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Review

The Argumentative Theory: Predictions and Empirical Evidence

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The argumentative theory of reasoning suggests that the main function of reasoning is to exchange arguments with others. This theory explains key properties of reasoning. When reasoners produce arguments, they are biased and lazy, as can be expected if reasoning is a mechanism that aims at convincing others in interactive contexts. By contrast, reasoners are more objective and demanding when they evaluate arguments provided by others. This fundamental asymmetry between production and evaluation explains the effects of reasoning in different contexts: the more debate and conflict between opinions there is, the more argument evaluation prevails over argument production, resulting in better outcomes. Here I review how the argumentative theory of reasoning helps integrate a wide range of empirical findings in reasoning research.

Trends

High-level cognitive mechanisms – from reasoning to explanation or metacognition – are increasingly understood as having social functions.

More specifically, many of these mechanisms are thought to have evolved to help people communicate more efficiently.

In the case of reasoning, its main function would be to exchange arguments with others.

This shift towards a social view of reasoning is related to a change in the norms used to evaluate good reasoning performance, away from the norms of classical logic and towards norms that better capture the strength of everyday arguments, such as Bayesian norms.

A Social Turn in the Study of Higher Cognition

The study of **reasoning** (see Glossary) is one of the foundational areas of cognitive science. For years the psychology of reasoning has been dominated by a logicist paradigm that emphasized strict adherence to **logical norms**. Similarly, the field of judgment and decision making – which also bears on human reasoning – has been guided by the use of stringent norms of probability and expected utility as benchmarks for sound performance. Both fields found that these norms were often violated [1,2]. Although it is conceivable that human reasoning could be profoundly dysfunctional, many have rejected this conclusion and questioned instead the norms used to evaluate reasoning performance. Researchers are now turning to different logics [3], to Bayesian norms [4], and to ecological rationality [5].

Most of the work using these new norms of rationality, however, still relies on the assumption that the main function of human reasoning is to improve on individual cognition (for an exception see [4]). In particular, dual-process theories see reasoning as being aimed at the correction of misguided lower-level intuitive processes [1,2]. This assumption is challenged by recent theories that see much of higher cognition as having social functions [6–12]. According to these theories, mechanisms of higher cognition have evolved because they help us interact and communicate better with each other. In the case of reasoning, the main challenger to the standard view has been the argumentative theory of reasoning [9,13], detailed below (although see also, e.g., [14]).

Other disciplines have already integrated the social dimensions of reasoning. Social, developmental, educational, and political psychologists have shown that reasoning is profoundly influenced by social factors such as the need to justify one's opinions or the exchange of arguments with others. The results obtained in these disciplines are relevant for our understanding of reasoning but have been largely neglected by cognitive science. These disciplines

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could benefit from a more cognitive approach and cognitive science could benefit from paying more attention to the social dimension of reasoning [12,15].

The main claim of this review is that the argumentative theory of reasoning can act as a bridge between the cognitive and the social approaches to reasoning, and as an integrative framework to make sense of findings about reasoning stemming from many disciplines.

The Argumentative Theory of Reasoning

The argumentative theory of reasoning comprises two main claims, one about what reasoning is and one about what its function is [9,13]. The first claim is that reasoning is a specific subset of cognitive mechanisms dedicated to the processing of arguments. The vast bulk of cognition performs perceptual, motoric, and inferential functions without any attention being paid to reasons. By contrast, reasoning evaluates reasons – for instance, when someone offers us a reason to change our mind – and reasoning produces reasons, whether in solitary ratiocination or in **argumentation**.

In line with recent developments in reasoning research (e.g., [14]), the argumentative theory also claims that the main function of reasoning is argumentation. This entails being able to produce arguments to convince others and to evaluate others' arguments so as to be convinced when, and only when, warranted. In evolutionary terms, the exchange of arguments improves communication by allowing messages to be transmitted even in the absence of sufficient trust [10,13]. Efficient communication, in turn, is necessary for the high degree of cooperation that characterizes our species.

As an example, consider Sarah and Martin, a couple discussing which of two apartments they should rent. Sarah has an initial preference for the apartment in Soho. If Martin simply says 'No, we should get the one in Brooklyn', Sarah is unlikely to be swayed purely by her trust in him. Instead, Martin has to offer arguments in favor of his preferred option: that the rent is lower, that his commute is shorter, etc. Sarah can then provide counterarguments and arguments of her own: that her commute would be worse, that the Soho apartment is larger, and so forth. The exchange of arguments should allow Sarah and Martin to make a better decision.

The exchange of arguments is not only useful in situations of joint decision making but also in simple cases of testimony. If Sarah believes she should take subway line A, she might not be persuaded if Martin says 'No, you should take line B'. By contrast, she will be likely to change her plans if he says 'Line A wasn't working this morning, you should take line B'.

Argumentation would be evolutionarily stable because it makes those who engage in it better off on average: those who produce arguments are more likely to get their messages across than if they relied only on trust and those who receive arguments can accept beneficial messages they might otherwise have rejected. As a result, argumentation allows good ideas and sound beliefs to spread.

The hypothesis that reasoning evolved to allow people to exchange arguments with each other leads to several predictions regarding how reasoning should work. Crucially, these predictions differ sharply between the production of arguments and the evaluation of others' arguments. The function of argument production is to convince someone in an interactive setting. Conviction can hardly be achieved by providing interlocutors with arguments for their views or against that of the speaker. Argument production should thus be marked by a strong myside bias (or confirmation bias): people overwhelmingly produce arguments that support their point of view or attack that of the interlocutor.

Glossary

Argumentation: the public exchange of arguments meant to convince. It is enabled by the cognitive skill of reasoning, which allows reasoners to find and evaluate the arguments they publicly exchange.

Inference: a cognitive process that takes a representation as input, transforms it – usually in an epistemically cogent manner – and produces another representation as output. For instance, an inference can take the features of an individual's face as input and produce as output predictions about this individual's traits; say, that a male with a square jaw is more likely to be aggressive. The vast majority of inferences are performed without their inputs or mechanisms being represented as reasons or arguments.

Logical norms: for most of its history, the psychology of reasoning has used as a normative benchmark the norms of classical logic. For instance, in the case of the conditional statement 'if *p* then *q*', two inferences are valid ('*p*, therefore *q*' and '*non-q*, therefore *non-p*'), while two are invalid ('*q*, therefore *p*' and '*non-p*, therefore *non-q*'). These norms can clash with common sense, as seen when they compel participants to reject the argument 'If there is a lion, then there are lion tracks; there are lion tracks, so there is a lion' simply because its premise is not expressed in a manner that would make the argument logically valid ('If there are lion tracks, then there is a lion').

Query theory: offers an algorithmic account of decision making. When faced with a decision, people consider intuitions regarding what decision to make in turn. For each intuition, they query information in memory to decide whether it is a good intuition or not. The first queries conducted interfere with later queries, so the order of the queries plays an important role in the final outcome.

Reasoning: a specific type of inferential mechanism that allows us to find and evaluate reasons. For instance, when someone looks for arguments that could lead someone to accept 'you should vote for Arturo' or when someone evaluates the quality of 'Arturo has good economic policies' as an argument for accepting 'you should vote for Arturo', they are reasoning.

The second prediction is that reasoners, when they produce arguments, are lazy [16]. They do not make too much effort looking for very strong arguments, in particular by attempting to anticipate what counterarguments might be raised against their arguments. Instead, it is more economical to rely on the back and forth of conversation to see which arguments are effective and which arguments are countered and then to reply to the specific counterarguments raised. For instance, when Martin argues that the Brooklyn apartment is better because his commute would be shorter, Sarah might provide a good counterargument: that hers would be longer. But then Martin could point out that she has to go to work only twice a week, while he does so every weekday. Martin's argument would have been stronger if he had anticipated Sarah's argument from the start, but the end result would have been the same and he would have had to expend more cognitive effort looking for potential counterarguments. With hindsight, it might seem as if anticipating counterarguments is easy, but in fact the task is generally difficult. Many counterarguments can be raised against most arguments; for instance, Sarah could have argued that she has had the longest commute for years, that her new commute would take her through unsavory parts of the city, that it would be at rush hour, etc. Although Martin could try to anticipate all of these counterarguments, it is more efficient to see which ones are actually raised and to address only these.

The argumentative theory predicts that reasoners, when they produce arguments, are biased and lazy. By contrast, when they evaluate others' arguments – particularly arguments that challenge their views – they are demanding but objective. They are demanding – that is, they require that the arguments be of good enough quality – because they do not want to be swayed by poor arguments. But they are also objective enough to recognize strong arguments, even if the arguments challenge their views or come from untrustworthy sources. After all, accepting such arguments is, from the point of view of listeners, the whole point of argumentation. The argumentative theory thus predicts a fundamental asymmetry in reasoning: that reasoners are biased and lazy when they produce arguments, but objective and demanding when they evaluate others' arguments.

The fundamental asymmetry of reasoning can account for the myriad contradictory effects that reasoning has been shown to have on our beliefs and decisions. It is when they evaluate others' arguments that reasoners are most objective and demanding. Reasoning should thus yield its best outcomes when reasoners devote as much time as possible to evaluating others' arguments, rather than only producing their own. Two main factors determine the extent to which reasoners engage in this evaluation of others' arguments. The first is the extent of dialog, since it is dialog that allows the confrontation with others' arguments. The second is the extent of conflict, since people are most demanding in the evaluation of interlocutors' arguments when they disagree with the interlocutors' conclusions (see Table 1, Key Table and Box 1 for developmental evidence).

Solitary Reasoning with Little or No Intrapersonal Conflict

When people reason on their own, they can be more or less conflicted about the decision or the belief they are reasoning about. In some circumstances, people reason when they already have a strong intuition regarding the right answer, so there is little or no intrapersonal conflict. For instance, some reasoning problems are known to elicit strong intuitions. Take the bat and ball:
A bat and ball cost $1.10 together.
The bat costs $1 more than the ball.
How much does the ball cost?
When faced with this type of problem, participants have an immediate intuition regarding the correct answer; here, that it is 10c. Then, most participants start reasoning about the problem, and the way they do so illustrates how reasoning produces arguments. Participants mostly find arguments that support their initial intuition and do not ensure that these arguments are sound;

Key Table

Table 1. The Effects of Reasoning as a Function of the Amount of Conflict and of Dialog[a]

	Amount of Conflict	
Amount of Dialog	*Little or No Conflict*	*Conflict*
No Dialog	**Reasoning on our own about a topic on which we have a strong opinion.** We mostly find arguments supportive of our opinion and accept them even if they are not very strong.*	**Reasoning on our own about a topic on which we have conflicted intuitions.** We find arguments supporting different intuitions, so the intuition with the most available arguments wins.*
Receiving Arguments without Dialog	**Receiving an inconclusive argument about a topic on which we have a strong opinion.** We generate counterarguments to motivate our rejection of the argument we have received. The argument is either ineffective or it backfires.*	**Receiving a strong argument about a topic on which we have a strong opinion or a decent argument about a topic on which we have a weak opinion.** We change our mind in the direction supported by the argument.**
Dialog	**Exchanging arguments with others on a topic on which we all agree.** Arguments for the agreed-on opinion pile up; they are not well examined. Discussants might become more extreme in their support of this opinion.*	**Exchanging arguments with others about a topic on which we disagree.** Arguments for the different opinions are produced and evaluated. The best-defended opinion, which is usually the best opinion available, proves more influential.**

[a]In terms of ratio of argument production to argument evaluation, some cells (*) are nearly entirely dominated by the production of arguments while other cells (**) are dominated by the evaluation of others' arguments.

indeed, they could hardly be sound, since the correct answer is 5c [17]. This combination of myside bias and laziness – which is sometimes referred to as motivated reasoning (e.g., [18]) – has been observed in many different settings, such as forensic science [19], consumer behavior [20], politics [21], and investment behavior [22].

Box 1. Early Development of Argumentation

From very early – as early as 2 years of age – children engage in argumentation. The exchange of arguments plays an important role in their interactions with adults (in some cultures at least; see [76]) and peers [77,78]. Observational studies suggest that young children possess significant argumentative skills. For instance, observations of conversations within the family have revealed that primary-school children tend to use arguments from authority appropriately [79] and are more likely to be swayed by sound arguments from authority [80].

Experimental studies are now offering more conclusive evidence regarding young children's argumentative skills. These studies have revealed that preschoolers as young as 3 years of age are more likely to accept good than poor or circular explanations and arguments [81–85]. For instance, in an experiment 3-year-olds tended to believe a character who told them that 'The dog went this way because I've seen him go in this direction' over one who told them that 'The dog went this way because he went in this direction' [82].

Preschoolers also modulate their argument production appropriately. When pairs of preschoolers play together, they are more likely to offer justifications for unconventional moves than for conventional ones, for which they rely on common ground [86]. Preschoolers also adapt the content of their arguments to their audience. For instance, they are more likely to make a premise explicit when they have good grounds to believe it is not known by the audience [87].

The existence of early-emerging argumentation skills does not mean that there is not ample room for development and improvement. For instance, one experiment on argument evaluation found that children up to age 8 years had difficulties distinguishing strong from poor arguments in support of an unequal distribution of resources [88]. Similarly, the arguments children produce improve in quality and diversity. For example, primary-school children are more likely than preschoolers to use arguments from authority or to point out inconsistencies in their interlocutor's position [89]. Various pedagogical tools can accelerate this improvement in argumentation skills (Box 2).

The myside bias affects how we look for arguments both internally – through memory and **inference** – and externally. A preference for externally presented arguments that support our beliefs is often called selective exposure. For instance, in one experiment participants were made to select which of two paintings they thought most likely to be preferred by others [23]. They could then choose, on the basis of their titles, from a series of reviews of the two paintings. Participants tended to choose reviews whose titles suggested they would favor the painting the participants had said was the most popular.

The most straightforward consequence of the combination of myside bias and laziness that characterizes argument production is that when people reason on their own, reasoning typically fails to correct misguided intuitions (e.g., [24]). For instance, most participants who tackle the bat and ball on their own fail to provide the right answer, although it is mathematically trivial [25]. Solitary reasoning can even lead to an accumulation of arguments supporting our opinions, most of them poorly examined, leading to overconfidence [22,23] and polarization [26]. Solitary reasoning also provides people with excuses to engage in morally dubious behavior [27].

The negative effects of solitary reasoning are not caused by poor reasoning skills or ignorance. In some cases at least, it is the best reasoners [28], or those who are the most knowledgeable [29], who are the most biased. In some cases, however, solitary reasoners fail to find good enough reasons to justify holding on to their beliefs or decisions and they can then revise them on their own [27].

The biases of solitary reasoning can sometimes be attenuated, particularly by prior exposure to counterarguments in the course of discussion [30–32]. After the discussion, the availability of counterarguments can create intrapersonal conflicts, leading to more balanced reasoning.

Solitary Reasoning with Intrapersonal Conflict

People can also reason on their own about issues they have conflicting intuitions about. Reasoning should then look for arguments that support the various available intuitions and push towards the intuitions for which arguments are most easily found, a phenomenon referred to as reason-based choice (e.g., [33]). Reason-based choice has been shown to account for a wide range of decision-making results and biases [13]. For instance, participants find it difficult to justify choosing electronic products that have fewer features yet an identical price. As a result, they often choose products loaded with unnecessary features that make them more complicated to use and less satisfying [34].

Query theory provides a detailed account of the cognitive processes at play in reason-based choice. It suggests that people look for arguments supporting conflicting intuitions in turn. However, the process of finding arguments in support of the first intuition examined can interfere with the process of finding arguments for other intuitions. Minor differences in the way a problem is presented can have a strong influence on which intuition is examined first and thus on the ultimate answer of the participant. Query theory has been supported by various manipulations (e.g., [35]). For instance, some experiments switched the order in which participants considered different intuitions, yielding an inversion of the answers provided [36].

Exposure to Arguments that Generate Little or No Conflict

The argumentative theory of reasoning predicts that people evaluate others' arguments in a way that is objective and demanding. However, in contrast with argument production, which has immediately perceivable effects (the arguments produced), argument evaluation is more difficult to measure. The evaluation of the strength of an argument is only one of the factors that determine whether its conclusion is accepted. Prior beliefs regarding the plausibility of the argument's conclusion and the trustworthiness of the argument's source also have to be taken

into account. As a result, an argument's conclusion might be rejected, not because the argument was not evaluated properly, but because it failed to generate enough conflict with one's prior beliefs to lead to a change of mind. For instance, when Martin tells Sarah that his commute would be shorter from the Brooklyn apartment, she might appreciate that this is a point in favor of the Brooklyn apartment but not be swayed because the argument is not strong enough to overcome her preference for the Soho apartment. A typical reaction, in this situation, is for Sarah to produce counterarguments to justify her rejection of Martin's conclusion. In the course of a dialog, this production of counterarguments is constructive, as it helps Martin better understand Sarah's point of view and possibly address the specific reasons for her reticence to change her mind. However, if Sarah had, for instance, been exchanging arguments with Martin by text, and if Martin had then been unable to access his phone and reply to her counterarguments, Sarah might have become even more persuaded that she was right and Martin wrong.

Although the argumentative theory of reasoning assumes that reasoning evolved to be used in interactive contexts, in modern environments we often encounter arguments without being able to have a discussion with their source; for instance, when we read the newspaper, watch TV, or participate in a psychology experiment on argument evaluation. In these situations it might seem as if participants do not evaluate arguments objectively at all, since they often seem unaffected by arguments that challenge their point of view. Participants might even develop stronger attitudes in the direction opposite of the arguments – a backfire effect [37–40]. The explanation defended here is that participants evaluate the arguments objectively and that it is the subsequent production of unaddressed counterarguments that leads to these apparently irrational reactions. At least two sources of evidence can be adduced in support of this explanation: first, that participants have been shown in other contexts – reviewed below – to have good argument evaluation skills; and second, that when the counterarguments can be addressed people are much more likely to change their minds, as shown by the good performance in group discussion reviewed in the penultimate section.

Exposure to Arguments that Generate Conflict

As we have seen, when participants are exposed to arguments that fail to generate significant conflict with their prior beliefs and that they do not have the opportunity to discuss with the arguments' source, they can develop stronger attitudes as a reaction. However, some arguments are strong enough that they can change people's minds even without the possibility of dialog with their source. This is more likely to happen when people have relatively weak attitudes to start with. For instance, the studies demonstrating backfire effects among some participants often show that the arguments are effective for other participants; typically, those who were less strongly opposed to the arguments' conclusions (e.g., [39,40]). Arguments also provoke more conflict when they recruit the beliefs and values of the audience. For example, political arguments that appeal to the core values of the audience's political ideology tend to be more effective [41,42] (see also [43–45]). When the arguments are strong enough, they tend to be effective regardless of the audience's prior attitude [46–48]. For example, for problems similar to the bat and ball, participants exposed to an argument for the correct answer are as likely to change their minds irrespective of how confident they are in the wrong answer [25]. These studies suggest that people can be reasonably objective when they evaluate arguments – even arguments that challenge their beliefs.

Other studies have shown that people are demanding when they evaluate arguments. In particular, they differentiate between strong and weak arguments. The study of persuasion and attitude change has shown that when participants are given arguments on issues that they care about, good arguments are much more effective at changing their minds than weak ones [12]. When participants evaluate everyday arguments, they react appropriately to variations in

argument strength, whether strength is measured by Bayesian modeling [49–52], norms of classical logic [53], or norms of argumentation fallacies [54–57]. For instance, arguments from authority are deemed potentially fallacious if they come from non-expert sources or from sources with conflicts of interest, and participants appropriately discount such arguments [55].

Dialog

In a dialog, people have the opportunity both to produce arguments and to evaluate others' arguments – the ideal conditions for reasoning to allow good ideas and sound beliefs to spread. However, argument evaluation functions best – in particular, it is most demanding – when it bears on arguments that challenge one's beliefs. When people who agree on a topic exchange arguments about it anyway, the arguments are likely to remain relatively poorly examined. People sometimes develop stronger attitudes as they become aware of novel arguments supporting their opinion, a phenomenon known as group polarization (e.g., [58], although see [59]).

However, people are more likely to exchange arguments when they disagree over an issue. In this case, argument evaluation produces the best outcomes: in the back and forth of arguments and counterarguments, weak arguments are rejected and good ones end up swaying the audience. This is what happens when people discuss logical or mathematical problems, such as

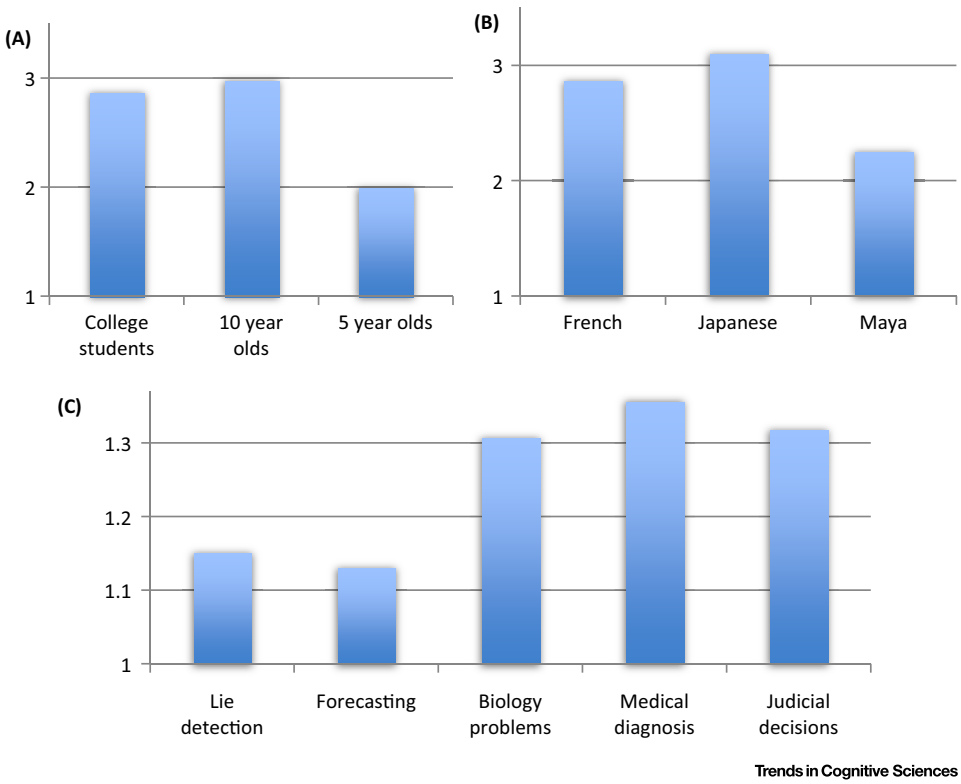

Figure 1. Effects of Group Discussion on Performance. This figure provides examples of the robustness of the improvements in performance brought about by group discussion. Represented are the ratios of performance following group discussion to individual performance, such that results above 1 indicate benefits of group discussion. (A) represents studies using tasks that have a demonstrably correct answer (such as the bat and ball presented in the main text) in three age groups: college students [25], 10-year-olds [25], and 5-year-olds [90]. (B) represents studies using tasks similar to those in (A) in three different populations: French college students [25], Japanese college students [91], and adults from a traditional Maya community [92]. (C) represents five studies that used a variety of less demonstrative tasks: detecting lies [93], forecasting of economic and political events [65], solving biological problems in a classroom [94], making medical diagnoses [95], and making judicial decisions [96].

Box 2. Argumentation and Education

The pedagogical benefits of group discussion have long been recognized [97–99], with an increasing number of schools adopting the practice of collaborative (or cooperative) learning. The benefits of group discussion for learning are robust across cultures and across domains (albeit with some variations) [99]. New technologies, such as clickers that allow students' answers to be monitored in real time during class, can promote dialog with the teacher and with peers, thereby improving learning performance [100].

Although group discussions should ideally occur in a broadly cooperative spirit [101,102], the role played by the exchange of arguments, and the adversarial and critical dimension it entails, has recently been underlined [103]. Group work is mostly beneficial for tasks that involve argumentation; for instance, problem solving compared with word reading [97]. Moreover, studies examining the content of the discussions have found that the exchange of arguments has a significant influence on individual learning [104,105]. These results are in line with the predictions of the argumentative theory of reasoning.

When students tackle a problem together, they sometimes reach a solution that none of them would have thought of on their own. Still, they must first have been provided with the conceptual tools necessary to solve the problem [106]. Argumentation during group discussion mostly serves to spread and combine the insights of different students rather than generate entirely new solutions.

Engaging in argumentation provides students with the experience of having one's arguments refuted and of being exposed to counterarguments. As a result, they can become better not only at arguing about the topic at hand but also at arguing about other topics. These improvements transfer, to some extent, to solitary reasoning, as students who have argued extensively with others come to write more balanced essays, anticipating more counterarguments and using better evidence for their arguments [31,32,107,108]. The same techniques can be used to improve teachers' argumentation skills [109].

the bat and ball problem presented above. A single group member who has the correct solution nearly always convinces other group members to adopt it [25,60,61]. For less clear-cut problems, discussion also tends to improve the outcome, sometimes to the point that the group decision is superior to that of its best individual member (e.g., [62]). Studies that have manipulated the amount of interaction or that have examined the content of interactions have found that the exchange of arguments is critical for these improvements to occur [63–65].

Box 3. Deliberative Democracy

Although voting is the dominant means of opinion aggregation in modern-day democracies, some political theorists have called for deliberation between citizens to play a more important role. These calls in support of deliberative democracy rest partly on procedural grounds – each voice should be heard, each issue pondered – but also, increasingly, on epistemic grounds [110]. The potential of deliberative democracy to achieve sound epistemic outcomes is supported by the argumentative theory of reasoning, as it claims that people should be less biased in their reasoning when they engage in dialog rather than reason on their own [111]. Deliberative democracy has now been extensively put to the test by having citizens come together and discuss policy. On the whole, these tests have revealed largely positive epistemic outcomes (e.g., [110,112]).

Although the benefits of deliberative democracy are relatively well established, the mechanisms causing these benefits are only starting to be investigated. In deliberative democracy experiments, participants are asked to deliberate, but they are also often provided with information on the issue at hand. Deliberation has been shown to play an independent role, adding up to the benefits of providing new information [113]. Detailed studies have attempted to correlate the quality of the arguments being offered with the degree of opinion change in the audience. These studies have found that, on the whole, deliberation with higher-quality arguments generates more opinion change [114–116], although in some cases repetition seems to play a more important role than argument quality [116]. A more detailed study of argument strength has found that people exposed to better arguments change their opinions more [117].

For the argumentative theory of reasoning, the back and forth of dialog enables improvements in argument quality by letting people address successive rounds of counterarguments. This would explain why deliberation yields better results when it is more conducive to such back-and-forth dialog: when the groups are not too large, when their members face each other, and when there is proper turn-taking [118]. Some conflict of ideas is also be critical for the exchange of arguments to yield felicitous results (see Table 1 in main text), which would explain why heterogeneous groups tend to make for better deliberation [119,120].

Figure 1 highlights the robustness of the benefits brought about by group discussion across age groups, cultures, and domains. Besides the domains mentioned in Figure 1, discussion has also been shown to improve performance in economic games [66], investment decisions [67], medical decision making [68,69], jury decisions [70], various educational tasks (Box 2), opinions about policy (Box 3), and other decision-making tasks [71].

Discussion is also much more effective than the simple presentation of arguments at changing people's minds. For instance, messages in favor of flu vaccination are largely ineffective [39] while discussion with experts significantly increases support for vaccination [72]. Similarly, politicians are more persuasive when they can exchange arguments with their constituents [73].

Note that, for dialog to be effective, those who participate in it must share some incentives. These incentives might be purely epistemic – everybody is better off with more accurate beliefs – but they must be present. Otherwise, people have no incentive to engage in constructive dialog and to exchange arguments.

Concluding Remarks

Considering reasoning as a social and, more specifically, argumentative mechanism helps make sense of its main attributes. Despite the broad recognition that people are biased and lazy when they produce arguments, the argumentative theory provides the first adaptive explanation for these attributes. It also offers the first adaptive explanation for the fundamental asymmetry of reasoning: the fact that when people evaluate others' arguments, compared with producing their own, they are objective and demanding.

On the basis of these attributes of argument production and evaluation, it is possible to account for the effects of reasoning. Contexts in which argument production strongly dominates over argument evaluation – that is, in the absence of dialog and of conflict between views – often lead to epistemically and practically deleterious outcomes. By contrast, contexts in which argument evaluation plays at least as large a role as argument production – that is, when people engage in dialog on an issue about which they disagree – allow superior outcomes, particularly the spread of the best ideas present in the group.

The superior performance of reasoning in discussion compared with reasoning alone has now been well established in various fields (Figure 1 and Boxes 2 and 3), yet it seems to remain largely counterintuitive. When asked to predict how well individuals and small groups would solve a logic problem, even experts – psychologists of reasoning – underestimate the improvement brought about by group discussion [74]. Teaching people about the value of argumentation might thus help them make the best of their reasoning abilities [75] (see Outstanding Questions).

Outstanding Questions

What happens when we read or hear an argument? Is the evaluation that occurs at this stage biased by our prior beliefs in the argument's conclusion or the trust we grant the argument's source?

Can we develop a neuroscience of argumentation? Neuroscientific studies of reasoning have focused on problems that require lengthy reasoning and that are very different from everyday arguments. What are the brain regions involved when we produce or evaluate the simple arguments we find in everyday conversations?

What are the links between the mechanisms that evaluate reasons in argumentation and in explanations of behavior? We use reasons not only to argue but also to justify and to explain. How are these functions related?

How do we learn to produce arguments? To what extent is the early production of arguments a spontaneous process or one guided by which arguments children encounter? What are the flaws in the way children evaluate arguments? Are there categories of arguments that children systematically fail to understand?

How can people be educated about the benefits of argumentation? Does participating in successful group discussion make people realize that it is an effective tool to improve reasoning performance?

How can we use digital tools to scale up deliberation so that more people can deliberate together effectively?

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