(Ideo)Logical Reasoning: Ideology Impairs Sound Reasoning

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Abstract

Beliefs shape how people interpret information and may impair how people engage in logical reasoning. In 3 studies, we show how ideological beliefs impair people's ability to: (1) recognize logical validity in arguments that oppose their political beliefs, and, (2) recognize the lack of logical validity in arguments that support their political beliefs. We observed belief bias effects among liberals and conservatives who evaluated the logical soundness of classically structured logical syllogisms supporting liberal or conservative beliefs. Both liberals and conservatives frequently evaluated the logical structure of entire arguments based on the believability of arguments' conclusions, leading to predictable patterns of logical errors. As a result, liberals were better at identifying flawed arguments supporting conservative beliefs and conservatives were better at identifying flawed arguments supporting liberal beliefs. These findings illuminate one key mechanism for how political beliefs distort people's abilities to reason about political topics soundly.

Keywords: belief bias, political psychology, ideology, logical reasoning, syllogistic reasoning

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Is logical reasoning the antidote to seemingly intractable political disagreements, or might it be a key ingredient in the poison of political partisanship? On the one hand, rationality and logic offer great promise: the application of principles of sound inference has the potential to improve decision-making and promote political consensus. On the other hand, the application of logic is rarely objective or rational (Morgan & Morton, 1944). Decades of research on human judgment—or even a glimpse at modern political dysfunction—reminds us that humans are imperfect at applying logical principles. Opposing political partisans often disagree not only about their political beliefs, but also over the *logical soundness* of arguments supporting those beliefs.

In the present article, we examine whether one bias that is endemic to human reasoning – namely, belief bias – interferes in perceptions of logic in political arguments. Belief bias refers to a common tendency for the subjective believability of an argument's conclusion to influence evaluations of the logical soundness of the entire argument (Evans, Barston, & Pollard, 1983; Oakhill & Johnson-Laird, 1985; Feather, 1964). Consider, for example, the following syllogism (Norenzayan, Smith, Kim, & Nisbett, 2002):

All things made of plants are healthy.

Cigarettes are made of plants.

Therefore, cigarettes are healthy.

Although this argument is logically sound (the conclusion follows logically from the premises), many people will evaluate it as unsound due to the implausibility of its conclusion about the health value of cigarettes. If, however, "cigarettes" is replaced by

"salads," ratings of the logical soundness of the argument will increase substantially even though substituting a plausible conclusion for an implausible one has no effect on whether that conclusion follows logically from the premises. Belief bias (originally referred to as "atmosphere effects"), which has a long history in psychological research (e.g., Morgan & Morton, 1944; Sells, 1936), can degrade logical reasoning by predisposing people to incorrectly judge unsound arguments as logically sound when their conclusions are subjectively believable and to incorrectly judge sound arguments as unsound when conclusions are less believable (Janis & Frick, 1943).

Research has previously shown that motivated reasoning, in various forms, can degrade formal logical reasoning. Gervais, Shariff, and Norenzayan (2011) found that antipathy toward an outgroup increased participants' likelihood of committing the conjunction fallacy. Kahan et al. (2017) showed that participants' political motivations interfered with their ability to form valid conclusions about empirical data. Belief bias in particular has been observed across cultures (though to differing degrees; Norenzayan et al., 2002) and in a number of contexts (Evans, Barston, & Pollard, 1983; Oakhill & Johnson-Laird, 1985; Newstead, Pollard, Evans, & Allen, 1992). Feather (1964), for example, found that people's religious beliefs biased their likelihood of evaluating pro-religious and anti-religious syllogisms as sound or unsound.

However, there are reasons to suspect that belief bias may present unique problems within the context of political reasoning. First, bias is pervasive during the evaluation of political arguments. Politics evoke motivations to defend the legitimacy and morality of one's policy views, political party, and cultural connections, and these motivations can bias political judgments in predictable ways. Committed partisans

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evaluate the same scientific evidence as more valid when it supports rather than challenges their political views (Lord, Ross, & Lepper, 1979), they evaluate the identical policy more favorably if they believe their own party supports it rather than the opposing party (Cohen, 2003), and they even see less violence in the same video of a political demonstration if they support the cause of the protest than if they oppose it (Kahan, Hoffman, Braman, & Evans, 2012). There is evidence that these effects may not be mitigated by superior reasoning skills. In fact, those with higher abilities in analyzing quantitative information can use those abilities to selectively interpret data to suit their desired political outlooks (Kahan, Peters, Dawson, & Slovic, 2017). These reasoning biases appear to occur automatically (Smith, Ratliff, & Nosek, 2012), and a "bias blind spot" may result in underestimating the impact of such biases on one's own judgments even when those same biases are readily recognizable when committed by others (Pronin, Lin, & Ross, 2002).

A second reason that belief bias causes unique problems in the political domain is that political beliefs are often divided along ideological lines. Individuals or groups with differing beliefs should be biased to perceive logical soundness in opposite directions. In the example above, virtually everyone finds "salads are healthy" a more believable statement than "cigarettes are healthy." But the same is not true of assertions frequently made in political discourse like "tax increases harm the economy" or "abortion is murder." Liberals and conservatives are likely to have opposing beliefs about the truth values of such statements. Belief bias should thus cause arguments with these conclusions to seem logically sound to one group while appearing logically unsound to the other. This, in turn, promotes a specific pattern of "mirror-image" judgment errors in

which each side tends to be overly lax in accepting the logic of arguments with politically palatable conclusions and overly critical of the logic of arguments with politically unpalatable conclusions.

In three studies, we examined the impact of belief bias on liberals' and conservatives' abilities to evaluate the logical soundness of political arguments. In Study 1, we observed significant belief bias effects among liberals and conservatives from YourMorals.org who evaluated the logical soundness of classically structured logical syllogisms supporting liberal or conservative beliefs. In Study 2, we observed ideological belief bias effects among participants from ProjectImplicit.org who were trained in logical reasoning before evaluating political syllogisms presented in natural language similar to what one might encounter in popular media. In Study 3, we replicated Studies 1 and 2 in a nationally representative sample and again observed belief bias effects among both liberals and conservatives.

Studies

The complete data and analysis scripts for all studies are available at https://osf.io/njcqc/.

Study 1

Materials and Methods. Participants were 1374 visitors (30.1% female, M_{age}=40.09, SD_{age}=16.50) to YourMorals.org, a psychological research website where volunteers complete psychological surveys in exchange for personalized feedback about their results. Political ideology was measured along a continuous 7-point scale (1=*Very Liberal*, 7=*Very Conservative*) with additional options for "Don't know/not political", "Libertarian", and "Other". There were 924 in the final sample (490 Liberals, 110

Moderates, and 324 Conservatives) after excluding participants who did not indicate their political ideology along the 7-point Liberal-Conservative spectrum.

Participants completed a test of logical reasoning (using Norenzayan et al., 2002 as a guide) consisting of 16 syllogisms in which the terms within the premises and conclusions were political in nature (See Table 1). Participants were asked to judge whether each conclusion logically followed from its premises. The premises were balanced such that half of the arguments were sound and half were unsound. Further, they were equally divided among two classical logical structures: modus ponens (MP; If P, then Q. P. Therefore, Q) and modus tollens (MT; If P, then Q. Not Q. Therefore, not P.). The study manipulated what might be called partisan believability, that is, half of the syllogisms contained conclusions that were consistent with liberal ideological beliefs (e.g., "Abortion is not murder"), while the other half contained conclusions that were consistent with conservative ideological beliefs (e.g., "Tax increases harm the economy").

Participants were specifically instructed to judge whether or not the conclusion of each syllogism followed logically from its premises, while assuming that all of the premises were true and limiting themselves only to information presented in the premises. They were asked to "*Choose YES if, and only if, you judge that the conclusion can be derived from the given premises. Otherwise, choose NO.*"

See SI for the manipulation check results for all three studies.

Table 1: The breakdown of logical arguments and the participant stimulus for the three studies.

	Study 1: Ideological	Study 2 and 3: Ideological	Study 3: Non-ideological
Premise 1	All drugs that are dangerous should be illegal.	Judge Wilson believes that if a living thing is not a person, then one has the right to end its life.	Doctor Simmi believes that if a tumor is not detected, then the surgery will proceed as planned.
Premise 2	Marijuana is a drug that is dangerous.	She also believes that a fetus is a person.	She also believes that a tumor was detected.
Conclusion	Therefore, Marijuana should be illegal.	Therefore, Judge Wilson concludes that no one has the right to end the life of a fetus.	Therefore, Doctor Simmi concludes that the surgery will not proceed as planned.
Participant Stimulus	All drugs that are dangerous should be illegal. Marijuana is a drug that is dangerous. Therefore, Marijuana should be illegal .	Judge Wilson believes that if a living thing is not a person, then one has the right to end its life. She also believes that a fetus is a person. Therefore, Judge Wilson concludes that no one has the right to end the life of a fetus.	Doctor Simmi believes that if a tumor is not detected, then the surgery will proceed as planned. She also believes that a tumor was detected. Therefore, Doctor Simmi concludes that the surgery will not proceed as planned.

Results. For each of the following three studies, we report two separate regressions, predicting the perceived logical soundness of arguments and the accuracy of each participant's judgements, respectively. For each model reported below, we first report each significant main effect and interaction term observed in the model, followed by a more detailed explanation of the interaction term testing each study's primary hypothesis.

For Study 1, a logistic regression with a three-way interaction was conducted to predict perceived logical soundness using the political ideology of the argument's conclusion (henceforth argument ideology; liberal vs. conservative), soundness of the argument (sound vs. unsound), and participant political ideology (henceforth participant

ideology; 1=*Very Liberal*, 7=*Very Conservative*) as predictor variables, while controlling for the logical structure. (For all studies, see SI for the data on demographics (Table SI1), results controlling for demographics (Table SI2) and manipulation checks (Table SI3)).

We observed main effects of participant ideology and argument soundness, such that, for participant ideology, participants at higher levels of conservatism[1] perceived sound arguments as less sound (*OR*=0.93) and, for argument soundness, perceived sound arguments as more sound (*OR*=8.59). There was no main effect of argument ideology (*OR*=0.92). There was, however, a main effect of argument's logical structure (*OR*=0.75), such that modus tollens arguments were perceived as less sound. We also observed a two-way interaction between participant ideology and argument soundness (*OR*=0.78), but no two-way interaction between argument soundness and argument ideology (*OR*=0.94).

Most relevant to our hypothesis, there was a two-way interaction between participant ideology and argument ideology (*OR*=1.49). Specifically, at higher levels of conservatism, participants were less likely to rate syllogisms with liberal conclusions as sound, (*b*=-0.04, *p*<.001) and more likely to rate syllogisms with conservative conclusions as sound (*b*=0.04, *p*<.001). This effect was not qualified by the actual soundness of the syllogisms. That is, there was no three-way interaction between participant ideology, argument soundness, and argument ideology (*OR*=0.99). See Table 2 for full results. See Table 3 for the summary statistics for all three studies.

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[1] Throughout the paper "higher levels of conservativism" can also be interpreted as "lower levels of liberalism". We simply mean at greater values on the political ideology scale, ranging from 1 = *Very Liberal* to 7 = *Very Conservative*.

Table 2: Study 1 logistic regression with three-way interaction predicting perceived logical soundness.

	Odds Ratio	RSE	[95% Conf. Interval]	
PI	0.93	0.02 (.003)	0.88	0.97
AS	8.59	0.65 (<.001)	7.40	9.96
PI X AS	0.78	0.03 (<.001)	0.73	0.84
AI	0.92	0.05 (.138)	0.3	1.03
PI X AI	1.49	0.04 (<.001)	1.41	1.58
AS X AI	0.94	0.06 (.277)	0.83	1.06
PI X AS X AI	0.99	0.03 (.621)	0.93	1.04
Logical Structure	0.75	0.03 (<.001)	0.70	0.80

Notes: PI is Participant Ideology, AS is Argument Soundness, AI is Argument Ideology. *p* values are given in the parentheses.

Table 3: Coefficients for logistic regression with three-way interaction predicting perceived logical soundness for Studies 1 to 3.

	Study 1 (*Odds Ratio*)	Study 2 (*b*)	Study 3 (*b*)
PI	0.93 (.003)	-0.02 (.577)	0.02 (.433)
AS	8.59 (<.001)	0.66 (<.001)	0.55 (<.001)
PI X AS	0.78 (<.001)	-0.11 (.039)	-0.08 (.022)
AI	0.92 (.138)	0.11 (.157)	0.22 (.002)
PI X AI	1.49 (<.001)	0.16 (.002)	0.08 (.036)
AS X AI	0.94 (.277)	-0.04 (.721)	-0.07 (.454)
PI X AS X AI	0.99 (.621)	-0.04 (.602)	0.04 (.404)
Logical Structure	0.75 (<.001)	-0.53 (<.001)	-0.43 (<.001)
Argument's Topic			
Abortion	--	0.01 (.862)	0.06 (.383)
Capital Punishment	--	-0.99 (<.001)	-0.65 (<.001)
Government Intervention	--	-0.19 (<.001)	-0.22 (<.001)

Notes: PI is Participant Ideology, AS is Argument Soundness, AI is Argument Ideology. *p* values are given in the parentheses. Base argument topic is affirmative action.

On average participants correctly judged 73% of the syllogisms. To better understand the influence of belief bias on participants' accuracy, we conducted a second three-way logistic regression to predict the *accuracy* of each judgment based on the participant's ideology and argument's ideology. There was a main effect of participant ideology such that participants at higher levels of conservatism had greater accuracy ($OR=1.08$). There was no main effect of argument soundness ($OR=1.16$), nor of argument ideology ($OR=1.07$). There was, however, a main effect of each argument's logical structure ($OR=0.55$), such that modus tollens arguments had worse accuracy.

There was a two-way interaction between participant ideology and argument soundness ($OR=0.67$), between participant ideology and argument ideology ($OR=0.67$), and between argument soundness and argument ideology ($OR=0.80$).

Most importantly, there was a three-way interaction between participant ideology, argument soundness, and argument ideology ($OR=2.20$). Specifically, the more conservative the participant, the more likely sound syllogisms with conservative conclusions were to be evaluated correctly as sound ($b=0.01$, $p=.006$), but the less likely unsound syllogisms with conservative conclusions were to be evaluated correctly as unsound ($b=-0.06$, p<.001). The opposite pattern of errors was found for syllogisms with liberal conclusions. In these cases, the more conservative the participant, the less likely sound syllogisms were to be evaluated correctly ($b=-0.06$, $p<.001$) and the more likely unsound syllogisms were to be evaluated correctly ($b=0.02$, $p=.003$). Thus, the accuracy of participants' judgments depended on participants' ideologies, the syllogisms' ideologies, and the soundness of the syllogisms. See Figure 1. See Table 4 for full results. See Table 5 for the summary statistics for all three studies.
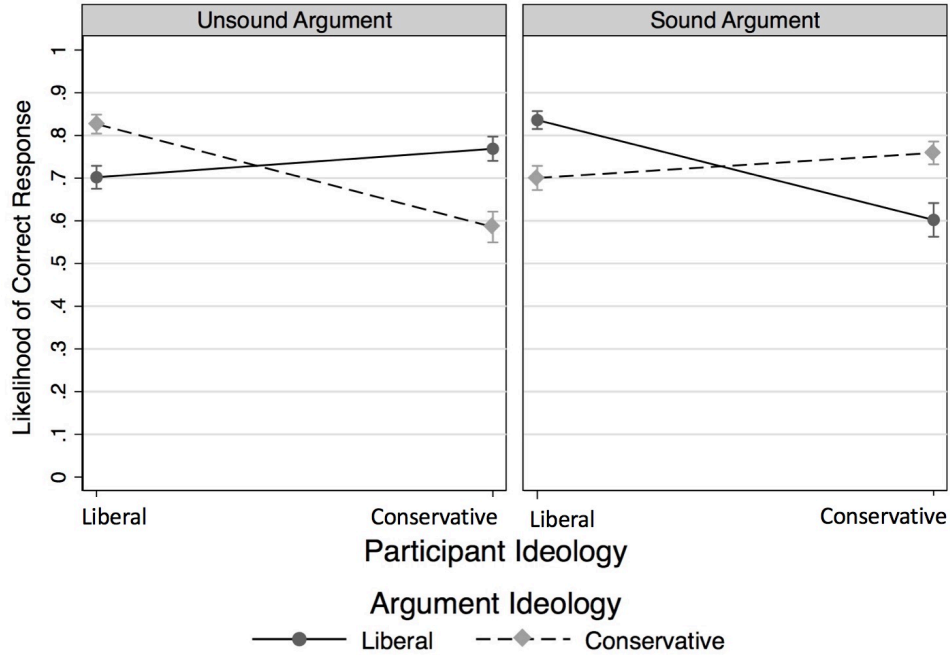
Figure 1: Study 1 results for the likelihood of correct responses for sound liberal arguments, sound conservative arguments, unsound liberal arguments, and unsound conservative arguments for liberal and conservative participants. Error bars are 95% CI.

Table 4: Study 1 logistic regression with three-way interaction predicting accuracy of participant's judgements.

	Odds Ratio	RSE	[95% Conf. Interval]	
PI	1.08	0.03 (.003)	1.03	1.14
AS	1.16	0.09 (.066)	0.99	1.35
PI X AS	0.67	0.03 (<.001)	0.62	0.73
AI	1.07	0.06 (.198)	0.96	1.19
PI X AI	0.67	0.02 (<.001)	0.63	0.71
AS X AI	0.80	0.07 (.011)	0.68	0.95
PI X AS X AI	2.20	0.11 (<.001)	1.99	2.43
Logical Structure	0.55	0.02 (<.001)	0.52	0.60

Notes: PI is Participant Ideology, AS is Argument Soundness, AI is Argument Ideology. *p* values are given in the parentheses.

Table 5: Coefficients for logistic regression with three-way interaction predicting accuracy of participant's judgements for Studies 1 to 3. All coefficients are *Odds ratios*.

	Study 1	Study 2	Study 3
PI	1.08	1.00	0.97
	(.003)	(.818)	(.416)
AS	1.16	4.01	2.80
	(.066)	(<.001)	(<.001)
PI X AS	0.67	0.89	0.98
	(<.001)	(.024)	(.761)
AI	1.07	1.00	0.83
	(.198)	(.984)	(.019)
PI X AI	0.67	0.88	0.95
	(<.001)	(.009)	(.201)
AS X AI	0.80	1.03	1.33
	(.011)	(.780)	(.016)
PI X AS X AI	2.20	1.26	1.17
	(<.001)	(<.001)	(.011)
Logical Structure	0.55	0.44	0.48
	(<.001)	(<.001)	(<.001)
Argument's Topic			
Abortion	--	1.17	0.99
		(.057)	(.958)
Capital Punishment	--	1.05	0.82
		(.576)	(.052)
Government Intervention	--	1.06	1.00
		(.395)	(.951)

Notes: PI is Participant Ideology, AS is Argument Soundness, AI is Argument Ideology. *p* values are given in the parentheses. Base argument topic is affirmative action.

Discussion. Results from Study 1 indicate that participants showed ideological belief bias – they perceived arguments as more logically sound to the extent that their conclusions were congenial with their ideologies, and this relationship was mediated by participants' specific ideological beliefs. This led them to be overly harsh evaluators of the soundness of politically challenging arguments (i.e., more likely to judge a sound argument as unsound) and overly lax evaluators of the soundness of politically congenial arguments (i.e., more likely to judge an unsound argument as sound).

Although Study 1 provided preliminary evidence for ideological belief bias, the rigid, syllogistic structure of the logical arguments limits the generalizability of these

findings. In Study 2, we aimed to better understand the extent to which ideological belief bias influences everyday political judgments by examining ideological belief bias effects using stimuli designed to be more similar to the language one encounters conversationally. In Study 2, we also provided participants with a training task prior to the actual task to ease the difficulty of the task.

Study 2

Materials and Methods. One thousand, seven hundred and forty-three participants (65.4% female; M_{age}=34.25, SD_{age}=13.39) entered the study at Project Implicit, a public research and education website (https://implicit.harvard.edu/). Participants choose to participate for a variety of reasons (e.g. class requirements, personal curiosity, research recruitment) and were randomly assigned to this study amongst a pool of studies. Political ideology was again measured along a continuous 7-point scale (1=*Very Liberal*, 7=*Very Conservative*). There were 1,489 participants in the final sample (622 Liberals, 515 moderates, and 353 Conservatives) after excluding those who did not indicate their political ideology along the 7-point spectrum.

Before completing a test for logical reasoning, participants completed a training session that reviewed the essentials of logical reasoning and introduced the structure of the logical arguments. The training reinforced participants' knowledge about logical reasoning with four arguments that participants should easily recognize as sound or unsound (e.g., "*If a person is pregnant, then that person is a woman. Taylor is pregnant. Therefore, Taylor is a woman*"). Participants read the arguments (half MP, half MT), evaluated their soundness, and then received immediate feedback with the correct answer.

After the training session, participants completed a test with four syllogisms in which the terms within the premises and conclusions were political in nature (as in Study 1) and in addition were framed in a less formal and more conversational language (See Table 1). Similar to Study 1, the syllogisms were balanced according to soundness, ideology, and logical structure. Finally, for the four syllogisms presented to the participant, one was on the topic of capital punishment, one was on abortion, one was on government intervention, and one was on affirmative action. See the SI for the full set of arguments.

After reading the arguments, to elicit their evaluation of the logic and the confidence of their answer participants were asked to, "Evaluate whether the claims are logically sound or not, and how confident you are about your assessment," using a 6-point scale (-3=*Logically Unsound, Very Confident*; -2=*Logically Unsound, Confident*; -1=*Logically Unsound, Slightly Confident*; 1=*Logically Sound, Slightly Confident*; 2=*Logically Sound, Confident*; 3=*Logically Sound, Very Confident*).

Results. Given the continuous outcome variable in Study 2, a linear mixed effects model with three-way interactions was conducted to predict logical soundness ratings using the argument ideology, the soundness of the argument, participant ideology, logical structure, and argument topic as predictor variables.

Consistent with Study 1, there was a main effect of argument soundness such that participants perceived sound arguments as more sound (b=0.66). However, there was no main effect of participant ideology (b=-0.02) or argument ideology (b=0.11). There was, however, a main effect of argument's logical structure such that modus tollens arguments are perceived as less sound (b=-0.53) and of argument's topic such that arguments

concerning capital punishment were perceived as the least sound (b=-0.99). There was also a two-way interaction between participant ideology and argument soundness (b=-0.11), but no two-way interaction between argument soundness and argument ideology (b=-0.04).

Most relevant to our hypothesis, we again observed that participants' evaluations of the logical syllogisms depended, in part, on their ideological leanings and the arguments ideology, as evidenced by a significant interaction between participant ideology and argument ideology (b=0.16). Specifically, the more conservative the participant, the more syllogisms with conservative conclusions were rated as sound (b=0.06, p=.026) and the more syllogisms with liberal conservatives were rated as unsound (b=-0.07, p=.006). This was again found regardless of the actual soundness of the arguments, i.e. there was no three-way interaction between participant ideology, argument soundness, and argument ideology (b=-0.04). See Table 6 for full results.

Table 6: Study 2 linear regression with three-way interaction predicting perceived logical soundness.

	b	SE	[95% Conf. Interval]	
PI	-0.02	0.04 (.577)	-0.09	0.05
AS	0.66	0.08 (<.001)	0.50	0.81
PI X AS	-0.11	0.05 (.039)	-0.21	-0.01
AI	0.11	0.08 (.157)	-0.04	0.27
PI X AI	0.16	0.05 (.002)	0.06	0.26
AS X AI	-0.04	0.12 (.721)	-0.27	0.18
PI X AS X AI	-0.04	0.07 (.602)	-0.18	0.10
Logical Structure	-0.53	0.06 (<.001)	-0.64	-0.42
Argument's Topic				
Abortion	0.01	0.08 (.862)	-0.14	0.17
Capital Punishment	-0.99	0.08 (<.001)	-1.15	-0.84
Government Intervention	-0.19	0.08 (<.001)	-0.34	-0.03

Notes: PI is Participant Ideology, AS is Argument Soundness, AI is Argument Ideology. *p* values are given in the parentheses. Base argument topic is affirmative action.

Despite the training session, on average participants only judged 53.0% of the logical arguments correctly—reaffirming that logical reasoning is cognitively difficult, perhaps especially so when evaluating less formal, conversational arguments. To further examine the factors influencing judgment *accuracy*, we conducted a three-way logistic regression with accuracy as the dependent variable. There was no main effect of participant ideology ($OR=1.00$) or argument ideology ($OR=1.00$). There was, however, a main effect of argument soundness such that there was a greater accuracy for sound arguments ($OR=4.01$) and each argument's logical structure such that there was a worse accuracy for modus tollens arguments ($OR=0.44$). We did not observe a main effect of

argument topic ($OR=1.01$). (See SI for breakdown of correctness based on the structure and the topic of the argument). There was a two-way interaction between participant ideology and argument soundness ($OR=0.89$), between participant ideology and argument ideology ($OR=0.88$), but not between argument soundness and argument ideology ($OR=1.03$).

Most importantly, there was a three-way interaction between participant ideology, argument soundness, and argument ideology ($OR=1.26$). Thus, as political conservatism increased syllogisms with conservative conclusions were less likely to be evaluated correctly if they were unsound ($b=-0.03$, $p=.005$), and syllogisms with liberal conclusions were less likely to be evaluated correctly if they were sound ($b=-0.02$, $p=.003$). However, as political conservatism increased, there was no difference for syllogisms with conservative conclusions that were sound ($b=3.82 \times 10^3$, $p=.626$) and for syllogisms with liberal conclusions that were unsound ($b=-1.32 \times 10^4$, $p=.988$). See Figure 2 below. See Table 7 for full results.
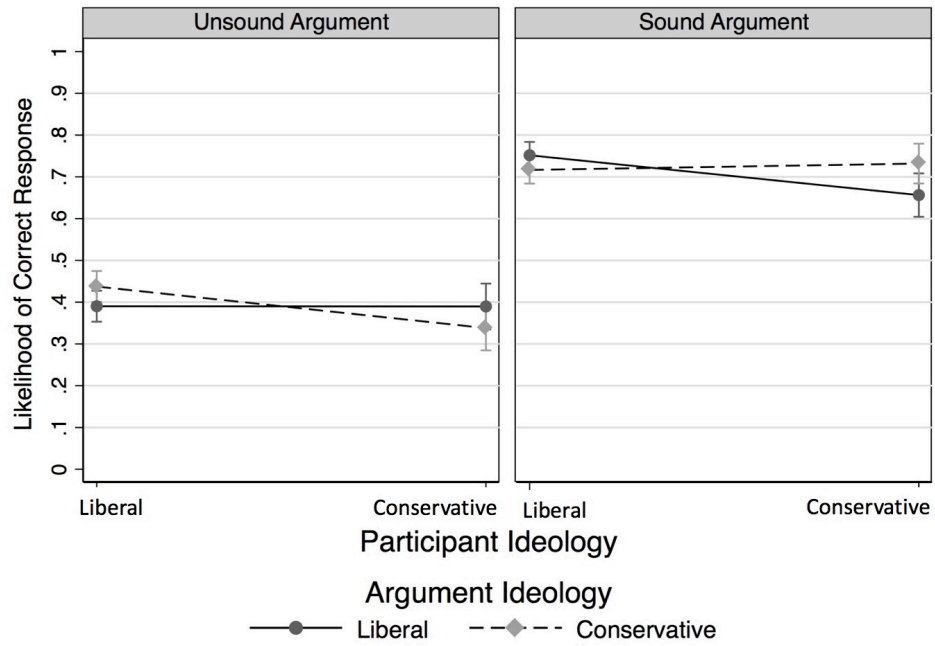
Figure 2: Study 2 results for the likelihood of correct responses for sound liberal arguments, sound conservative arguments, unsound liberal arguments, and unsound conservative arguments for liberal and conservative participants. Error bars are 95% CI.

Table 7: Study 2 logistic regression with three-way interaction predicting accuracy of participant's judgements.

	Odds Ratio	RSE	[95% Conf. Interval]	
PI	1.00	0.04 (.818)	0.94	1.08
AS	4.01	0.34 (<.001)	3.40	4.74
PI X AS	0.89	0.05 (.024)	0.80	0.98
AI	1.00	0.08 (.984)	0.86	1.17
PI X AI	0.88	0.04 (.009)	0.81	0.97
AS X AI	1.03	0.18 (.780)	0.83	1.29
PI X AS X AI	1.26	0.09 (<.001)	1.11	1.45
Logical Structure	0.44	0.02 (<.001)	0.39	0.49
Argument's Topic				
Abortion	1.17	0.09 (.057)	0.99	1.38
Capital Punishment	1.05	0.09 (.576)	0.88	1.25
Government Intervention	1.06	0.08 (.395)	0.92	1.23

Notes: PI is Participant Ideology, AS is Argument Soundness, AI is Argument Ideology. p values are given in the parentheses. Base argument topic is affirmative action.

Discussion. Study 2 provides further evidence for ideological belief bias, with an advantage of a large, but distinct internet sample and with the use of more conversational language in the stimuli. The results in Studies 1 and 2 both showed that participants evaluated entire political arguments based on whether or not the arguments' conclusions aligned with participants' ideologies, and that this effect was driven by participants' ideological beliefs. In Study 3, a similar logical reasoning task was administered to a nationally representative sample. Additionally, participants in Study 3 were administered

a logical reasoning task that is devoid of political content in order to test whether liberals and conservatives differ in logical reasoning skills.

Study 3

      Materials and Methods. Study 3 was conducted on a nationally representative sample of 1109 participants (48.3% female; M_{age}=49.81, SD_{age}=17.16). Time-Sharing Experiments for Social Sciences (TESS) funded the sampling for the study and GfK Group implemented the survey. Due to funding constraints with sample sizes potential participants who selected "4" on 7-point political ideology scale (1=*Very Liberal*, 7=*Very Conservative*) were screened out, and the final sample was 552 Liberals and 557 Conservatives.

      In Study 3, participants completed two logical reasoning tasks. Both tasks were similar to those described in Study 2, however the arguments in the first task were non-political in nature ("Chief Pava believes that anyone who has a khntzor can participate in the Ump Festival. She also believes all Lonbums have khntzors. Therefore, Chief Pava concludes that Lonbums can participate in the Ump Festival." Norenzayan et al., 2002) After reading extensive directions participants read four arguments and evaluated their soundness on a 6-point factor scale (1=*Logically Unsound, Very Confident* to 6=*Logically Sound, Very Confident)*. The first two arguments tested the logic of, "If P, then Q. P. Therefore, Q" (MP), and the next two tested the logic of "If P, then Q. Not Q. Therefore, not P" (MT). (See SI).

      After the non-ideological arguments task, participants completed a test with four syllogisms in which the terms within the premises and conclusions were political in nature and identical to the arguments in Study 2. See the SI for the full set of arguments.

The response options and manipulation check were identical to those of Study 2.

Results. As in Study 2, a linear mixed effects model with three-way interactions was conducted to predict logical soundness ratings using the argument ideology, the soundness of the argument, participant ideology, logical structure, and argument topic as predictor variables. Results indicate a main effect of argument soundness such that participants perceived sound arguments as more sound (b=0.55). Also, there was a main effect of argument ideology (b=0.22) such that conservative arguments were considered more sound. However, there was no main effect of participant ideology (b=0.02). Finally, we observed a main effect of the argument's logical structure such that modus tollens arguments were perceived as less sound (b=-0.43) and of argument's topic such that arguments about capital punishment were perceived as the least sound (b=-0.65). For two-way interactions, the interaction between participant ideology and argument soundness was significant (b=-0.08), the interaction between argument soundness and argument ideology was not significant (b=-0.07).

As in Studies 1 and 2, participants in Study 3's nationally representative sample displayed evidence of ideological belief bias, although the effect was somewhat less pronounced than in the previous two studies. In line with Studies 1 and 2, there was a significant two-way interaction between participant ideology and argument ideology on judgments of argument soundness, b=0.08, suggesting that evaluations of the logical syllogisms depended, in part, on their ideological leanings. In Study 3, however, participants with greater conservatism rated arguments with conservative conclusions as more sound (b=0.08, p<.001) but did not differ on their ratings for arguments with liberal conclusions (b=-0.02, p=.316). These effects were again independent of the soundness of

the argument, as indicated in the three-way interaction ($b=0.04$). See Table 8 for full

results.

Table 8: Study 3 linear regression with three-way interaction predicting perceived logical soundness.

	b	SE	[95% Conf. Interval]	
PI	0.02	0.03 (.433)	-0.03	0.07
AS	0.55	0.07 (<.001)	0.42	0.69
PI X AS	-0.08	0.04 (.022)	-0.16	-0.01
AI	0.22	0.07 (.002)	0.08	0.35
PI X AI	0.08	0.04 (.036)	0.01	0.15
AS X AI	-0.07	0.10 (.454)	-0.26	0.18
PI X AS X AI	0.04	0.05 (.404)	-0.06	0.14
Logical Structure	-0.43	0.05 (<.001)	-0.53	-0.33
Argument's Topic	-0.14	0.02 (<.001)	-0.18	-0.09
Abortion	0.06	0.07 (.383)	-0.07	0.19
Capital Punishment	-0.65	0.07 (<.001)	-0.79	-0.52
Government Intervention	-0.22	0.07 (<.001)	-0.35	-0.09

Notes: PI is Participant Ideology, AS is Argument Soundness, AI is Argument Ideology. *p* values are given in the parentheses. Base argument topic is affirmative action.

On average, participants correctly judged 55.93% of the syllogisms. We again

conducted a three-way logistic regression to predict the accuracy of participant's

judgement. There is no main effect of participant ideology ($OR=0.97$). There was,

however, a main effect of argument ideology where arguments with conservative

conclusions had worse accuracy ($OR=0.83$), argument soundness where sound arguments

had greater accuracy ($OR=2.80$), and argument's logical structure where modus tollens

arguments had worse accuracy (*OR*=0.48). And, there was no main effect of argument topic (*OR*=0.98). There was no two-way interaction between participant ideology and argument soundness (*OR*=0.98), and between participant ideology and argument ideology (*OR*=0.95). There was a significant interaction between argument soundness and argument ideology (*OR*=1.33).

Most importantly, there was a three-way interaction between participant ideology, argument soundness, and argument ideology (*OR*=1.17). As political conservatism increased, syllogisms with conservative conclusions were more likely to be evaluated correctly if they were sound (*b*=0.01, *p*=.054), and less likely to be evaluated correctly if they were unsound (*b*=-0.02, *p*=.020). However, as political conservatism, increased there was no difference for syllogisms with liberal conclusions that were sound (*b*=-0.01, *p*=.230) or unsound (*b*=-0.01, *p*=.485). See Figure 3 below. See Table 9 for full results.
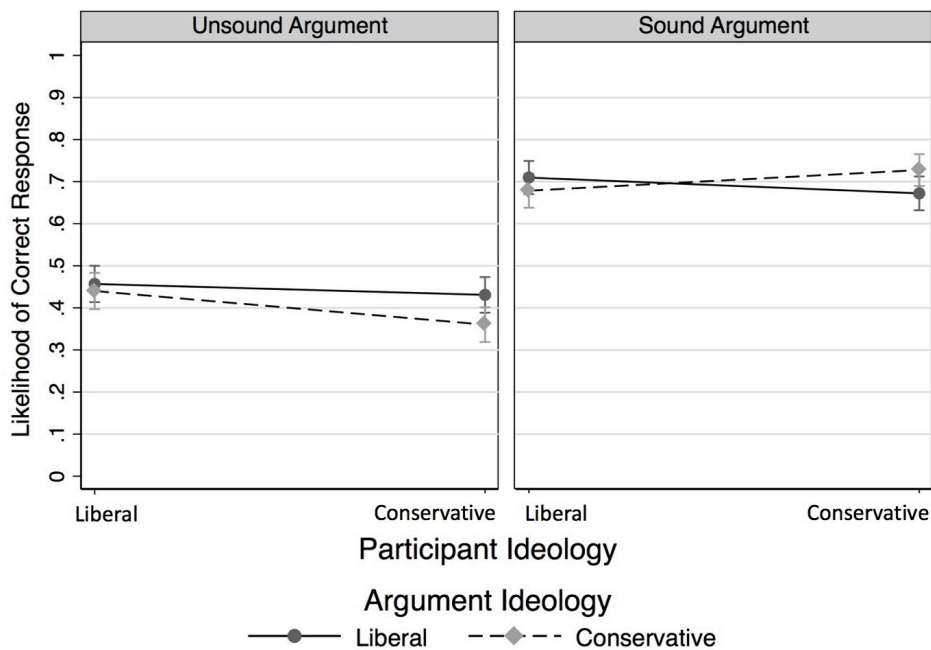

Figure 3: Study 2 results for the likelihood of correct responses for sound liberal arguments, sound conservative arguments, unsound liberal arguments, and unsound conservative arguments for liberal and conservative participants. Error bars are 95% CI.

Table 9: Study 3 logistic regression with three-way interaction predicting accuracy of participant's judgements.

	Odds Ratio	RSE	[95% Conf. Interval]	
PI	0.97	0.03 (.416)	0.91	1.04
AS	2.80	0.27 (<.001)	2.33	3.38
PI X AS	0.98	0.05 (.761)	0.89	1.09
AI	0.83	0.07 (.019)	0.71	0.97
PI X AI	0.95	0.04 (.201)	0.87	1.03
AS X AI	1.33	0.16 (.016)	1.05	1.68
PI X AS X AI	1.17	0.07 (.011)	1.04	1.33
Logical Structure	0.48	0.03 (<.001)	0.43	0.54
Argument's Topic	0.98	0.03 (.497)	0.94	1.04
Abortion	0.99	0.09 (.958)	0.83	1.20
Capital Punishment	0.82	0.08 (.052)	0.68	1.00
Government Intervention	1.00	0.08 (.951)	0.86	1.18

Notes: PI is Participant Ideology, AS is Argument Soundness, AI is Argument Ideology. *p* values are given in the parentheses. Base argument topic is affirmative action.

Discussion. The key ideological belief bias effects observed among liberals and conservatives in Studies 1 and 2 replicated in a nationally representative sample. Participants' evaluations of the logical soundness of political arguments were influenced by their ideologies, and these judgments were driven by participants' specific ideological beliefs.

Our analysis of belief bias by liberals and conservatives may naturally raise the question, "are liberals and conservatives differently susceptible to the bias"? However, our data are not well-suited to answer such questions conclusively. In a recent meta-

analysis comparing biased assimilation between liberals and conservatives, Ditto and colleagues (2018) identified a study's *stimulus match* as a critical experimental factor necessary for generalizing ideological differences in bias. In other words, the stimuli evaluated by liberals and conservatives must be equivalent in their informational content, separate from their partisan framing. Although we attempted to match the stimuli that measured liberal and conservative belief bias in as many ways as possible, it is likely that the arguments we chose were not equally polarizing for liberals and conservatives. For example, in Study 3, the mean difference in agreement ratings between arguments with liberal and conservative conclusions for liberal participants was 0.39 (t(1050)=7.40, p<.001, 95%CI[0.29,0.49]), and the corresponding difference for conservatives was 1.48 (t(1050)=30.00, p<.001, 95%CI[2.29,3.77]). Further, we observed inconsistent ideological differences in our samples: Study 1 participants with increasing degrees of political conservatism were more likely to evaluate syllogisms correctly (*OR*=0.94), but there was no main effect of participant ideology in Study 2 (*OR*=1.00) or Study 3 (*OR*=0.97). Finally, participants from the nationally representative sample in Study 3 did not show differences in their correctness on non-ideological content, b=0.01, t(1109)=0.41, p=.965, 95%CI[-0.04,0.07]. Taken together, our results are well suited to show *that* there is ideological belief bias on both the Left and Right, but the evidence is not sufficient to generalize relative differences in the degree to which this bias occurs between liberals and conservatives.

General Discussion

In three high-powered studies (total *N*=2,898), we observed evidence that people's political beliefs impact their ability to reason logically about political issues.

Biased beliefs about political arguments' conclusions caused liberals and conservatives to make predictable patterns of errors. Specifically, participants evaluated the logical structure of entire arguments based on whether they believed in or agreed with the arguments' conclusions. Although these effects were modest in magnitude, they were persistent: we observed these biases in evaluations of both classically-structured logical syllogisms and conversationally-framed political arguments, across a variety of polarized political issues, and in large Internet and nationally representative samples.

These results demonstrate that belief bias is a pervasive problem in political reasoning that affects both liberals and conservatives. Participants failed to overcome ideological belief bias effects even after a training session on logical reasoning and explicit instructions on how to evaluate logical soundness. These studies also emphasize that belief bias can be particularly problematic in the political domain because of pre-existing differences in partisans' political beliefs. That is, political opponents' judgments of logical soundness were biased in opposite directions, meaning that liberals and conservatives came to disagree not only about their political beliefs, but also in their perceptions of what it means to be logical at all.

Future research should examine whether and how individual differences might mitigate political belief bias. It is possible that indicators of cognitive ability, such as high numeracy, would improve overall performance. However, there is also evidence that enhanced cognitive abilities may exacerbate, rather than mitigate, our biases in a politically motivated setting (e.g., Kahan, Peters, Dawson, & Slovic, 2017).

Returning to our introductory question, is logical reasoning the antidote to political disagreement, or is it the poison? Our results suggest that it might be both. On

the one hand, logical reasoning led participants to evaluate a majority of arguments in each study correctly, regardless of their political orientation. On the other hand, liberals and conservatives frequently and predictably disagreed in their evaluations of logical soundness. Conclusions and arguments that appear believable and therefore logically sound to liberals appear unbelievable and therefore unsound to political conservatives, and vice versa, regardless of the actual soundness of the arguments. While partisanship alone may push liberals and conservatives apart in their beliefs, ideological belief bias then pushes liberals and conservatives apart even in the perceived logic underlying those political beliefs.

Despite this, a more optimistic view of our results is that understanding these predictable biases could ultimately improve political reasoning. Consistent with bias blind spot research (Pronin et al., 2002), reasoners appear to be better at identifying biased reasoning in others than in themselves. That is, liberals were better at identifying flawed arguments supporting conservative beliefs and conservatives were better at identifying flawed arguments supporting liberal beliefs. A takeaway from this research, then, may be that reasoners should strive to be epistemologically humble. If logical reasoning is to serve as the antidote to the poison of partisan gridlock, we must begin by acknowledging that it does not merely serve our objectivity, but also our biases.

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Supplemental Information

Demographics

Table SI1: Demographic data for studies 1, 2 and 3.

Demographics	Study 1	Study 2	Study 3
Age	40.09 (16.50)	34.41 (13.18)	49.81 (17.16)
Men	65.04%	35.06%	51.67%
Completed College	69.09%	51.78%	40.94%
White	--	71.71%	74.93%
Political Ideology			
Liberals	53.03%	46.44%	49.77%
Moderates	11.90%	35.19%	--
Conservatives	35.07%	18.37%	50.23%
N	924	1198	1109

Power Analysis

A priori statistical power analysis was conducted for Study 3 only. The key question of interest is the impact of participant ideology on soundness ratings of arguments. From our preliminary work, the most appropriate comparison for power estimation was Study 2's analysis of Participant Ideology X Argument Ideology, $F(1, 835) = 10.14$, $p < 0.01$, $\eta p2 = 0.01$. G*Power program under F-test family, ANOVA: Fixed effects, special, main effects and interactions statistical test, and a priori type of power analysis was used to determine sample size. Based on the aforementioned information, the sample size needed to achieve at least power of 0.95 is 1072.

Results, Controlling for Demographics

Table SI2: Coefficients for regressions with three-way interaction predicting perceived logical soundness, controlling for demographics.

	Study 1[c]	Study 2[d]	Study 3[d]
PI	0.93**	-0.02	0.02
AS	8.67***	0.66***	0.55***
PI X AS	0.78***	-0.12**	-0.08**
AI	0.93	0.07	0.22**
PI X AI	1.49***	0.15**	0.07
AS X AI	0.92	-0.02	-0.07
PI X AS X AI	0.99	0.00	0.04
Logical Structure	0.74***	-0.57***	-0.43***
Topic[a]		-0.18***	-0.14***
Age	1.00	-0.01***	-0.01**
Gender	1.09	0.04	0.04
Education	0.89***	-0.01	0.01
Race[b]		-0.04	-0.09*
N	924	1198	1109

Note: *** $p < .001$, ** $p < .01$, * $p < .05$

[a] Topic was only applicable for studies 2 and 3.

[b] Race was not collected in Study 1.

[c] Study 1 coefficients are odds ratios.

[d] Study 2 and Study 3 coefficients are from mixed-effects models.

Manipulation Checks

Study 1

As a manipulation check, participants also rated the believability of each conclusion, independent of its context within the syllogisms in the reasoning task, on a scale from 1 = *Definitely False* to 7 = *Definitely True*.

To test the effectiveness of our manipulation of the ideology of the arguments, we conducted two linear regressions predicting agreement with the argument conclusions as the outcome variable and argument soundness, participant ideology, and their interaction terms included as predictor variables. One regression included only those arguments that were designed to be liberal in nature and another that included only those arguments that were designed to be conservative in nature. These analyses showed that participant ideology interacted with argument ideology such that participants rated arguments as true more when the argument's ideology matched their own ideology ($b = 0.68$, $SE = 0.02$, p <.001, 95% $CI = [0.65, 0.71]$), than when the argument ideology conflicted with their own ($b = -0.61$, $SE = 0.01$, $p < .001$, 95% $CI = [-0.64, -0.58]$).

Table SI3: Study 1 linear regressions predicting agreement with the argument conclusions for only arguments with liberal conclusions.

	b	RSE	[95% Conf. Interval]	
PI	-0.61	0.01 (<.001)	-0.64	-0.58
AS	-0.05	0.04 (.192)	-0.12	0.02
PI X AS	-0.08	0.02 (<.001)	-0.11	-0.04

Notes: PI is Participant Ideology and AS is Argument Soundness. p values are given in the parentheses.

Table SI4: Study 1 linear regressions predicting agreement with the argument conclusions for only arguments with conservative conclusions.

	b	RSE	[95% Conf. Interval]	
PI	0.68	0.02 (<.001)	0.65	0.71
AS	-0.06	0.04 (.082)	-0.13	0.01
PI X AS	0.00	0.02 (.877)	-0.03	0.03

Notes: PI is Participant Ideology and AS is Argument Soundness. p values are given in the parentheses.

Study 2

As a manipulation check, Study 2 participants independently reported their agreement with each conclusion, "Regardless of other statements, to what extent do you agree with this statement:" and the response options was a 5-point scale (1= Strongly Disagree to 5 = Strongly Agree).

As in Study 1, to test the effectiveness of our manipulation of the ideology of the arguments, we conducted two linear regressions predicting agreement with the argument conclusions as the outcome variable and argument soundness, participant ideology, and their interaction term included as predictor variables. One regression included only those arguments that were designed to be liberal in nature and another that included only those arguments that were designed to be conservative in nature. These analyses showed that participant ideology interacted with argument ideology such that participants rated arguments as true more when the argument's ideology matched their own ideology ($b = 0.28, SE = 0.02, p < .001, 95\% CI = [0.23, 0.30]$), than when the argument ideology conflicted with their own ($b = -0.24, SE = 0.02, p < .001, 95\% CI = [-0.28, -0.20]$). See SI for the full results.

Table SI5: Study 1 linear regressions predicting agreement with the argument conclusions for only arguments with liberal conclusions.

	b	RSE	[95% Conf. Interval]	
PI	-0.24	0.02 (<.001)	-0.28	-0.20
AS	0.01	0.04 (.823)	-0.08	0.10
PI X AS	-0.04	0.03 (.108)	-0.10	0.01

Notes: PI is Participant Ideology and AS is Argument Soundness. *p* values are given in the parentheses.

Table SI6: Study 1 linear regressions predicting agreement with the argument conclusions for only arguments with conservative conclusions.

	b	RSE	[95% Conf. Interval]	
PI	0.28	0.02 (<.001)	0.23	0.30
AS	0.05	0.04 (.216)	-0.03	0.13
PI X AS	0.01	0.03 (.653)	-0.04	0.06

Notes: PI is Participant Ideology and AS is Argument Soundness. *p* values are given in the parentheses.

Study 3

As a manipulation check, Study 3 participants independently reported their agreement with each conclusion, "Regardless of other statements, to what extent do you agree with this statement:" and the response options was a 5-point scale (1= Strongly Disagree to 5 = Strongly Agree).

Again, to test the effectiveness of our manipulation of the ideology of the arguments, we conducted two linear regressions predicting agreement with the argument conclusions as the outcome variable and argument soundness, participant ideology, and their interaction term included as predictor variables. One regression included only those arguments that were designed to be liberal in nature and another that included only those arguments that were designed to be conservative in nature. These analyses showed that participant ideology interacted with argument ideology such that participants rated

arguments as true more when the argument's ideology matched their own ideology (b = 0.27, SE = 0.02, $p <$.001, 95% CI = [0.23, 0.30]), than when the argument ideology conflicted with their own (b = -0.28, SE = 0.02, $p <$ .001, 95% CI = [-0.32, -0.24]). See SI for the full results.

Table SI7: Study 1 linear regressions predicting agreement with the argument conclusions for only arguments with liberal conclusions.

	b	RSE	[95% Conf. Interval]	
PI	-0.28	0.02 (<.001)	-0.32	-0.24
AS	-0.19	0.11 (.099)	-0.41	0.04
PI X AS	0.04	0.03 (.107)	-0.01	0.09

Notes: PI is Participant Ideology and AS is Argument Soundness. p values are given in the parentheses.

Table SI8: Study 1 linear regressions predicting agreement with the argument conclusions for only arguments with conservative conclusions.

	b	RSE	[95% Conf. Interval]	
PI	0.27	0.02 (<.001)	0.23	0.30
AS	-0.15	0.11 (.160)	-0.37	0.06
PI X AS	0.02	0.02 (.345)	-0.03	0.07

Notes: PI is Participant Ideology and AS is Argument Soundness. p values are given in the parentheses.

Correctness by Topic and Logic Style

The table below provides the percentage of correct responses based on the topic of the

argument and the logical type of the argument. In Study 1, the arguments were not

differentiated by any particular topic. However, in studies 2 and 3 each argument was

either on affirmative action, abortion, capital punishment or government intervention, and

each of the four arguments that the participant sees was on a different topic in random

order.

Table SI9: Percentage of correctly evaluating logical arguments based on argument topic and style for studies 1, 2 and 3.

Argument Type	Study 1[c]	Study 2	Study 3
Topic			
Affirmative Action	--	55.20%	56.63%
Abortion	--	56.56%	57.26%
Capital Punishment	--	55.44%	53.29%
Government Intervention	--	55.60%	56.54%
Logic			
Modus Ponens[a]	78.53%	64.84%	64.16%
Modus Tollens[b]	67.53%	46.56%	47.70%
N	924	1198	1109

[a] Sound form is "If P then Q. P. Therefore, Q" and unsound form is, "If P then Q. Q. Therefore, P."
[b] Sound form is, "If P then Q. Not Q. Therefore, Not P" and unsound form is, "If P then Q. Not P. Therefore, Not Q"
[c] Study 1 arguments were not differentiated by topics

Mediational Analyses

Study 1

A belief bias account of these effects is supported by the mediating role of conclusion believability in judgments of soundness. Regression results indicated that in addition to predicting soundness judgments, the interaction between participant and argument ideology was a significant predictor of participants' believability ratings for the arguments' conclusions, $b = 0.71$, $SE = 0.012$, $p < .001$, 95% CI [0.69, 0.73], and that believability ratings were a significant predictor of soundness judgments, $b = 0.14$, $SE = 0.006$, $p < .001$, 95% CI [0.13, 0.15]. Moreover, the interaction between participant and argument ideology was no longer a significant predictor of soundness judgments after controlling for the perceived believability of the conclusions, $b = -0.01$, $SE = 0.009$, $p = .457$, 95% CI [-0.03, 0.01], consistent with full mediation. Approximately 96.07% of the variance in the total effect was accounted by the indirect effect using a bootstrap estimation approach with 1000 samples (Shrout & Bolger, 2002).

Study 2

As in Study 1, mediation analysis indicated that these effects could be accounted for by the partisan differences in factual beliefs. The interaction between participant and argument ideology was a significant predictor of the mediator, participants' agreement with the arguments' conclusions, $b = 0.27$, $SE = 0.015$, $p < .001$, 95% CI [0.25, 0.31], and that participants' agreement with the argument was a significant predictor of soundness ratings, $b = 0.25$, $SE = 0.028$, $p < .001$, 95% CI [0.19, 0.31]. The interaction of participant and argument ideology was no longer a significant predictor of soundness ratings after controlling for participants' agreement with the arguments' conclusions, $b =$

0.01, SE = 0.030, p = .951, 95% CI [-0.05, 0.06], consistent with full mediation.

Approximately 93.21% of the variance in the total effect was accounted by the indirect

effect.

Study 3

Importantly, regression results revealed that these effects could be accounted for by

participants' beliefs. The interaction of participant ideology and argument ideology was a

significant predictor of the mediator, participants' agreement with the argument, b = 0.18,

SE = 0.008, p < .001, 95% CI [0.17, 0.20], and that participants' agreement with the

argument was a significant predictor of soundness ratings, b = 0.20, SE = 0.021, p < .001,

95% CI [0.15, 0.24]. The interaction of participant ideology and argument ideology was

no longer a significant predictor of soundness ratings after controlling for participants'

agreement with the arguments' conclusions, b = 0.02, SE = 0.011, p = .099, 95% CI [-

0.00, 0.04], consistent with full mediation. Approximately 65.01% of the variance in the

total effect was accounted by the indirect effect.