were provided with the distribution of opinions in a group that reached a majority consensus either through genuine deliberation (an epistemically reliable opinion formation mechanism) or by being forced to provide certain opinions by an angry member (an epistemically unreliable mechanism). The level of confidence that people had in the likelihood that the majority was correct was higher for the cases in which the judgement of the group was formed through deliberation<sup>152</sup>. Reliability can be influenced by many factors, such as the competence of the informants<sup>153</sup>, but also their motivations<sup>138</sup>, incentives<sup>154</sup> and intentions<sup>15</sup>.

As for the effect of dependence, people sometimes change their beliefs more when receiving information from groups of individuals that have independent sources, as opposed to groups that repeat the same second-hand information<sup>135,155–157</sup>. However, there are two caveats to this finding. First, people typically underweight the influence of dependence. In some studies, people have failed to discount dependency as much as rational models predict they should<sup>37,158</sup>, and in some studies, people have failed to distinguish between independent and repeated information at all (unless prompted explicitly<sup>155</sup>)<sup>159</sup>. Second, much of this research investigates relatively simple forms of dependence (such as copying a primary source), but some real-life informational dependence structures are much more complex. For instance, some dependencies are asymmetric: some people influence others but are not influenced by them. In these cases, dependencies can lead to counterintuitive results in which dependency increases informativeness. If the opinions of an expert and a novice are to be summarized into aggregated opinion, for example, and the expert was permitted to share their judgement with the novice before aggregation, then there can be a dependency advantage (such that the aggregated opinion is more informative in the case in which the novice depends on the expert than in a case in which they provide their judgements independently)<sup>160,161</sup>. In such complex settings, especially those requiring joint inferences (such as inferring truth from information about both reliability and dependence), people might rely on heuristics (such as following the majority<sup>32</sup>) to change their beliefs rather than performing the optimal Bayesian inference.



**Fig. 2 | Optimal learning from aggregated opinion.**

The mean judgements made by participants of the truth of statements based on aggregated opinion (first graph) are better modelled by a Bayesian model (second graph) than a model that is sensitive to the margin of opinion<sup>309</sup> (third graph) or a model that quickly converges to the majority<sup>153</sup> (fourth graph). For further details, see ref. 33. Figure adapted with permission from ref. 33, Sage.

In summary, research has shown that adults are sensitive to factors that rationally influence the informativeness of aggregated opinion, including the size, reliability and dependence of groups. In related work, research in developmental psychology has charted the development of sensitivity to these considerations (Box 2).

## Ignoring aggregate opinion

Research on conformity and learning emphasizes the pliability of beliefs to opinion. Given this emphasis, it should not be surprising that applied researchers have tried to communicate aggregated opinion as a lever to shape beliefs. For instance, much research has focused on communicating scientific consensus to reduce the prevalence of antisocial beliefs<sup>162,163</sup>. Findings from this research are often framed in a positive light: influential studies have reported that communicating scientific consensus can effectively change the beliefs of those who did not already believe the scientific consensus<sup>164</sup>, and many studies have found and emphasized that expert opinion can shape the scientific beliefs of laypeople<sup>62,165–167</sup>. Similar research on political behaviour aims to reduce anti-democratic attitudes by correcting out-party misperceptions through aggregated opinion. Researchers are again optimistic that these interventions can remedy societal issues such as polarization<sup>168</sup>. This work has suggested that correcting misperceptions can significantly increase support for fair elections<sup>169</sup>, increase liking of out-group members<sup>170</sup>, reduce support for gerrymandering<sup>171</sup> and decrease dehumanization<sup>172</sup>, among other outcomes<sup>173</sup>.

Yet, the way this work is framed obscures two important facts. First, the beliefs of many individuals remain unmoved in studies that correct their misperceptions about the distribution of opinion. For instance, in a study that examined 96 controversies across science, morality, politics and religion, when participants learned the true levels of population disagreement with their views (which, on average, involved approximately 25% more disagreement than they assumed), approximately 85% of people reported not questioning their views and approximately 75% did not change their beliefs at all<sup>174</sup>. Second, the average effect size for consensus messaging is small: around one-tenth to three-tenths of a standard deviation in meta-analyses for scientific consensus<sup>164,175</sup> with similarly weak effects in studies of anti-democratic attitudes<sup>176,177</sup>. To make this effect size concrete, consider a scientific belief measured on a hundred-point scale, for which the pooled standard deviation in responses is 20 (ref. 178). The effect of consensus messaging with an effect size of one-tenth would be around a 2% shift. This small effect size is consistent with claims in the science communication literature that interventions that simply aim to inform people of relevant facts are typically ineffective in changing unscientific beliefs<sup>179–181</sup>.

Such persistence of belief amid dissent is related to a broad family of phenomena that describe how people fail to change their beliefs when faced with disconfirmatory evidence<sup>182–185</sup>. These phenomena include confirmation bias<sup>186,187</sup>, closed-mindedness<sup>188,189</sup>, cognitive rigidity<sup>190,191</sup>, conservatism in updating<sup>192,193</sup>, motivated reasoning<sup>194,195</sup>, primacy effects in judgement<sup>196,197</sup>, belief perseverance<sup>198,199</sup> and reactions to cognitive dissonance<sup>200,201</sup>, and have been the subject of inquiry since the seventeenth century<sup>202</sup>. This research suggests that aggregated opinions (and other forms of disconfirmatory evidence) often fail to influence beliefs, especially when they contradict beliefs held on local evidence (such as first-hand observations)<sup>203</sup>. Just as people at times conform to and learn from aggregated opinion, at times they also ignore it and persist in their views. Thus, the key question is not

whether opinion shapes belief but rather when it does so and what psychological mechanisms are responsible.

## Mechanisms that drive responses to aggregated opinion

Although research on conforming to, learning from, and ignoring aggregate opinion has been pursued in somewhat independent research traditions, these traditions share the goal of explaining when and why people change (or fail to change) their beliefs in response to aggregated opinion and often posit common mechanisms. The paths to persistence model<sup>174</sup> is an effort to systematize and extend this work, and for that reason, we focus on it here. The model systematizes previous work in grouping families of mechanisms posited by research traditions from social psychology<sup>201,204,205</sup> to cognitive psychology<sup>2,150,206</sup>, including formal models of social influence<sup>117,118,120</sup> and social learning<sup>132,135,207</sup>. The model extends previous work by considering how these families of mechanisms, or ‘paths’, jointly shape responses to aggregated opinion, including interactions across paths.

Although the primary goal of the paths to persistence model is to explain cases in which people persist in their beliefs in the face of aggregated opinion, the mechanisms involved in learning from, conforming

## Box 2 | Development of learning from opinion

A foundational puzzle in developmental psychology is how to explain the rapid development and impressive scope of children’s understanding of the world, and a central piece of the solution is social learning<sup>311–313</sup>. For instance, most preschoolers (3–4 years of age) believe basic cosmological facts — such as that the Earth is spherical — not because they have seen the Earth from space, but because they can learn from others<sup>314</sup>.

The capacity of children to learn from others demonstrates sensitivity to the core determinants of the informativeness of opinion and their sensitivity changes as they develop. In describing these developmental findings, we give age ranges that mark typical points in a dynamic developmental trajectory rather than discrete stages of development<sup>315</sup>. By 3 years of age, children draw stronger inferences from multiple informants (versus a single informant)<sup>316</sup>; at 4 years of age, they systematically prefer learning from reliable (versus unreliable) testimonies of informants<sup>317</sup>; and by 6 years of age, they can differentiate between the informativeness of multiple second-hand versus first-hand sources of knowledge<sup>318</sup>. By 8 years of age, children tailor methods of opinion collection to different kinds of judgement tasks: they prefer group deliberation for reasoning-based judgement tasks (such as a Sudoku puzzle), and independent crowdsourcing for popularity-based judgements (such as the favourite fruit of the group)<sup>152</sup>. Moreover, children are sensitive to the factors that influence the informativeness of opinion when navigating disagreements<sup>319,320</sup>. The early and rapid development of these learning mechanisms underscores their importance to social learning<sup>9,312</sup>. Importantly, it is difficult to generalize developmental research to learning from aggregated opinion in adults, not only because some processes might be unique to development but also because studies with children overwhelmingly focus on responses to the testimony of a handful of informants, rather than testing inferences from (or about) aggregated opinions.

to or ignoring aggregate opinion are all potentially relevant, for two reasons. First, the mechanisms that drive learning and conformity do not necessarily result in belief change. For instance, someone could evaluate aggregated opinion with the aim of learning, discover that the individuals in the group are unreliable informants, and so persist in their original beliefs as a consequence of reliability-sensitive learning mechanisms. Second, exhaustively identifying the conditions that generate belief persistence is equivalent to exhaustively identifying the conditions that generate belief change, whether that change occurs through conformity, learning or some other process.

The paths to persistence model posits four families of mechanisms, or paths, that can each generate persistence: the informational, functional, ontological and computational paths (Table 2). In brief, a person might discount the opinions of others because they perceive the informants to be ignorant, biased or stupid (informational path); sense that changing their beliefs can have bad social or personal consequences (functional path); or consider the issue to be subjective or unknowable (ontological path). In addition, a person might fail to accurately represent or reason about the opinions of others owing to cognitive limitations (computational path). By contrast, a person will be likely to change their beliefs if they perceive others who disagree as smart, view change as beneficial, regard issues as objective, and carefully consider the opinions of others. Here we first describe each path and the evidence that supports it; we then consider how the paths interact.

## The informational path

The informational path captures epistemic reasons to ignore or heed the opinions of others. This path is sensitive to what aggregated opinions reveal about the world. Having a smaller number of unreliable and dependent informants can make the opinions of others less informative about the world and lead to belief persistence. By contrast, aggregated opinion ascribed to a large group of reliable and independent informants can be a path to belief change amid dissenting opinion. Research on naive realism (the tendency of people to assume that their perceptions reflect reality) has shown that individuals often view people who disagree with them as ignorant<sup>208,209</sup>, biased<sup>210,211</sup>, unintelligent<sup>212</sup> and moulded by mass media<sup>213,214</sup>; that is ‘brainwashed’<sup>215</sup>. Making denigrating inferences about people who

disagree is common in media<sup>216</sup>, and can be found even in children 8–9 years of age who frequently label disagreeing peers as uninformed or ignorant<sup>217</sup>. This research shows that disagreements can lead to inferences of unreliability and dependence, which in turn lower the likelihood of belief change in response to the opinion of others. For example, even children change their beliefs less when they receive personal reports from incompetent informants<sup>218–220</sup>, and adults who are prompted to carefully evaluate dependence also change their beliefs less when there is more dependency among informants<sup>155</sup>. These examples illustrate how informational considerations can be a path to persistence, and correspondingly, how rejecting the information path to persistence can support belief change.

## The functional path

The functional path captures practical (non-epistemic) reasons to persist in or change one’s beliefs. These reasons include the social, emotional and pragmatic consequences of holding versus changing beliefs. In the social sphere, research on conformity emphasizes social pressures that make belief pliable<sup>86,88</sup>, but the same mechanisms can restrict belief change. For example, some beliefs are maintained because they are held by a majority of one’s in-group, and the perceived harmful consequences of belief change in this social context can lower the likelihood of belief change<sup>221–223</sup>.

Beliefs also have important intrapersonal functions, which can influence persistence and change. For example, holding certain beliefs (such as the belief that one’s business will survive economically challenging periods<sup>224</sup>) can promote effective decision-making by boosting self-esteem<sup>225,226</sup> and limiting ambiguity<sup>227,228</sup>. Other beliefs, such as the belief that the world is just (in particular, that good things happen to good people and bad things happen to bad people<sup>229</sup>), hold intrinsic value for believers<sup>230,231</sup>. Consider an activist campaigning for an unpopular cause. If they readily changed their beliefs after seeing a poll that suggests little public support, they might be less likely to pursue difficult lobbying and persuasion efforts with possible long-term benefits<sup>232</sup>. Moreover, the egalitarian beliefs of the activist could ground their identity and give them a sense of existential justice<sup>233–235</sup>, providing psychological benefits such as a sense of purpose and drive<sup>236</sup>.

**Table 2 | Four paths to belief persistence and belief change**

Path	Driver of persistence	Example persistence response	Driver of change	Example change response
Informational	People who disagree are not reliable informants	An individual who is an anti-vaxxer might discount scientific consensus because they believe that scientists merely parrot the agenda of a government agency	People who disagree are reliable informants	An individual who is a science-denier who learns about the scientific method might be more likely to accept scientific consensus
Functional	Changing opinion would have negative interpersonal or intrapersonal effects	A supporter of a corrupt politician might ignore polls that show that most people detest the politician owing to social pressures from friends who also support the politician	Changing opinion would have positive interpersonal or intrapersonal effects	A person who has moved to a new town and is attempting to adjust to their social context, and as a consequence conforms to a new set of norms
Ontological	Do not think that there is an objective truth	A listener of alternative jazz might ignore dislikes on their social media playlists because they see musical taste as subjective	Think that there is an objective truth	A person considering veganism can learn more from the opinions of a person who is vegan after understanding the objective harms of industrial meat production
Computational	Time pressure or lack of cognitive resources	A consumer might ignore Amazon reviews for a cheap product because they do not have the time to optimize their purchase	Sufficient cognitive resources available	A student who is deeply engaged in a moral philosophy course might suspend judgement on ethical debates after realizing their complexity



These examples highlight the important interpersonal and intrapersonal functions that beliefs serve<sup>237</sup> and how they can anchor beliefs amid conflicting opinion<sup>194</sup>. Importantly, these functions can also promote change. For instance, in cases in which the opinions of one's in-group change over time<sup>238,239</sup>, or in which individuals migrate to new social contexts<sup>240,241</sup>, the interpersonal pressure towards having in-group consistent beliefs can result in more belief change<sup>242</sup>. Thus, the balance of interpersonal and intrapersonal costs and benefits can determine whether the functional path leads to belief persistence in response to aggregated opinion.

## The ontological path

The ontological path to persistence has received less attention than the elements within the informational or functional paths and concerns the meta-epistemic status of the issue itself, which can promote or block belief change. For instance, an issue can be an objective matter of fact (such as the atomic number of gold) or a subjective preference (such as which flavour of ice cream is best), and can be knowable (such as how many US presidents have been men) or potentially beyond human verification (such as whether pets go to heaven). If an issue is seen as subjective or a matter of 'mere opinion', there is no shared reality to which disparate opinions should rationally converge<sup>243,244</sup>. By contrast, agreement theorems in computer science that focus on objective beliefs show that rational learners informed of the disparate beliefs of each other converge to a consensus opinion<sup>245,246</sup>. These observations about rational belief revision are reflected in human psychology. For instance, someone who views morality as a matter of personal preference can ignore the dissenting views of others because they do not regard them as a guide to any shared reality<sup>247</sup>, and empirical research has shown that construing moral issues as subjective indeed facilitates the co-existence of diverse beliefs (indicating that individuals do not change their beliefs despite encountering dissent)<sup>248–251</sup>. Beyond subjectivity, the opinions of others can be irrelevant to one's own when issues are perceived as unknowable<sup>252–255</sup>. For instance, if someone learns that others disagree with them concerning the possibility of time travel, regarding the issue as fundamentally unknowable can shield their belief from the influence of dissent, and evidence has suggested that unknowability indeed facilitates persistence on religious and political issues<sup>256–258</sup>. By contrast, establishing the objective knowability of propositions can promote belief change when presented with aggregated opinion. For instance, combining information about the scientific consensus on global warming with an explanation of the mechanisms of global warming (which plausibly illustrate the objective knowability of global warming) results in substantial belief change<sup>259</sup>, whereas interventions that provide scientific consensus alone do not yield much change<sup>175</sup>. Thus, perceiving issues as components of an objective reality can get people to heed the opinions of others, although important issues are often sustained amid disagreement owing to perceptions of subjectivity or unknowability.

## The computational path

Finally, the computational path identifies how mental resources can either cause persistence (for instance, when people are distracted from attending to aggregated opinion) or belief change (for instance, when people are prompted to deeply consider the implications of aggregated opinion). Evaluating informational, functional and ontological considerations when encountering aggregated opinion can be challenging because there are limitations to the amount and kinds of computation that people can deploy when reasoning<sup>260,261</sup>. These limitations cause

information to be processed in a qualitatively shallow way in many cases<sup>262,263</sup>, especially when processing information in the face of the distractions in everyday life<sup>264</sup>. Shallow processing can facilitate persistence of beliefs in the face of contradictory evidence<sup>265,266</sup>, whereas deep reflection on relevant evidence can facilitate belief change<sup>267,268</sup>. Beyond not being able to or choosing not to reason comprehensively owing to these cognitive constraints, people might also lack coherent conceptual background on issues and fail to change their beliefs owing to such limitations in their representations<sup>269–271</sup>. For example, if someone does not know that mRNA is used in modern vaccines, learning of the scientific consensus on the safety of mRNA technology would fail to move their beliefs about the safety of vaccinations. Public opinion scholars have observed that people often form politically relevant beliefs (such as the safety of vaccination) without sufficient care, knowledge or expertise<sup>272,273</sup>. In these ways, the resources available for informational, functional or ontological evaluation can themselves moderate the effect of aggregated opinion on belief.

## Interactions between the paths to persistence

The four paths reviewed thus far interact in driving responses to opinion. For instance, whether an issue is conceptualized as objective (an ontological consideration) influences whether the expertise of others (an informational consideration) is relevant. Imagine learning that 85% of experts consider an item to be the best. If the item is a Wi-Fi router that can be evaluated on objective performance criteria, expert consensus might sway the purchase. However, if the item is a painting that will only be privately viewed, the expertise of others might have less influence on the purchase<sup>274</sup>. Accordingly, emphasizing the subjectivity of a domain can attenuate the role of the informational path when faced with dissent<sup>217,275</sup>. Similarly, when issues are objectively verifiable (for example, whether a bear was sighted on a school campus), then the independence of various witnesses providing testimony on the issue influences judgements more than when issues are seen as complex and hard to verify (for example, the likely success of a tax policy)<sup>159</sup>.

Another important interaction is that the informational value of dissenting opinions might be better appreciated when functional considerations are attenuated. For instance, if it is salient that the loved ones of an individual will judge them negatively for changing their beliefs and they feel insecure, they might be less likely to consider the informational value of opinion because the social cost is too high. However, if the same person engages in self-affirmation exercises to boost their self-esteem, they might be better positioned to open-mindedly evaluate others as informants<sup>276</sup>. Finally, conceptualizing an issue as subjective can facilitate socially adaptive responses to opinion: subjectivity leads to more belief change when aggregated opinion comes from known peers<sup>277</sup> (such that it is socially valuable and important to conform) but leads to less belief change when aggregated opinion comes from anonymous others online<sup>278</sup> (such that conformity holds no social value). These examples illustrate the importance of considering all paths to persistence in parallel and, correspondingly, why insights from across psychology and the social sciences more generally are crucial for understanding when and how beliefs are shaped by aggregate opinion.

## Summary and future directions

Aggregated opinion guides everyday judgements and decisions in a remarkably diverse range of contexts. Online review platforms curate ratings for everything from movies to professors<sup>279</sup>, social media platforms tally attitudes to practically all posted content<sup>29</sup>, and a growing

polling industry constantly collects societal opinions on issues ranging from the morality of abortion<sup>280</sup> to the Israel–Palestine conflict<sup>281</sup>. In this Review, we synthesized an expanding yet still siloed cross-disciplinary literature on this distinct form of social information.

We first provided a working definition of aggregated opinion and described its simplicity as a snapshot of many attitudes and its complexity as the product of a process with many decision points. We then discussed how social psychologists have focused on the mechanisms that drive people to conform to opinion (that is, change their beliefs to align with the opinions of others), how cognitive psychologists have focused on the mechanisms that drive people to learn from opinion (that is, change their beliefs in accordance with the evidentiary value of the opinions provided), and yet how people frequently ignore the opinions of others instead (that is, they do not change their beliefs in light of opinion at all). Next, we summarized four key considerations for belief persistence (the informational content of opinion, the functional consequences of changing one's beliefs, the ontological status of issues in question and the computational constraints that govern belief updating) and how these factors interact in jointly shaping responses to aggregated opinion. We now turn to future directions for research on aggregated opinion and highlight important gaps in the literature. We focus on how opinions are integrated with other forms of information (including information about the causal history of opinion), how inferences from opinion are constrained by related beliefs that people hold and how the mechanisms driving responses to opinion (highlighted throughout this Review) can be leveraged in effective belief-change interventions.

One set of questions concerns how aggregated opinion is integrated with other sources of information. Aggregated opinion is typically not presented in isolation, but is accompanied by other kinds of evidence<sup>78</sup>. For instance, on Amazon, a shopper sees a summarized star rating (aggregated opinion) and snippets of the testimony of individual consumers that provide qualitative or experiential insight into the product<sup>282,283</sup>. Similarly, likes on social media are often given to content that also contains reasons for a given opinion (such as evidence from a news article), and public opinion polls might contextualize their results in light of other characteristics of their samples (such as age or gender of the respondents). These combinations raise an important set of questions about how people integrate diverse sources of information with aggregated opinion when learning about the world. For example, the strength of different information types might cause people to overweight strong qualitative reviews despite the presence of strong aggregated opinion to the contrary or vice versa. Formal models could provide computational accounts of these joint inferences. Work on this front could draw inspiration from efforts to use Bayesian methods in qualitative research<sup>284,285</sup> and advances in natural language processing that enable increasingly sophisticated quantification of semantic content<sup>286,287</sup>.

A related question is how knowledge of the stages of aggregated opinion (sampling, measurement, collection, summarization and presentation) might influence belief change. There is little systematic research on how people make use of these features when drawing inductive inferences about or from aggregated opinion (aside from work in marketing, which has investigated how opinions influence product perceptions in some detail<sup>279</sup>). However, research on how sampling assumptions guide inductive inferences<sup>288–290</sup> can easily be generalized to the setting of aggregated opinion. For example, as much as people sometimes discount first-order evidence that was collected in a biased manner (although often to an extent that falls

short of normative expectations<sup>291–293</sup>), they might discount aggregated opinion upon learning that it was elicited through misleading or ambiguous questions.

In keeping with almost all research on aggregated opinion, we have focused on factors that affect how it influences single beliefs; yet, research on explanatory coherence and the role of auxiliary hypotheses on disconfirmation and related issues has found that much of the resilience of belief is a consequence of the presence of other supporting beliefs<sup>294,295</sup>. For instance, people's intuitive theory of vaccination is constituted of a large set of beliefs, and each belief in this network informs and constrains others<sup>296</sup>. Although increasing research attention has been paid to this embeddedness of belief in political psychology<sup>297–299</sup>, there is little work on how it might influence disagreement broadly or inferences from aggregated opinion in particular. For example, people might discount large-scale disagreement if they perceive it as coming from a group with a systematically misaligned perspective on the world<sup>300</sup>.

Further understanding these aspects of belief change and persistence in the face of aggregated opinion also has applications for belief correction. As we reviewed above, interventions that aim to change beliefs through aggregated opinion, such as those that communicate scientific consensus to bolster belief in climate change, tend to have small effects<sup>175</sup> – an observation that has contributed to pessimism about the capacity for individual-level interventions to promote behavioural change<sup>301</sup>. Importantly, these kinds of interventions merely communicate consensus, without targeting the underlying mechanisms that sustain belief<sup>162,302,303</sup>. The paths to persistence model offers an alternative approach: tailoring interventions to the issue-specific and person-specific factors that drive persistence. For instance, if a subset of the population regards the causes of climate change as fundamentally unknowable (an ontological factor), providing information about the reliability of scientists (an informational factor) is unlikely to have large effects. Developing tailored interventions requires shifting towards person-focused research that aims to measure and address the particular belief systems and reasons anchoring the beliefs of individuals, across three research fronts. First, researchers need to investigate considerations beyond the informational. For example, there is little research on interventions that intervene on ontological commitments regarding different controversies. Second, it will be key to investigate the joint effects of these considerations<sup>162,304</sup>. Third, interventions must be designed to account for potential heterogeneity across people in the mechanisms that sustain beliefs, for instance, presenting tailored counter-evidence<sup>305,306</sup>.

Importantly, accounting for heterogeneity across people requires examining heterogeneity across cultures and nations, yet most of the research reviewed here was conducted with samples of participants from the USA. There can be substantial variation across populations in seemingly basic cognitive mechanisms<sup>39,40</sup>. Examining cultural heterogeneity in the mechanisms that drive responses to aggregated opinion is important, both for developing richer and more accurate theories and for developing interventions that can be effectively deployed beyond the USA.

Finally, our discussion throughout has focused on how aggregated opinions influence the beliefs of people about the world. Yet, much of the practical consequence of understanding these beliefs derives from their capacity to guide action. For instance, worries about the possibility that people might conform to pre-election polls – and change their voting behaviour as a consequence – have driven roughly half of the countries in the world to impose restrictions on

such polling<sup>307</sup>. Some research on opinion – including political science research on the bandwagon effect<sup>21,308</sup> – has explicitly investigated the link between aggregated opinion and behaviour, but much research (especially in psychology) remains focused on inference rather than action (a trend that has remained relatively consistent since the earliest research on attitudes<sup>45</sup>). It is important that future research investigates the opinion-to-inference-to-action pipeline more systematically to understand how aggregated opinion shapes belief and how that belief manifests in the world.

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The authors declare no competing interests.

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