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How Aggregated Opinions Shape Beliefs

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Abstract

People's beliefs and behavior are increasingly shaped by *aggregated opinions*: the elicited, quantified, and summarized judgments of tens to millions of strangers. Today, ratings guide purchases, likes guide shares, and polls guide votes. In this Review, we consolidate cross-disciplinary research to clarify how aggregated opinion affects people's beliefs. We draw on philosophy to clarify what conceptually distinguishes aggregated opinion from other forms of evidence, political science to describe its functional origins in collective judgment and decision-making, and psychology to highlight the mechanisms driving how individuals conform to, learn from, and ignore others' opinions at scale. We weave together these diverse strands of research around a central problem: how individuals draw inductive inferences about the world based on others' opinions.

Keywords: judgment; decision-making; belief; aggregated opinion; learning; persistence

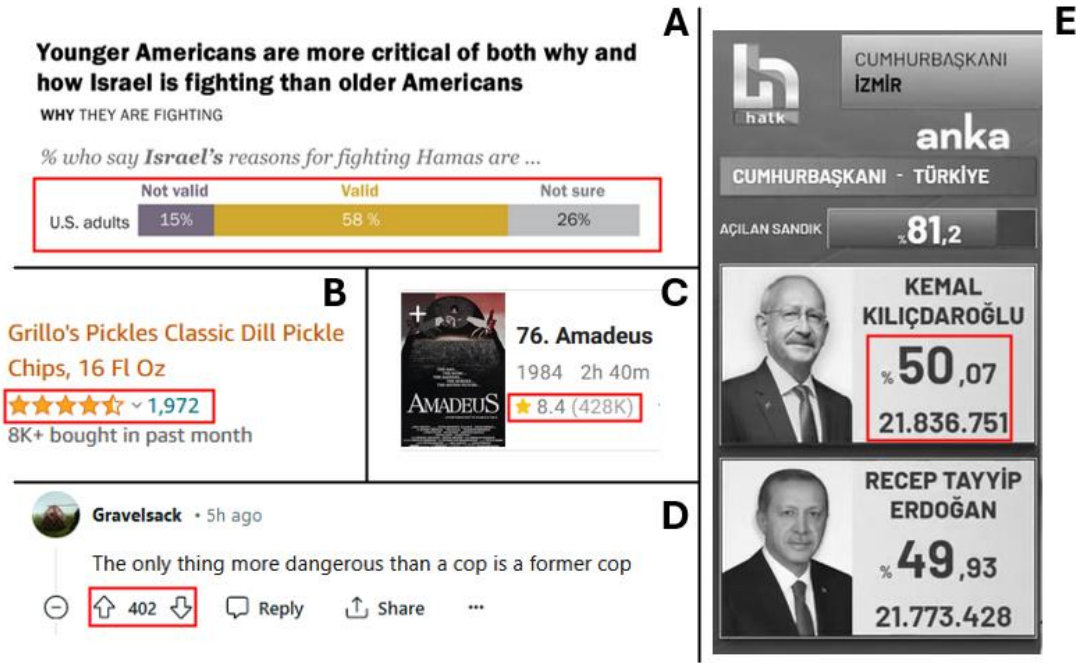
Introduction

Social learning extends the horizon of our beliefs beyond the grasp of direct experience. Such learning often takes a familiar form: face-to-face, personal, qualitatively rich interactions among acquaintances. For instance, children learn about the world through the testimony of their parents[1–3], social animals reach collective decisions by sharing information in small groups[4–6], and societies accumulate culture through stories exchanged among kin[7–9]. Humans and other social animals are therefore equipped with cognitive mechanisms for evaluating informants; from tracking the accuracy of their reports[10–12] to monitoring their communicative intent[13–15]. With the advent of voting in ancient Greece, however, humanity was introduced to a novel, distinctively impersonal form of social information: the expressed, gathered, and quantified beliefs of many strangers—*aggregated opinion*[16,17]. Evaluating this novel form of information can require distinct skills (e.g., quantitative reasoning), motivations (e.g., understanding global sentiment), and knowledge (e.g., sampling methodology).

Over time, aggregated opinion has expanded in political importance to become a defining feature of democratic governance[18,19], an active driver of electoral outcomes[20–22], and a force shaping public opinion on key issues such as climate change[23,24]. Moreover, media technologies have spread the influence of aggregated opinion beyond politics through surveys (e.g., the Gallup poll), repositories (e.g., IMDb ratings), and metrics of opinion (e.g., Facebook likes), such that daily life is now steeped in salient and easily-accessible data on others' views[25,26] (see Figure 1).

Figure 1

Aggregated Opinion is Diverse and Prevalent



Note. Red boxes highlight different representations of aggregated opinion. **A** shows the results of a public opinion poll by Pew Research, **B** shows the average star rating for a product on Amazon, **C** shows the average review for a movie on IMDb, **D** shows the summed up- and down-votes for a comment on Reddit, and **E** shows an example of vote tracking during the 2023 Turkish presidential elections on Halk TV.

As the prevalence and importance of aggregated opinion has increased, an emerging cross-disciplinary literature has explored its properties: statisticians and political scientists have studied how it can be measured[27,28], social and cognitive psychologists have studied how it is evaluated,[29,30] and economists and philosophers have analyzed how it ought to be interpreted[31,32]. In this Review, we bring these literatures together to consolidate cross-disciplinary insights on how aggregated opinions shape beliefs. In the first section, we focus on theory: we define opinion,

contrast it with other forms of social information, and describe three basic factors that influence its informativeness. In the second section, we focus on empirical results. We review literature on when people conform to, learn from, and effectively ignore information from aggregated opinion.[1] 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. Our aim throughout is to highlight the ways in which aggregated opinion is continuous and discontinuous with other influences on belief, and to offer a bird's-eye view of existing literature to facilitate further cross-disciplinary integration.

Defining, Measuring, and Evaluating Opinion

Aggregated opinion is a diverse phenomenon. It can be about virtually any topic, gathered for any reason, and communicated in a variety of ways: A pickle company might commission market research to understand which flavors are in-demand; a Spartan assembly might vote to decide whether someone should be ostracized; a social media platform might include 'like' buttons to boost engagement. A flexible definition that captures this diversity is that aggregated opinion is the *elicited, quantified, and summarized attitudes of a collection of individuals* (see Box 1). This definition highlights two distinctive properties of aggregated opinion: the complexity of its causal

[1] We note that the vast majority of the empirical evidence in this paper comes from studies conducted in the U.S, and should not be assumed to generalize to all people[33]—especially given the relative novelty of aggregated opinion as a form of social information. For the sake of conciseness and readability, we will use the term 'people' when referring to the results of studies, but readers should keep in mind that extensive cross-cultural work is needed to investigate the generalizability of these results. Similarly, we will speak of 'mechanisms' and 'inferences' generically, though it is highly likely that how people perceive and respond to aggregated opinion is a function of their cultural environment[34].

history and the simplicity of its content. Understanding these properties is necessary for making sense of people's inferences from opinion.

Box 1: Two Approaches to Defining Opinion

Broadly, social scientists have approached opinion as either a *latent* or *explicit* construct. Early political theorists, for instance, considered public opinion to be the dynamic, emergent, and latent sentiments of a collective[35–37], whereas later empirical scholars defined it as the summarized attitudes of a collection of individuals regarding some proposition in a given moment[38–40]. Here we adopt an explicit definition, as it offers a more direct link to measurement, but with some caveats. Important questions include what kinds of attitudes can constitute opinion (e.g., whether factual beliefs, religious credences, and personal preferences should all be considered opinions[41]), and whether there are different kinds of opinion (e.g., whether opinions formed through deliberation across years, and opinions rapidly formed in response to surveys, have sufficiently different properties to qualify as different kinds[40]). We thus take the explicit, operationalist definition to be a provisional tool that facilitates empirical research[42]—one that should be enriched over time to capture nuances long noted by the latent camp[43].

Complex Causal History

Aggregated opinion is the result of a complex process with five elementary stages: sampling, measurement, collection, summarization, and presentation. Each stage uniquely sculpts the final product, with implications for what can—and cannot—be inferred from a given instance of aggregated opinion.

The process of aggregation begins with a target population: a group whose opinions are of interest. Yet often it is impractical to collect the opinions of the entire population, so opinions are

sampled instead. Broadly, samples exist on a continuum from convenience samples (obtained from easily accessible members of the population) to probability samples (obtained randomly from the population)[44]. Ideal samples are representative: their characteristics generalize to the population.

Attitudes of interest are then solicited from the sample through an *instrument*. Typically, the instrument is a question accompanied by a response scale. Where ideal sampling is *representative*, ideal measurement is *reliable* and *valid*, such that responses are stable, capture attitudes of interest, and generalize to other judgments and behaviors[45].

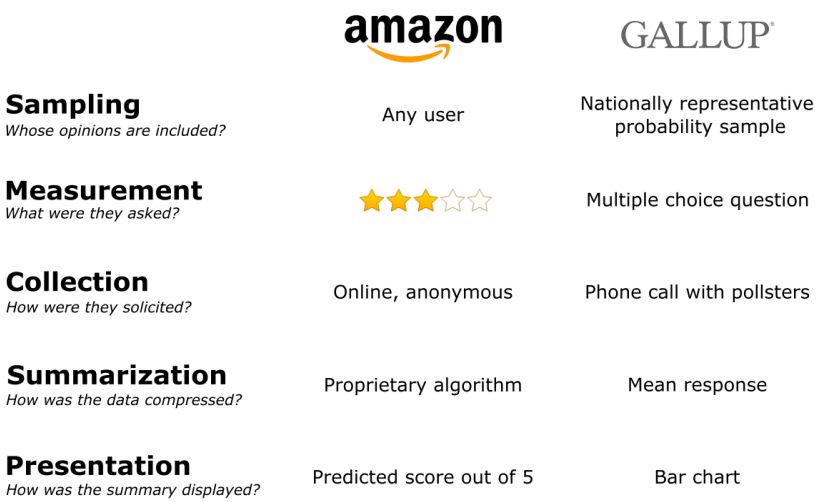
Following measurement, opinion is collected. Different collection methods involve different trade-offs: online surveys produce less desirability bias and more sharing of sensitive information, for example, but are prone to noisy responding[46]; minimal questionnaires are less likely to be biased by the researcher, but more likely to elicit unconsidered responses than polls that involve deliberative components[47].

Collected opinions are finally aggregated and presented. Often, measures of central tendency (such as the mean or median) are used to summarize and communicate opinion data, even though the same statistics can be consistent with many opinion distributions[48,49]. More nuanced forms of aggregation are possible: Amazon's product ratings, for instance, are the output of a proprietary machine-learning algorithm that takes factors such as recency into account[50]. Aggregated opinions can then be presented in numerical or analog formats.

Taken together, these five stages reveal the many degrees of freedom involved in aggregation: even if we reduced each stage to a choice between three options, there would be 243 distinct kinds of aggregated opinion to consider. This underlines the causal complexity of aggregated opinion as a form of social information (see Figure 2).

Figure 2

Aggregated Opinion Can Take Many Forms



Note. Figure shows two examples illustrating the large set of considerations that shape aggregation.

Research in marketing and science communication, as well as political science, has investigated how these factors influence people's inferences from opinion. For instance, different presentations of ratings can lead to different product quality judgments (e.g., left-digit bias can make 3.8/5 seem much worse than the equivalent rating in stars)[51–54], and presenting scientific consensus in different formats can lead to different degrees of confidence in the extent of consensus (e.g., pie charts may better communicate consensus than metaphors)[55–57].

Simplicity of Content

Though aggregated opinion is the result of a complex process, its contents are remarkably simple: as we have defined it, it is just a report of attitudes. Contrast this with the information contained in testimony: for example, a child telling her mom that she did not break a vase. This

testimony will not only contain an attitude (*it wasn't me!*), but also reasons, evidence, and arguments that support those attitudes (*I was with dad!*)[58]. Moreover, there will be a barrage of dynamic nonverbal information available to the mother—from pitch to posture, gaze aversion to facial expression[59]. Aggregated opinion omits this qualitative richness to provide a compressed snapshot of the attitudes of many.

This simplicity of content leads to an observation with important implications: on many issues, aggregated opinion is a fundamentally different kind of evidence from testimony, one that can only offer *indirect* reasons to doubt one's beliefs[60]. For instance, learning that 50% of your friends disagree with you about the answer to a tricky math problem (say, whether 5 + 5 * 5 equals 30 or 50) might lead you to question your own conclusion—perhaps others have access to information you lack, or perhaps others engaged in more careful reasoning. But the fact that they disagree with you is not itself a reason for why 30 is right and 50 is wrong—that comes down, in this example, 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[61–63]. Epistemologists—philosophers studying knowledge—call this indirect kind of evidence *higher-order* evidence (see Box 2).

Box 2: Higher-order evidence

Epistemologists draw a distinction between *first-order* and *higher-order* evidence. To illustrate, consider taking a psychology exam and learning two things as you exit the testing room: (a) that Skinner, not Watson, wrote *Verbal Behavior*, and (b) that you were drugged before you took the exam. Your confidence that you will receive a perfect score on the essay on behaviorism, where you claimed that Watson wrote *Verbal Behavior*, should take a hit from each revelation—

but in different ways. Learning (a) offers direct (or first-order) evidence that you made a mistake, but (b) 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 processed the information on the test correctly. This distinction has implications for how people draw inferences from aggregated 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[64,65]. Opinion, disagreement, and similar forms of social information are often better characterized as providing higher-order evidence, though they typically provide a complex blend of the two[62].

Responding to Aggregated Opinion

Having characterized key theoretical properties of aggregated opinion, we turn to empirical evidence on people's responses to it. We review research on how people conform to, learn from, and ignore others' opinions.

Conforming to the Aggregate

Early social psychological studies of opinion focused on people's tendency to *conform* to others' judgments and behavior, in part responding to the horrors of World War 2[66]. In Asch's landmark studies, for instance, a naïve participant was placed in a room with six to nine confederates, who consecutively reported their judgments in an easy perceptual task (matching line lengths). When confederates unanimously identified obviously inaccurate options, a majority (75%) of naïve participants at least once outwardly conformed to the group's (obviously inaccurate) consensus[67,68]. Later work extended this paradigm to other domains, group sizes, and

cultures, and found that these factors moderate conformity in nuanced ways, while replicating the finding that people in small groups conform to the unanimous opinions of others[69–73].

Though most research on conformity involves aggregated opinion (as participants only witness others' reported attitudes, rather than their detailed testimony), the Asch paradigm differs from our initial examples of polls and ratings in many ways (for example, the group size is smaller, and others' nonverbal reactions are observed). Two strands of research have shown that conformity also plays a role in these more canonical examples of aggregated opinion. First, recent research has documented conformity in online preference and judgment tasks, where others' opinions are summarized and presented as average ratings[74–76]. Second, political scientists have long investigated whether voters become more likely to turn-out and vote for candidates whom they learn to be increasingly popular in polls[20,77,78]. Though field studies show mixed results, experimental studies tend to find effects of conformity[21,79,80].

Importantly, people conform both to observed—and inferred—opinion. Research on *pluralistic ignorance* 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 behaviors. In Allport's seminal studies, for instance, students in a fraternity overestimated each other's willingness to racially discriminate against minorities—and they discriminated against minorities, in part to conform to this self-actualizing norm[81,82]. These mistaken inferences are rooted in biased *exposure* to others' attitudes (e.g., over-exposure to a salient sub-group of a larger population[83,84]), and biased *processing* of others' attitudes (e.g., over-generalization to others of individuals' own attitudes[85–87]). Recent work has explored these errors and the processes underlying them as potential drivers of affective polarization in the U.S[88–91].

Theorists often emphasize *social influence* as a causal factor driving conformity. Latané's Social Impact Theory, for instance, posits that conformity is driven by a multiplicative function of the strength (i.e., power and status), immediacy (i.e., proximity), and quantity of a dissenting group's members[92,93]. These factors are thought to influence one's judgments because attitudes play a social function as signals of group affiliation[94,95]. 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[96,97]. Consequently, people often adopt beliefs on new issues that match those of their in-group, and assume that out-groups hold different beliefs[98,99]. Other theories of conformity share the same mechanistic logic: people are attracted to (or repulsed by) each other's beliefs as a function of social factors such as power and similarity[100–102]. These mechanisms also underpin most agent-based and evolutionary models of societal opinion dynamics[103–106].

Social factors clearly play a role in driving conformity—more powerful individuals, for instance, conform less than the powerless[107–109], and conformity is less prevalent when judgments are made privately[67,110,111]. Yet they are not the sole drivers of how people evaluate and respond to opinions. Theories of conformity typically acknowledge that opinion can play an *informational* role beyond the affiliative[72,112,113], though this role is often minimized in experimental tasks investigating conformity (e.g., in the Asch paradigm) through the use of stimuli with obvious answers[73]. The capacity for opinion to inform has received deeper empirical treatment in cognitive and developmental psychology research on how people *learn from*, rather than conform to, others' opinions.

Learning from the Aggregate

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[114–116]. For instance, most preschoolers understand basic cosmological facts—such as the Earth being spherical—not because they are little globetrotters, but because they can learn from others[117]. If such learning goes beyond regurgitation, it should be sensitive to three basic factors: the quantity, reliability, and dependence of informants (see Box 3).

Box 3: Quantity, Reliability, and Dependence Determine the Informativeness of Opinion

From an epistemic standpoint, in the absence of additional facts about the aggregation process, inferences from aggregated opinion should be sensitive to at least the following three basic factors. The first factor is the *reliability* of the individuals constituting the sample. Bayesian analyses of social learning formalize reliability as the likelihood that the informants' reports track the true state of evidence on some proposition[118,119]. This likelihood can be influenced by many factors, such as the competence of the informants[120], but also their motivations[121], incentives[122], and intentions[123]. Typically, the more reliable the informants, the more informative their opinions are about the truth of propositions.

The second factor moderating inferences from opinion is *dependence*, which can be formalized as the sensitivity of informants to common elements in a causal network[124] (though it is often simplified to the correlation between informant reports[125–127]). Dependence is influenced by many factors, such as the amount of shared information between informants[128], the extent of communication between them[129], and the similarity of informants' prior knowledge[130]. Despite the received wisdom that dependence reduces the informativeness of opinion[131–133], this is not

generally true from a theoretical standpoint[134,135], and empirically, small group discussions can improve the average performance of groups on a variety of judgment tasks[136–140].

Finally, the size of the group influences the informational content of aggregated opinion, a fact recognized in the earliest analyses of the optimality of learning from opinion, such as Condorcet's Jury Theorem[141], and Galton's research on the wisdom of crowds[142]. Generally, larger groups of informants lead to more informative aggregated opinion. For instance, even when group members are biased, weighted averages of group judgments can outperform the best individual group members as long as biases aren't systematic[143,144].

Recent research suggests that children are indeed highly sensitive to these factors. By three years of age, children draw stronger inferences from multiple informants (vs. a single informant)[145], at four years, they systematically prefer learning from reliable (vs. unreliable) informants' testimonies[146], and by the age of six, they can differentiate between the informativeness of multiple second-hand vs. first-hand sources of knowledge[147]. By eight, children's social learning is nuanced enough to tailor methods of opinion collection to different kinds of judgment tasks—they prefer group deliberation for reasoning-based judgment tasks (e.g., a Sudoku puzzle), and independent crowdsourcing for popularity-based judgments (e.g., the group's favorite fruit)[148]. Moreover, children are sensitive to these factors when navigating disagreements[149,150].[2] The early and rapid development of these learning mechanisms underscores their importance as key enablers of cumulative cultural evolution[115,152].

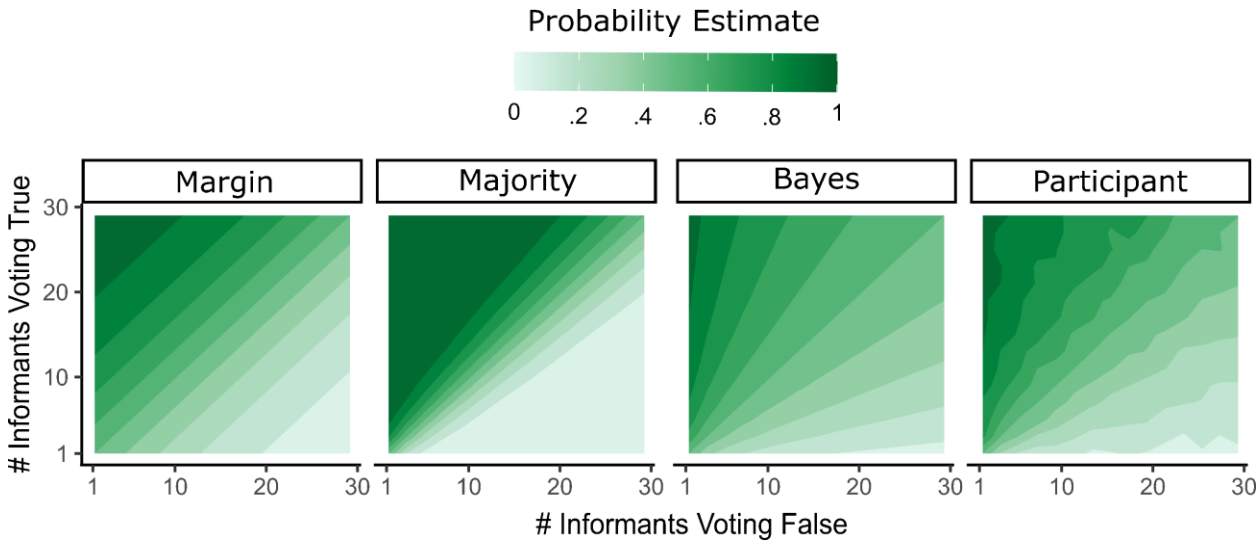
[2] We note that these age ranges do not mark discrete stages of development but instead mark typical points in a dynamic developmental trajectory[151].

It is difficult to generalize developmental research to adults' learning from aggregated opinion, not only because some processes may 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. For this, we turn to work in computational and cognitive psychology, which has recently focused specifically on opinion at larger scales, and investigated how the three basic factors of quantity, reliability, and dependence shape inferences.

When it comes to quantity, recent evidence suggests that people update their beliefs more when provided with the opinions of larger groups—for conspiratorial beliefs[153], consumer ratings[154,155], polls[156], and in collective reinforcement learning tasks[157]. Beyond simply updating more, people can learn from and update their prior beliefs rationally in simple cases: participants' inferences and belief updates in response to densely sampled opinion distributions show a close fit to the predictions of a Bayesian model, when compared to alternative heuristics[30] (see Figure 3).

Figure 3

Optimal Learning from Aggregated Opinion



Note. This contour plot compares the predictions of two models from epistemology and economics (one sensitive to the margin of opinion[158] and the other quickly converging to the majority[120]) with a Bayesian model and participant judgments. In the study, participants were provided with a random subset of 225 opinion distributions (e.g., 22 informants indicating that a statement is true, and 12 indicating false, is one distribution) that densely sampled the space. Participants then inferred the truth of propositions based on opinions. The Participant plot shows a linear interpolation of mean judgments; figure uses data from Oktar, Lombrozo, and Griffiths (2024).

When it comes to research on reliability, scholars of science communication have shown that for key issues such as climate change, people are more likely to update their beliefs upon learning about scientific consensus when they perceive scientists as competent and trustworthy[159–161]. More generally, research in learning from testimony and demonstration has shown that children, adults, and even great apes are sensitive to the reliability of informants across many contexts[12,162–165].

As for dependence, people often learn more from groups of individuals that receive independent information, as opposed to groups that regurgitate the same second-hand information[128,166–168]. However, there are two caveats: first, people typically underweight the influence of dependence[125,169–171], and second, much of this research investigates relatively simple forms of dependence (e.g., copying a primary source)—when, in reality, informational dependence structures are much more complex, and can lead to counterintuitive results (e.g., in some cases, dependency can increase informativeness)[134,135,172]. In such complex settings, especially those requiring joint inferences (such as inferring truth from information about both reliability and dependence), people may rely on heuristics (such as following the majority[29]).

In sum, the findings of developmental and cognitive research have shown that people frequently update their beliefs more when provided with consensus from larger, more reliable, and less dependent groups.

Ignoring the Aggregate

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 leverage opinion to shape beliefs. For instance, much research has focused on communicating scientific consensus—in the form of the aggregated opinions of experts—to reduce the prevalence of antiscientific beliefs[173,174]. Findings from this research are often framed in a positive light: influential studies report that "communicating scientific consensus appears to be an effective way to change factual beliefs about contested science topics"[175]; with many more studies finding and emphasizing that expert opinion can shape lay scientific beliefs[55,159,176–180]. Similar research on political behavior aims to reduce anti-democratic attitudes by correcting partisans' misperceptions of each other's aggregated opinion. Researchers are again optimistic that these interventions have "the potential to increase social cohesion and wellbeing of populations around the world[181]." This work has found that correcting misperceptions can significantly increase support for fair elections[182], increase liking of out-group members[183], reduce support for gerrymandering[184], and decrease de-humanization[185], among other outcomes[186].

Yet, the way this work is framed obscures two important facts. First, many individuals' beliefs remain unmoved in these studies; second, the average effect size for consensus messaging is small, hovering around one- to three-tenths of a standard deviation in recent meta-analyses for scientific consensus[175,179,187] and in recent studies of anti-democratic attitudes[188,189]. To make this

concrete, consider a scientific belief measured on a hundred-point scale, where the pooled standard deviation in responses is twenty[190]. The effect of consensus messaging with an effect size of one-tenth would be around a two percent shift.[3] Just as people conform to and learn from aggregated opinion, then, they also ignore it and persist in their views.

This tendency for people to ignore others' opinions is not limited to the scientific domain—the dissenting opinions of millions rarely give people pause about whether God exists, whether abortion is immoral, or whether gun laws should change[195]. In one study, when participants learned the true levels of population disagreement with their views (which, on average, involved ~25% more disagreement than they assumed), ~85% reported not questioning their views[195]. And persistence can happen in the face of staggering quantities of dissenting opinion, as with conspiracy theorists and cultists, who sustain their beliefs amid nearly unanimous societal dissent[196,197]. Such persistence is related to a broad family of phenomena describing how people fail to update their beliefs when faced with disconfirmatory evidence—a family that includes confirmation bias[198,199], closed-mindedness[200,201], cognitive rigidity[202,203], conservatism in updating[204,205], motivated reasoning[206,207], primacy effects in judgment[208,209], belief perseverence[210,211], reactions to cognitive dissonance[212,213], among others[214–217], and has been the subject of inquiry since the 17th century[218]. This research suggests that aggregated opinions (and other forms of disconfirmatory evidence) often fail to influence beliefs, whereas research covered in prior sections clearly shows that opinion can shape belief as well. Thus, the key question is not

[3] This is in keeping with science communication scholars' long-running critiques of the 'deficit model,' which frames unscientific beliefs as emerging from a lack of relevant knowledge, and results in interventions that merely aim to inform, and are thus often ineffective[191–194].

whether opinion shapes belief—sometimes it does, often it does not—but rather *when* opinion shapes belief, and the psychological mechanisms responsible.

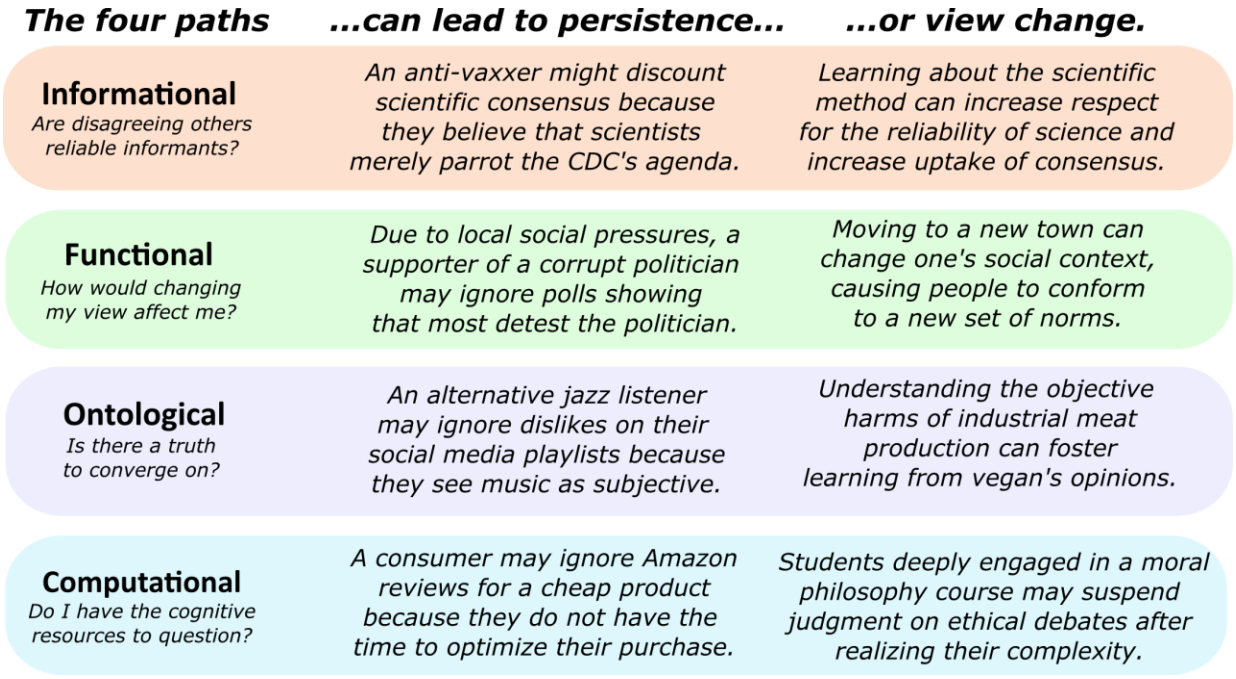
Mechanisms Driving Responses to Aggregated Opinion

Although research on conforming to, learning from, and ignoring the aggregate has been pursued in somewhat independent research traditions, these traditions share the goal of explaining when and why people do (or don't) shift their beliefs in response to aggregated opinion, and they often posit common mechanisms. The Paths to Persistence Model (PPM)[195] is a recent effort to systematize and extend this work by grouping families of mechanisms and characterizing their influence and interactions.

The PPM identifies four factors—the informational, functional, ontological, and computational—as core drivers of belief persistence in the face of disagreement (see Figure 4). People may discount others' opinions by perceiving informants as ignorant, biased, or stupid (*informational*); sense that changing their beliefs can have bad social or personal consequences (*functional*); or consider the issue to be subjective or unknowable (*ontological*). Additionally, they may fail to accurately represent or reason about others' opinions due to cognitive limitations (*computational*). On the flipside, positive inferences can drive view questioning and change: if people perceive disagreeing others as smart, view change as beneficial, issues as objective, and if they carefully consider others' opinions, they are likely to update their beliefs.

Figure 4

Four Paths to Persistence (or View Change)



Note. The four paths of the PPM and how they facilitate different responses to opinion are shown.

We first describe each factor and the evidence that supports it; we then describe how the paths interact.

The Informational Path: What Opinions Reveal about the World

The informational path captures *epistemic* reasons to heed or ignore others' opinions. Just as having a larger number of reliable and independent informants can make others' opinions more informative about the world, rejecting these features—for instance, perceiving others as unreliable informants—can be a path to persistence amid dissenting opinion. In fact, research on naïve realism (people's tendency to take their perceptions as reflecting reality) has shown that individuals often view those who disagree with them as ignorant[219,220], biased[221,222],

unintelligent[223,224], and molded by mass media[225,226]—in a word, 'brainwashed[227]'. Such denigrating inferences of disagreeing others are common in media[228] and can be found even in children, who frequently label disagreeing peers as uninformed or ignorant as early as 8-9 years old[147,229]. Thus, whether aggregated opinion moves people's beliefs depends on whether informants are seen as reliable—and frequently, they are not.

The Functional Path: The Social, Emotional, and Pragmatic Dimensions of Beliefs

The functional path captures *practical* (i.e., non-epistemic) reasons to persist versus question one's views, including the social and emotional consequences of holding versus changing beliefs. Research on conformity emphasizes social pressures that make opinion pliable[69,70], for instance, though the same mechanisms can restrict rather than promote change (for example, some beliefs are maintained because they are held by a majority of one's ingroup[230–232]). Beliefs also play important intra-personal functions. For example, some beliefs promote effective decision-making by boosting self-esteem[233,234] and limiting ambiguity[235,236], and some beliefs hold intrinsic value for believers[237,238]. Consider a women's rights advocate in the 1920s—if she readily questioned her views about suffrage after seeing a poll suggesting the unpopularity of the movement, she might be less likely to pursue difficult lobbying and persuasion efforts with possible long-term benefits[239]. Moreover, her egalitarian beliefs could ground her identity and give her a sense of existential justice[240–242]. These examples highlight the important inter- and intra-personal functions beliefs serve[243], and these functions frequently anchor beliefs amid conflicting opinion[206]—though, in the right context, they can promote change as well.

The Ontological Path: The Factual Status of Disputed Issues

The third, ontological path to persistence has received less attention, and concerns the (meta-epistemic) status of the *issue* itself: whether it is an objective matter of fact (like the atomic number of Gold), or a subjective opinion (like which flavor of ice cream is best); something knowable (like how many U.S. presidents have been men) or potentially beyond human verification (like whether pets go to heaven). If an issue is seen as fundamentally subjective[244–246], a matter of "mere opinion," there is no shared reality to which disparate opinions must converge[247,248]. For instance, someone who views morality as being fundamentally a matter of personal preference could ignore dissenting views to the contrary[249–252]. Beyond subjectivity, others' opinions can be irrelevant to one's own when issues are perceived as unknowable[253–255]; for instance, if I consider the possibility of time travel to be fundamentally a mystery, learning about others' views on it may not influence mine[256–258]. Thus, perceiving issues as components of a shared reality can get people to heed others' opinions—though important issues are often sustained amid disagreement due to perceptions of subjectivity or unknowability.

The Computational Path: Constraints on Belief Revision

The final, *computational* path identifies mental resource limitations that prevent belief revision. Evaluating informational, functional, and ontological considerations when encountering aggregated opinion can be challenging, because there are limitations to the amount and kinds of computation we can deploy when reasoning[259,260]. These limitations cause information to be processed in a qualitatively shallow way in many cases[261,262], especially with the abundance of distractions in everyday life[263]. Beyond not being able to (or choosing not to) reason comprehensively due to these cognitive constraints, people may also lack coherent conceptual

background on issues, and fail to update their beliefs due to such limitations in their representations[264–266]. For example, if I do not know that mRNA is used in modern vaccines, learning of scientific consensus on the safety of mRNA technology would fail to move my beliefs about the efficacy of vaccinations[267,268]. Such constraints frequently anchor beliefs and prevent people from appropriately responding to aggregated opinion.

Joint Effects of Informational, Functional, Ontological, and Computational Considerations

There is good reason to think that the four considerations reviewed thus far interact in driving responses to opinion. For instance, whether an issue is conceptualized as objective (an ontological consideration) influences whether expertise (an informational consideration) is relevant. Imagine learning that 85% of experts consider some product to be the best: If the product in question is a Wi-Fi router with objective performance criteria, expert consensus may sway your purchase, but if it is a painting you plan to admire in a private office, others' expertise may influence your judgments less[269]. Accordingly, emphasizing the subjectivity of a domain can reduce appeals to informational explanations[229,270]. Another important interaction is that the informational value of dissent may be better appreciated when functional considerations are attenuated. For instance, if the fact that your loved ones will judge you for changing your beliefs is made salient, and you feel insecure, you may be less likely to consider the informational value of opinion—but if you engage in self-affirmation exercises that boost your self-esteem, you may be better positioned to open-mindedly evaluate others as informants[271]. Finally, conceptualizing an issue as subjective may facilitate socially adaptive responses to opinion: subjectivity leads to more belief change for disagreements with known peers[272] (when it is valuable and important to conform), but less view change amid anonymous dissent online[273] (when conformity holds no

social value). These examples illustrate the value of considering all paths to persistence in parallel, and correspondingly why insights from across subdisciplines of psychology (and across the social sciences more generally) are crucial for understanding when and how beliefs are shaped by aggregate opinion.

Box 4: Tailored Interventions

As mentioned in the main text, 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[187]—an observation that has contributed to pessimism about the capacity for individual-level interventions to promote behavioral change[274]. Importantly, these kinds of interventions merely communicate consensus, without targeting the underlying mechanisms that sustain belief[173,275,276]. The PPM offers an alternative approach: tailoring interventions to the issue- 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 scientists' reliability[277] (an informational factor) is unlikely to have large effects.

Developing tailored interventions requires advancing research on three fronts: First, investigating considerations beyond the informational—there is little, if any, research intervening on people's ontological commitments regarding different controversies, for example. Second, investigating the joint effects of these considerations[173,278]. Third, designing interventions that account for potential heterogeneity across people in the mechanisms that sustain beliefs—for instance, presenting tailored counter-evidence[279].

Summary and Future Directions

Aggregated opinion, historically a powerful tool for democratic decision-making, now guides everyday judgments and decisions in a remarkably diverse range of contexts. Online review platforms curate ratings for everything from movies (e.g., IMDb) to professors (e.g., RMP)[280]; social media platforms tally attitudes to practically all posted content[26]; and a growing polling industry constantly taps into societal opinion on issues ranging from the morality of abortion[281] to the Israel-Palestine conflict[282]. In this Review, we synthesized an expanding yet siloed cross-disciplinary literature on this distinct form of social information.

We first provided a working definition of aggregated opinion and described its key properties: its simplicity as a snapshot of many attitudes, and its complexity as the product of a process with many decision points. We then discussed the psychological mechanisms underpinning when people conform to, learn from, and ignore it. We summarized four key considerations: the informational content of opinion (e.g., the quantity, reliability, and dependency of informants), the functional consequences of changing one's beliefs (e.g., the inter- and intrapersonal costs and benefits), the ontological status of issues in question (e.g., their perceived subjectivity and unknowability), and the computational constraints governing belief updating (e.g., the underlying coherence of people's representations). Finally, we described how these factors can interact in jointly shaping people's responses to opinion. We now turn to particularly important and underappreciated questions for future research.

Integrating Opinion with Other Sources of Information

Typically, aggregated opinion is not presented in isolation, but is accompanied by other kinds of evidence[62]. When shopping on Amazon, for instance, we see both a summarized rating and snippets of individual consumers' testimony that provide qualitative or experiential insight

into the product[283,284]. Similarly, likes on social media are given to particular content—often containing first-order evidence (such as links to a news article), and public opinion polls may contextualize their results in light of other characteristics of their samples. This raises an important set of questions about how people integrate diverse sources of information with aggregated opinion when learning about the world. For example, do people overweight strong qualitative reviews, despite the presence of strong aggregated opinion to the contrary, or vice versa? And what kinds of formal models could provide computational accounts of these joint inferences? Work on this front could draw inspiration from recent efforts to use Bayesian methods in qualitative research[285,286] as well as advances in natural language processing that allow for increasingly sophisticated quantification of semantic content[287,288].

Disentangling Webs of Belief

In keeping with almost all research on aggregated opinion, we have focused on factors that influence how opinion influences individual beliefs—yet research on explanatory coherence and the role of auxiliary hypotheses on disconfirmation, among other work, argues that much of the resilience of belief is a consequence of the presence of other beliefs that support it[289,290]. There is a large set of beliefs that constitute people's intuitive theory of vaccination, for instance, and each belief in this network informs and constrains others[291]. Though increasing attention has been paid to this embeddedness of belief in political psychology[292–294], there is little work on how it may influence disagreement broadly, or inferences from aggregated opinion in particular. For example, people may discount large-scale disagreement if they perceive it as coming from a group with a systematically misaligned perspective on the world[295]; and interventions may need to correct multiple beliefs at once to be effective (echoing our earlier observation on tailored interventions;

see Box 4). Developing such interventions requires shifting towards person-focused research that aims to measure and address the particular belief systems and reasons anchoring individuals' beliefs[296]. This may entail, for instance, developing nuanced profiles of individuals through multiple surveys.

How Features of Aggregation Shape Inferences

Earlier, we described five key steps involved in any instance of aggregated opinion: sampling, measurement, collection, summarization, and presentation. However, these features played little role when we summarized the mechanisms driving people's responses to opinion. This is because 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[280]). Recent research on how sampling assumptions guide inductive inferences[297–299] can easily be generalized to the setting of aggregated opinion: For example, much as people would not draw strong conclusions from first-order data that was collected in a biased fashion, they may discount aggregated opinion upon learning that it was elicited through misleading or ambiguous questions.

From Beliefs to Behaviors

Finally, our discussion throughout has focused on how aggregated opinions color people's beliefs 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 behavior as a consequence—has driven roughly half of the countries in the world to impose restrictions on such polling[300]. Some research on opinion, including political science research on the bandwagon effect[20,301], has aimed

to investigate the link between aggregated opinion and behavior explicitly—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[39]). It is important that future research investigate the opinion to inference to action pipeline more systematically, to help us understand not only how aggregated opinion shapes belief, but how that belief manifests in the world.

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