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Political ideology and environmentalism impair logical reasoning

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ABSTRACT

People are more likely to think statements are valid when they agree with them than when they do not. We conducted four studies analyzing the interference of self-reported ideologies with performance in a syllogistic reasoning task. Study 1 established the task paradigm and demonstrated that participants' political ideology affects syllogistic reasoning for syllogisms with political content but not politically irrelevant syllogisms. The preregistered Study 2 replicated the effect and showed that incentivizing accuracy did not alleviate these differences. Study 3 revealed that syllogistic reasoning is affected by ideology in the presence and absence of such bonus payments for correctly judging the conclusions' logical validity. In Study 4, we observed similar effects regarding a different ideological orientation: environmentalism. Again, monetary bonuses did not attenuate these effects. Taken together, the results of four studies highlight the harm of ideology regarding people's logical reasoning.

When it comes to solving a problem or finding a solution, Wason and Shapiro (1971) showed that people find it easier to deal with an abstract rule when relevant content is added (e.g., explaining the rule in an everyday context, such as using postage at the post office). In syllogistic reasoning, however, adding content can go both ways: A reasonable conclusion, like *all fires are hot,* is more likely to be judged to be valid than an unbelievable conclusion, like *all fires are cold,* independent of the two conclusions' logical validity (e.g., Evans et al., 1983; Oakhill et al.,

1989). This *belief bias* has been demonstrated numerous times in the psychological literature; it occurs when people's evaluations of the logical strength of a syllogism are influenced by their attitudes and beliefs rather than by its validity. Exhibiting a belief bias can result in flawed or irrational thinking, for example, when it causes people to accept an argument as logical even when it is not.

Accepting an invalid argument as logical independent of its logical validity can have wide-reaching consequences, especially in politics. Gampa et al. (2019) and Calvillo et al. (2020) suggest that individuals' political ideologies of being liberal versus conservative impact such evaluations of the logical soundness of presented arguments. If an argument's conclusion matches one's ideology, one is more likely to see it as valid, while one is less likely to see it as valid when it matches the opposing ideology. Moreover, one is more likely to see the flaw in an invalid conclusion when it matches the opposing ideology but may turn a blind eye to an invalid conclusion supporting one's ideology. In the present article, we report four studies replicating and extending these findings. Specifically, we show that incentivizing performance on a logical reasoning task cannot undo this ideological reasoning effect (Studies 2–4) and that the effects extend across cultures (from the US, Studies 1–3, to Germany, Study 4) and beyond conservative versus liberal ideologies (Studies 1–3) to environmentalism (Study 4).

There are many definitions of political ideology, and no universally accepted definition exists (e.g., Gerring, 1997). However, for the present set of studies, we follow the approach of Jost et al. (2009) and use Erikson and Tedin (2003) textbook definition of ideology: "a set of beliefs about the proper order of society and how it can be achieved" (p. 64). This definition readily applies to liberal and conservative political ideologies as well as environmentalism.

Research on political ideology often focuses on how liberals and conservatives differ in their thoughts, preferences, or personalities (e.g., Baron & Jost, 2019; Jost et al., 2003). For instance, liberals (vs. conservatives) have been described as more open-minded (Price et al., 2015), to excel at tasks that require response updating (vs. response inhibition; Buechner et al., 2021), and to care more about fairness (vs. loyalty; Voelkel & Feinberg, 2018). In contrast, conservatives (vs. liberals) were found to be angrier (Kettle & Salerno, 2017), more ideologically intolerant (Ganzach & Schul, 2021), motivated by the need for closure (De Keersmaecker et al., 2017; but see Baldner et al., 2018), and threatened by the competitive jungle they perceive the world to be (Duckitt & Sibley, 2009). Furthermore, liberals report greater policy consensus in the U.S. (Ondish & Stern, 2018) and across Europe (Brandt et al., 2022) than conservatives. Many of these effects seem especially pronounced in ideologically more extreme individuals (e.g., Harris & Van Bavel, 2021).

In the present paper, we first address the logical reasoning performance of people adhering to either ideology. Generally, people are more likely to engage in effortful reasoning when an intuitive solution contradicts

their beliefs but more likely to engage in self-serving intuitive reasoning when it matches their beliefs (Mata et al., 2015). Expanding on this observation, Washburn and Skitka (2018; see also Kahan et al., 2017) confronted participants with fictional scientific articles showing positive and negative outcomes caused by specific policies. The authors found that participants demonstrated science denial concerning conclusions that did not match their attitudes, leading to fewer correct interpretations of the results and greater distrust toward the researchers. Related to the present research, both liberals and conservatives did so similarly, meaning that such science denial may be present in both liberals and conservatives alike. However, the manipulated results presented to participants by Washburn and Skitka concerned societal topics (e.g., regulations regarding carbon emissions, effects of same-sex marriage on physical and mental health). Therefore, interested participants might have read a lot about these topics beforehand and found the presented numbers heavily conflicting with their experience, considering their disbelief to be justified.

Gampa et al. (2019) constructed a syllogistic reasoning task in response to this objection: Inferring a conclusion's validity in a syllogistic reasoning task is always possible by carefully processing the structure of its two premises. Thus, while it might be rational to be skeptical of a single scientific article that contradicts what one believes or has experienced in one's daily life, participants in the studies by Gampa and colleagues did not need to use the content of the premises: Participants were asked to infer the validity of a conclusion solely based on the logical premises. Although political content was used, there was an objectively correct response for each conclusion, dependent on its form but independent of its content.

Nevertheless, the content of syllogisms mattered: Participants behaved similarly to participants in studies on belief bias (e.g., Klauer et al., 2000). Liberal participants were more likely to identify invalid conservative than liberal conclusions, while conservative participants were more likely to identify invalid liberal than conservative conclusions. In another research project, Calvillo et al. (2020) reported similar findings, with liberal participants being more likely to accept liberal conclusions and conservative participants more likely to accept conservative conclusions. In contrast, cognitive reflection, the tendency to override a gut response by investing mental effort (Frederick, 2005), played no interactive role beyond a general increase in syllogistic reasoning performance. Aspernäs et al. (2023) went outside the US political system and applied the syllogistic reasoning task to a representative sample of Swedish participants. For hot-button issues like climate change and gender-neutral education, participants who fell on the leftist side of the spectrum were again more likely to see the flaw in conclusions that matched viewpoints of a rightist political ideology but were blind to flaws in conclusions that matched their more leftist viewpoint, and vice versa. And again, analytical thinking, assessed via cognitive reflection, was associated with syllogistic reasoning performance. Strikingly, the authors found a main effect of analytical thinking for leftist syllogisms

but not for rightist syllogisms. There was a hint of an interaction for rightist syllogisms, meaning that analytical thinking was associated with increased performance on rightist syllogisms for self-reported leftists but associated with decreased performance on rightist syllogisms for self-reported rightists. While the latter association was not statistically significant, this pattern would imply that analytical thinking helped self-reported rightists to overcome an ideological belief bias. In contrast, no such pattern emerged for self-reported leftists.

But researchers are not only interested in the presence or absence of biases like the ideological reasoning bias in syllogistic reasoning. They are also interested in overcoming or attenuating such an effect. Therefore, it is striking that, to date, no studies have tested a potential intervention. A way that many behavioral economists favor is using monetary incentives (e.g., Gneezy et al., 2011). Incentives can be used to try to overcome flawed reasoning or biases by providing a concrete reward or consequence for certain behaviors or decisions (e.g., Prior et al., 2015; cf. Lebreton et al., 2018). Incentives can encourage people to overcome flawed reasoning by providing a solid motivation to think more carefully or critically about their decisions. For example, in a study on ideological belief bias, researchers might offer a financial reward to participants for identifying flawed syllogisms to overcome the influence of preexisting beliefs or biases on their judgment.

Present research

We report four studies testing whether enriching syllogisms with political content can systematically affect people's logical reasoning performance. In all studies, participants attended two independent sessions. In a brief first session, we assessed their ideological stance. In a second session some days apart, we used a syllogistic reasoning task similar to previous research (Calvillo et al., 2020) that allows for filling in political content without altering the correct response for each syllogism. We expected that the ideological content would affect syllogistic reasoning performance dependent on the participants' self-reported ideologies. Participants should be more likely to correctly classify valid syllogisms whose conclusions match their viewpoint (i.e., mark them as correct) and invalid syllogisms whose conclusions do not match their viewpoint (i.e., mark them as incorrect). We expect this pattern to be true for both assessed ideologies (political ideology, environmentalism), for both cultures (USA, Germany), and across a host of background variables (e.g., analytical thinking aptitude). We furthermore were interested in the role of monetary incentives and whether they manage to attenuate the intensity of ideological syllogistic reasoning. Materials, data, scripts, preregistration (for Study 2), and supplemental material for all four studies are available at https://researchbox.org/200.

Study 1: Syllogistic reasoning in a U.S. convenience sample

In Study 1, we asked participants to infer the validity of a conclusion from its two premises. The syllogisms included nonwords to avoid overly complicated structures. They were further varied in three dimensions. First, conclusions were either valid (e.g., *all tropical birds are lofs, all lofs are colorful; therefore, all tropical birds are colorful*) or invalid (e.g., *all pefs are wild dolphins, all smart animals are pefs; therefore, all wild dolphins are smart animals*). Second, conclusions were of neutral (i.e., animals, plants, and objects) or political content (i.e., gun control, capital punishment, immigration, abortion, Affordable Care Act, and marriage equality). We used these six political issues because they were issues of a consistently sizeable partisan divide when the study was designed and conducted (Gallup, 2017). Third, to assess whether logical reasoning is affected by ideology, the political statements expressed either a liberal (e.g., *Therefore, all gun control reduces the number of mass shootings*) or a conservative viewpoint (e.g., *Therefore, gun ownership is an absolute, unrestrictable right*).

Method

Design, participants, and sample size considerations

The design of the experiment was self-reported political ideology as a continuous between-subjects variable × 2 within (syllogism content: neutral vs. political) × 2 within (syllogism validity: conclusion is valid vs. conclusion is invalid) × 2 within (syllogism's viewpoint: conclusion leaning toward liberal vs. leaning toward conservative viewpoint). Only syllogisms with political conclusions differed in viewpoints, and none of the participants reported being *very conservative*.

We set out to recruit 240 participants for our within-factors experiment; although there is no consensus on power analyses for generalized mixed models yet, the recruited sample size and the number of observations per participant should suffice to detect small-to-medium-sized effects and for the statistical models to converge (Brysbaert & Stevens, 2018). Recruitment was done over CloudResearch (Litman et al., 2017), tapping into Amazon's Mechanical Turk's (AMT) pool of workers. Previous research showed AMT as a valuable tool for research on political ideology (Clifford et al., 2015) and its samples to represent the U.S. population (Berinsky et al., 2012; but see also Anderson et al., 2019).

The experiment was conducted in two parts. In the first part, 235 participants indicated their political ideology but did not complete any syllogisms. Of these, 189 participants performed the syllogism task in the second part one week later. Of these 189 participants, 178 (94%) completed all syllogisms. However, we excluded 37 participants who marked every conclusion as correct and did not vary in their responses. Table 1 depicts the demographic composition of the remaining 141 U.S. residents. Participants were compensated with $1.00.

Table 1. Demographics.

Sociodemographic characteristic		Study 1	Study 2	Study 3	Study 4
		n (%)	n (%)	n (%)	n (%)
Age	18–24	20 (14%)	9 (5%)	15 (3%)	78 (82%)
	25–34	77 (55%)	83 (43%)	114 (26%)	17 (18%)
	35–44	23 (16%)	48 (25%)	128 (29%)	- (0%)
	45–54	11 (8%)	23 (12%)	70 (16%)	- (0%)
	55+	10 (7%)	29 (15%)	112 (26%)	- (0%)
Gender	Male	86 (61%)	98 (51%)	217 (49%)	11 (12%)
	Female	54 (38%)	94 (49%)	219 (50%)	84 (88%)
	Other	1 (1%)	- (0%)	3 (1%)	- (0%)
Ethnicity	Asian	9 (6%)	13 (7%)	23 (5%)	
	Black	4 (3%)	13 (7%)	35 (8%)	
	Hispanic	4 (3%)	- (0%)	34 (8%)*	
	White	117 (83%)	158 (82%)	358 (82%)	
	Other/multiple	7 (5%)	8 (4%)	23 (3%)	
Self-reported ideology	very liberal	18 (13%)	33 (17%)	43 (10%)	1 (1%)
	moderately liberal	37 (26%)	27 (14%)	68 (15%)	12 (13%)
	slightly liberal	28 (20%)	19 (10%)	71 (16%)	44 (46%)
	moderate	31 (22%)	28 (15%)	83 (19%)	27 (28%)
	slightly conservative	13 (9%)	26 (14%)	56 (13%)	11 (12%)
	moderately conservative	14 (10%)	29 (15%)	79 (18%)	- (0%)
	very conservative	- (0%)	30 (16%)	39 (9%)	- (0%)
Party ID	Democrats	71 (50%)	82 (43%)	164 (37%)	
	Independents	49 (35%)	38 (20%)	122 (28%)	
	Republicans	21 (15%)	72 (38%)	153 (35%)	

Note. In Study 3, Spanish, Hispanic, or Latino origin was assessed independently. Thus, percentages exceed 100%.

Procedure

In Part 1, participants indicated their demographics and political ideology. Then, they were told that they might be invited to a further research project. In Part 2, which took place one week later, participants worked on 24 syllogisms, one by one. Participants indicated their ideology and performed the syllogism task in two different sessions because we wanted to make the potential connection between self-reported political ideology and syllogistic reasoning performance less salient for participants. Figure 1 provides an overview of the participant flow between Parts 1 and 2.

Part 1

Participants indicated some demographic information (e.g., gender, age). Crucially, they described their political ideology on a 7-point scale ranging from *very liberal* to *very conservative*, with the midpoint *moderate*.

Part 2: Syllogisms

All participants had to judge the logical validity of the conclusions of the same 24 syllogisms in random order. Per political theme (i.e., gun control, capital punishment, immigration, abortion, Affordable Care Act, and
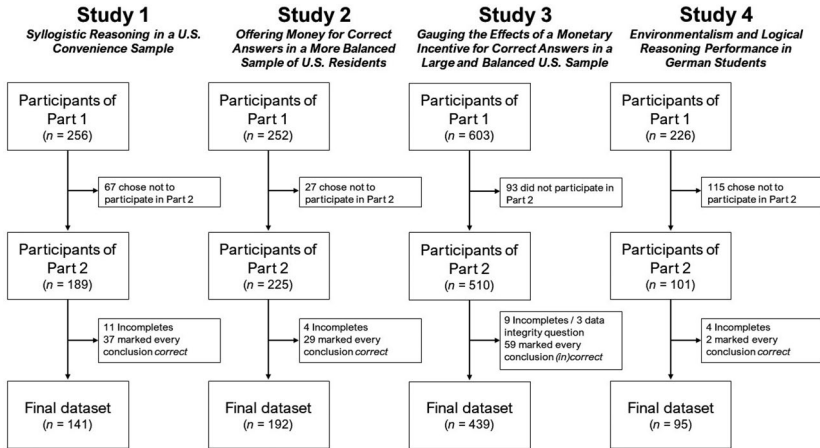
Participant Flow of Studies 1–4

Figure 1. Participant flow of Studies 1–4.

Table 2. Examples of neutral and political syllogisms varying in validity and ideological viewpoint.

Neutral syllogisms	
Valid	Invalid
(1)*All arns are colorful.*	(1)*All bolfs are tropical birds.*
(2)*All tropical birds are arns.*	(2)*All gray animals are bolfs.*
(3)*Therefore, all tropical birds are colorful.*	(3)*Therefore, all tropical birds are gray.*
(4)	
Political syllogisms – Liberal viewpoint	
Valid	Invalid
(1)*All abortions are mibs.*	(1)*All enrichments to the U.S. are vefs.*
(2)*All mibs are a personal choice.*	(2)*All vefs are immigrants.*
(3)*Therefore, all abortions are a personal choice.*	(3)*Therefore, all immigrants are an enrichment to the U.S.*
Political syllogisms – Conservative viewpoint	
Valid	Invalid
(1)*All expansions of health care are wuns.*	(1)*All dangers to our traditions are pavs.*
(2)*All wuns are bankrupting the U.S.*	(2)*All pavs are same-sex marriages.*
(3)*Therefore, all expansions of health care are bankrupting the U.S.*	(3)*Therefore, all same-sex marriages are dangers to our traditions.*

marriage equality), one conclusion expressed a liberal viewpoint, and one expressed a conservative viewpoint. We presented the same amount of valid and invalid conclusions for the liberal and conservative viewpoints. In other words, we balanced viewpoints and validity across all 12 political syllogisms so that every participant saw three conclusions of each combination of validity and viewpoint (see Table 2 for examples).

Participants were instructed to judge whether each conclusion necessarily followed its two premises by marking it *correct* or *incorrect*. Thus, the dependent variable was the participants' accuracy, meaning that a valid conclusion was marked correct and an invalid conclusion was marked incorrect.

Analyses

We fitted generalized linear mixed-effects models using the lme4 package (Bates et al., 2015) for R (R Development Core Team, 2008) to test our hypotheses regarding the interplay of ideology and logical reasoning. We chose maximal random effects structures specified by our experimental design (i.e., random intercepts for participants and random slopes for a conclusion's viewpoint or validity; Barr et al., 2013) and only reduced the model when there was singular fit or no convergence. To corroborate the significance of individual predictors or interaction effects between predictors, we calculated models of increasing complexity (Bolker, 2018). We will report only the full model and its incremental increase in model fit. Specific coefficients and test statistics for model comparisons can be found in tables in the supplemental material, referenced in the text as Tables S1–S15.

Results

We tested the influence of neutral and political content on performance in a syllogistic reasoning task across the ideological spectrum; mean accuracies are depicted in Table 3. For neutral syllogisms, we found that logical reasoning is not related to the participants' ideology. As expected, however, the results were different for political syllogisms. We observed that liberals were better at judging valid liberal statements and invalid conservative statements, whereas conservatives were better at judging valid conservative and invalid liberal statements. Overall, valid syllogisms were more often judged correctly than invalid ones.

Specifically, we first tested whether self-reported ideology explains variance in the accuracy for ideologically *neutral* syllogisms (see Table S1 in the supplemental material). These syllogisms only varied in their validity. The full model rendered a significant effect of validity, but neither ideology nor its interaction with validity was significant. Adding ideology and its interaction with validity to the model did not improve model fit compared to the model with validity as the sole predictor, $\chi^2(2) = 1.21$, $p = .546$. This suggests that all participants were more likely to correctly judge valid conclusions than invalid ones and implies that liberals and conservatives did not differ in their general logical reasoning.

Political syllogisms

We added a further predictor for analyzing *political* syllogisms, that is, whether they express a conservative or liberal viewpoint. Also, we added participants' accuracy for neutral conclusions to statistically control for participants' general syllogistic reasoning aptitude. The full model indicated that neither participants' ideology nor the syllogisms' ideological viewpoint was significant. Still, strong effects of the participants' accuracy for neutral conclusions and the conclusion's validity emerged. Whereas the two-way interaction between validity and viewpoint did not reach statistical significance, the two-way interactions between

Table 3. Mean accuracy as a function of self-reported political ideology, syllogism content, syllogism viewpoint, and syllogism validity in Studies 1–3.

	Self-reported political ideology							
	very lib.	moderately lib.	slightly lib.	moderate	slightly con.	moderately con.	very con.	total
Study 1								
Neutral	64%	77%	67%	67%	69%	71%	–	70%
valid	90%	98%	94%	94%	96%	98%	–	95%
invalid	38%	56%	39%	41%	41%	44%	–	44%
Political	66%	76%	67%	65%	75%	67%	–	70%
valid liberal	96%	99%	96%	90%	77%	86%	–	93%
invalid liberal	39%	55%	39%	38%	72%	57%	–	48%
valid conservative	69%	90%	86%	89%	90%	83%	–	86%
invalid conservative	61%	59%	46%	44%	62%	40%	–	52%
Study 2								
Neutral	72%	69%	72%	65%	67%	68%	69%	69%
valid	85%	86%	85%	82%	83%	80%	85%	84%
invalid	58%	51%	59%	49%	51%	56%	53%	54%
Political	66%	67%	69%	65%	62%	68%	64%	69%
valid liberal	86%	94%	91%	87%	82%	74%	82%	85%
invalid liberal	40%	48%	44%	43%	40%	63%	48%	47%
valid conservative	77%	73%	89%	83%	81%	85%	90%	82%
invalid conservative	60%	54%	51%	45%	45%	51%	38%	49%
Study 3								
Neutral	69%	67%	69%	66%	69%	68%	72%	68%
valid true	86%	95%	93%	92%	92%	93%	93%	92%
invalid true	43%	38%	45%	33%	42%	41%	46%	40%
valid false	81%	72%	73%	73%	76%	71%	71%	74%
invalid false	67%	63%	66%	67%	66%	68%	76%	67%
Political	63%	66%	65%	65%	70%	65%	66%	66%
valid liberal	87%	93%	91%	88%	90%	86%	74%	88%
invalid liberal	40%	38%	44%	43%	57%	52%	59%	47%
valid conservative	74%	80%	74%	81%	82%	82%	91%	80%
invalid conservative	52%	53%	51%	47%	50%	40%	40%	48%

Note. No participants claimed to be very conservative in Study 1.

ideology and both validity and viewpoint did. Most importantly, the three-way interaction between ideology, validity, and viewpoint was significant. Adding ideology and its two-way interactions with validity and viewpoint to the model did not improve model fit, $\chi^2(3) = 1.26$, $p = .740$, whereas adding the three-way interaction to the model did, $\chi^2(1) = 30.57$, $p < .001$, see Table S2. To further investigate this significant three-way interaction, we split the syllogisms regarding their validity.

Valid Conclusions. When looking at valid political conclusions, participants' accuracy for neutral conclusions and ideology were significant, whereas the conclusions' viewpoint was not (see Table S3). Notably, the interaction between ideology and viewpoint was significant. Adding this interaction to the model also significantly improved model fit, $\chi^2(1) = 14.66$, $p < .001$. Figure 2 (left side) depicts this interaction by showing the effect of a valid conservative conclusion on finding the correct answer across the ideological spectrum. More specifically, it depicts a lower accuracy for a valid syllogism with a conservative viewpoint compared to a valid syllogism with a liberal viewpoint for participants on the liberal side of the ideological spectrum but a heightened accuracy in participants on the conservative side of the ideological spectrum. This means that compared to a valid liberal conclusion, liberal participants were less likely to identify a valid conservative conclusion correctly, whereas conservative participants were more likely to do so. Note that because no participants identified as very conservative in the sample of Study 1, the effect for the conservative end of the ideological spectrum is extrapolated.

Invalid Conclusions. When looking at invalid political conclusions, participants' accuracy for neutral conclusions was significant, whereas ideology and viewpoint were not. Notably, the interaction between ideology and viewpoint was again significant, and adding this interaction to the model improved model fit, $\chi^2(1) = 7.92$, $p = .005$, see Table S4. Figure 2 (right side) depicts this interaction by showing that liberals were more likely to judge invalid conservative conclusions correctly by marking them invalid. In contrast, conservatives were less likely to do so, incurring errors by marking invalid conclusions as valid.

Discussion

We tested the hypothesis that political ideology systematically affects logical reasoning performance when encountering political content in a syllogisms task. Ideology interacted with whether the conclusion represents a conservative or liberal viewpoint and whether the conclusion is logically valid in affecting logical reasoning, easing the correct classification of logical syllogisms in some cases and impeding it in others. We observed a symmetrical pattern like in previous research (e.g., Calvillo et al., 2020; Gampa et al., 2019; Washburn & Skitka, 2018). Both sides of the ideological spectrum more likely judged a valid conclusion (i.e., a conclusion following from its premises) correctly when it matched their ideological side than when it matched the other side. Conversely, participants were more likely
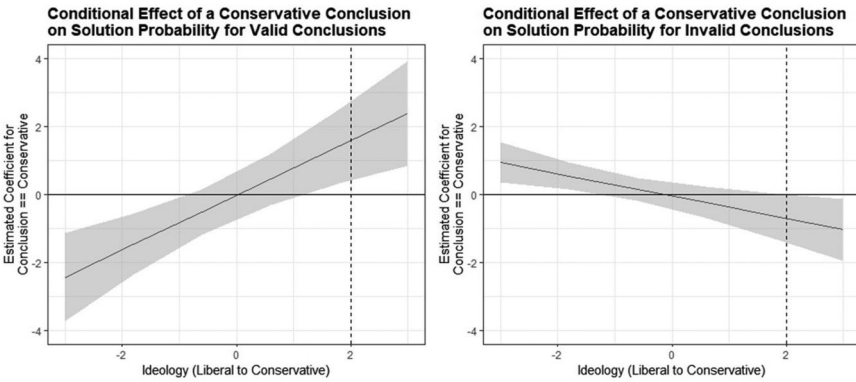
Figure 2. Study 1: conditional effect of the conclusions' viewpoint on participants' accuracy for valid (left panel) and invalid (right panel) syllogisms across the ideological spectrum. *Note.* Positive values signify higher accuracy. The left panel depicts the effect of viewpoint when a conservative statement with a valid conclusion is to be marked as correct. The right panel depicts the effect of viewpoint when a conservative statement with an invalid conclusion is to be marked as incorrect. Values to the right of the dashed line are projected because no participant of Study 1 identified as very conservative.

to see the flaw in an invalid conclusion (i.e., a conclusion not following its premises) when it was in line with the other side of the ideological spectrum but less likely when it matched their ideological viewpoint. Moreover, participants were, in general, more accurate regarding valid conclusions compared to invalid conclusions. This also held for neutral conclusions for which ideology did not play a role; it could thus be rooted in a general tendency to mark a conclusion as correct.

Limiting the generalizability of our results, participants holding conservative beliefs were underrepresented in our sample—only 19% of the participants identified as conservatives versus 59% who identified as liberals. However, when the study was conducted, self-identified conservatives outnumbered self-identified liberals on average by 35% to 26% in representative samples (Gallup, 2019). The underrepresentation of conservative participants can be a problem in convenience samples recruited on AMT who are more likely to lean liberal (Berinsky et al., 2012). Furthermore, one may argue that our design worked in our favor, as participants had to disavow their ideology by marking statements opposing their viewpoints as correct, constituting a costly behavior. Participants may thus not have been motivated enough to think thoroughly, as a correct answer takes more deliberative thinking than just accepting conclusions that support their ideological viewpoint.

Study 2: Offering money for correct answers in a more balanced sample of U.S. residents

We designed a second study to address these issues. First, we sampled participants according to their political ideology on CloudResearch (Litman

et al., 2017) to arrive at a more balanced sample. Second, we incentivized correct answers to make it more costly to ignore the syllogisms' structure in favor of one's political ideology. Third, we preregistered our hypotheses, analysis plan, and how many participants were recruited on AsPredicted. org (#5574). Fourth, we exploratively edited the neutral syllogisms so that their conclusions also varied in their direction (Morsanyi & Handley, 2012). More specifically, we presented participants with conclusions that were either objectively true (e.g., *all steel hammers are hard*) or objectively false (e.g., *all steel hammers are soft*).

Method

Participants and design

We once again set out to recruit 250 participants. We relied on the pre-screening feature offered by CloudResearch (Litman et al., 2017) and recruited 50 participants for each of the five levels of their ideology pre-screening variable to arrive at an ideologically balanced sample. In Part 2, 225 of the 252 participants of Part 1 (see Figure 1) took part. Of these, 221 participants (98%) completed all syllogisms. In line with Study 1, we excluded 29 participants who marked every conclusion as correct or incorrect. Table 1 (second column) provides an overview of the demographic composition of the remaining 192 U.S. residents. Participants were compensated with $1.00 for their participation in the 10 min online experiment; also, they earned a bonus of $0.04 per accurate answer in the syllogism task. The design of the experiment was self-reported political ideology as a continuous between-subjects variable × 2 within (content: neutral vs. political) × 2 within (validity: conclusion is valid vs. conclusion is invalid) × 2 within (viewpoint/veracity: leaning toward liberal vs. leaning toward conservative viewpoints for political syllogisms; true vs. false for neutral syllogisms).

Procedure

Except for the deviations listed below, the procedure followed Study 1.

Part 1

Part 1 questions were taken from Study 1. However, in addition to reporting their political ideology, participants indicated where they would fall between two opposing statements (on a seven-point bipolar scale). We asked participants about their standing on economic and social issues in general and about every topic we had political syllogisms tailored to. This allowed us to test whether we indeed selected heavily polarized issues. The observed strong correlations between ideology and each topic

(.498 ≤ r(177) ≤ .719; all ps < .001) and a strong intercorrelation of Cronbach's α = .908 confirmed this (more details can be found in the supplemental material).

Part 2: Syllogisms

As in Study 1, participants were again presented with 24 syllogisms in random order. In contrast to Study 1, the neutral syllogisms also varied in the veracity of their conclusion. Thus, the conclusions were true versus false for neutral syllogisms or leaning toward a liberal versus conservative viewpoint for political syllogisms. We balanced validity and viewpoint/veracity across all syllogisms; all participants saw the same number of valid, invalid, conservative-leaning, liberal-leaning, true, and false conclusions (see Table 2 for examples).[1]

Bonus Payment. Participants had to judge whether a conclusion necessarily followed from its premises or not by marking it as *correct* or *incorrect*, respectively. Each accurately judged conclusion increased the participants' payment by $0.04, allowing participants to double their pay if they had classified all 24 syllogisms correctly. Bonuses ranged between $0.36 and $0.96, M = $0.65, SD = $0.16.

Results

Again, we tested the influence of neutral and political contents on performance in a syllogistic reasoning task across the ideological spectrum (see Table 3, Study 2). We found that the accuracy for neutral syllogisms was not correlated with ideology; however, ideology correlated with accuracy in judging the logical validity of political syllogisms. Again, we observed that liberal participants were better at judging valid liberal and invalid conservative statements. In contrast, conservative participants were better at judging valid conservative and invalid liberal statements. Overall, accuracy was once again higher for valid syllogisms than for invalid ones.

As in Study 1, we began our analysis with neutral syllogisms. For these neutral syllogisms, the model with validity and ideology rendered a significant effect of validity but no significant effect of ideology or its interaction with validity; adding ideology did not improve model fit, $\chi^2(2)$ = 0.46, p = .795. This means that ideology did not affect syllogistic reasoning performance in neutral syllogisms; still, it matters whether the conclusion is valid or invalid. Again, participants exhibited a higher accuracy for valid than invalid syllogisms (see Table S5).

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[1]Among the syllogisms, we added two attention check items (Oppenheimer et al., 2009). In these items, participants read two neutral premises, and the conclusion asked participants to respond in a certain way (mark *incorrect/correct*). However, we refrained from using them as exclusion criteria because the conclusion could also have been construed as not logically following its premises. Some attentive participants of Study 4 brought this forth as they marked both conclusions in contrast to its instruction but in line with the overall task instructions. Accounting for the attention check items does not change the pattern of results.

Adding the conclusions' veracity (i.e., whether it is a true or false statement) as a main effect and its interaction with validity improved model fit, $\chi^2(9) = 223.43$, $p < .001$. However, further adding ideology (and its interactions) did not, $\chi^2(4) = 6.82$, $p = .146$. In the significant model with veracity and validity as predictors, validity heightened accuracy, but the effect of veracity was negative and statistically significant. Crucially the interaction term was in the opposite direction, that is, positive (but not statistically significant). Still, this pattern of results implies that when the conclusions were valid, true conclusions were more likely to be judged correctly. However, when the conclusions were invalid, true conclusions were less likely to be judged correctly.

Political syllogisms

When we analyzed the participants' accuracy regarding political syllogisms, we again adjusted for their accuracy for neutral syllogisms. This time, all predictors were significant. Most importantly, the three-way interaction between ideology, validity, and viewpoint turned out to be significant. Adding ideology and its two-way interactions with validity and viewpoint to the model did not improve model fit, $\chi^2(3) = 0.20$, $p = .978$, but adding the three-way interaction did, $\chi^2(1) = 35.47$, $p < .001$, see Table S6. To further investigate this significant three-way interaction, we split the political syllogisms regarding their validity.

Valid Conclusions. When looking at valid political conclusions only, participants' accuracy for neutral conclusions, their political ideology, and the conclusion's viewpoint were all significant predictors for classifying the conclusion correctly. More importantly, however, the interaction between ideology and viewpoint was significant and significantly improved model fit, $\chi^2(1) = 14.35$, $p < .001$, see Table S7. Figure 3 (left side) depicts this interaction by showing how the effect of a conservative conclusion on the participants' accuracy for valid conclusions varies across the ideological spectrum. As in Study 1, the effect of a valid conservative conclusion was negative for liberal and positive for conservative participants.

Invalid Conclusions. When looking at invalid political conclusions, participants' accuracy for neutral conclusions was the strongest predictor for judging their validity correctly, but ideology and viewpoint were also significant. Notably, the interaction between ideology and viewpoint was significant and improved model fit, $\chi^2(2) = 12.82$, $p < .001$, see Table S8. Figure 3 (right side) depicts this interaction by showing how the effect of a conservative viewpoint on the participants' accuracy for invalid conclusions varies across the ideological spectrum. More specifically, it is positive on the liberal side and negative on the conservative side of the ideological spectrum. This pattern of results replicates Study 1, showing that liberals are more likely to mark an invalid conservative statement as incorrect. In contrast, conservatives are less likely to do so.
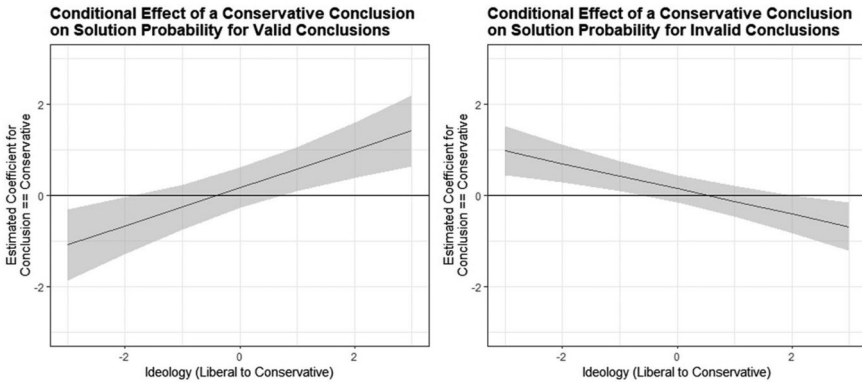
Figure 3. Study 2: conditional effect of the conclusion's viewpoint on participants' accuracy for valid (left panel) and invalid (right panel) syllogisms across the ideological spectrum.
Note. Positive values signify higher accuracy. In both cases, the presented effect is the effect of the conclusion expressing a conservative viewpoint.

Discussion

In our preregistered Study 2, we were able to replicate and extend the findings of Study 1. First, the pattern of findings turned out to hold for a more balanced set of participants. While we had to extrapolate our findings to participants on the conservative end of the ideological spectrum in Study 1, the results of Study 2 suggest that the effects of liberal versus conservative ideology are indeed symmetrical. Both ideologies negatively affect logical reasoning performance in the same way: Valid conclusions contrary to one's ideological orientation are incorrectly seen as invalid, and invalid conclusions that align with one's ideological orientation are wrongly seen as valid. Second, introducing a monetary bonus in Study 2 did not alleviate this effect. Participants still exhibited a handicap in correctly classifying ideology-related syllogisms' conclusions even when given a chance to double their pay.

Study 3: Gauging the effects of a monetary incentive for correct answers in a larger and balanced U.S. sample

Because we varied monetary incentives between Studies 1 and 2 but not within one study, we cannot be sure that their introduction did indeed fail to affect participants' syllogistic reasoning performance. Therefore, we designed a third study to address this issue further. We again sampled participants according to their political ideology, this time on CloudResearch's Connect platform (Litman et al., 2017). For one half of the participants, we incentivized correct answers to make it more costly to ignore the syllogisms' structure in favor of one's political ideology. The other half had no such monetary incentive

to perform well. Otherwise, we copied the procedure of Study 2. This means that in the neutral syllogisms, we again presented participants with conclusions that were either objectively true (e.g., *all steel hammers are hard*) or objectively false (e.g., *all steel hammers are soft*).

Method

Participants and design

We set out to have data from at least 200 participants per experimental condition. We relied on the prescreening feature offered by Connect and recruited 120 participants for each of the five levels of their ideology prescreening variable to arrive at an ideologically balanced sample. In Part 2, 510 of the 603 participants of Part 1 (see Figure 1) took part. Of these, 498 participants (98%) completed all syllogisms and indicated to have responded carefully. In line with Studies 1 and 2, we excluded 59 participants who marked every conclusion as correct or incorrect. Table 1 (Study 3) provides an overview of the demographic composition of the remaining 439 U.S. residents. Participants were compensated with $2.50 for their participation in the 10 min online experiment; also, participants in the monetary bonus condition earned a bonus of $0.10 per correctly judged syllogism. The design of the experiment was self-reported political ideology as a continuous between-subjects variable × 2 between (monetary bonus: present vs. absent) × 2 within (content: neutral vs. political) × 2 within (validity: conclusion is valid vs. conclusion is invalid) × 2 within (viewpoint/ veracity: leaning toward liberal vs. leaning toward conservative viewpoints for political syllogisms; true vs. false for neutral syllogisms).

Procedure

Except for the deviations listed below, the procedure followed Study 2.

Part 1

Part 1 questions were taken from Studies 1 and 2.

Part 2: Syllogisms

As in Studies 1 and 2, participants were again presented with 24 syllogisms in random order. Neutral syllogisms again also varied in the veracity of their conclusion. Thus, the conclusions were true versus false for neutral syllogisms or leaning toward a liberal versus conservative viewpoint for political syllogisms.[2]

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[2]In Study 3, we clarified the instructions of the two attention check items (Oppenheimer et al., 2009). Specifically, participants read in between the other syllogisms: "This is not a syllogism. This is testing whether

Independent Variable: Bonus Payment. Participants had to judge whether a conclusion necessarily followed from its premises or not by marking it as *correct* or *incorrect*, respectively. For participants in the monetary bonus condition, the introduction of the syllogism task further read that participants will receive a bonus of $0.10 on top of their compensation for each correct classification. This allowed participants in the monetary bonus condition to double their pay if they correctly classified all 24 syllogisms. Bonuses ranged between $0.60 and $2.40, M = $1.61, SD = $0.40.

Results

We tested the influence of neutral and political contents on performance in syllogistic reasoning across the ideological spectrum (see Table 3, Study 3). We found that accuracy for neutral syllogisms was not correlated with ideology; however, ideology correlated with accuracy for political syllogisms. Again, we observed that liberal participants were better at classifying valid liberal and invalid conservative statements. In contrast, conservative participants were better at classifying valid conservative and invalid liberal statements. Overall, accuracy was once again higher for valid syllogisms than for invalid ones. These patterns were revealed in the presence and the absence of a monetary, performance-based bonus.

Because the monetary bonus may have increased syllogistic reasoning performance, we, this time, began by comparing the experimental conditions in the number of correctly classified conclusions. However, participants with no bonus (M=15.8, SD=4.0) were not outperformed by participants who received a bonus for each correct response, M=16.3, SD=4.0, $t(437)$ = 1.54, p = .125, d=0.147, 95%-CI [−0.041; 0.33]. Similarly, marking every conclusion as correct or incorrect was not a function of the monetary bonus condition, $\chi^2(1)$ = 1.44, p = .268, φ = .054. This implies that participants who read that they would receive a significant bonus for each correct response were responding similarly to participants who did not receive a bonus.

We then focused our analysis on neutral syllogisms as in previous studies. For these neutral syllogisms, the model with validity and ideology rendered a significant effect of validity but no significant effect of ideology or its interaction with validity; adding ideology did not improve model fit, $\chi^2(2)$ = 1.17, p = .558. The same was true for adding whether participants received a monetary bonus: There was no significant effect of bonus nor interaction with validity; adding the monetary bonus did not improve model fit, $\chi^2(2)$ = 2.36, p = .307. This means neither ideology nor a monetary bonus affected syllogistic reasoning performance in neutral syllogisms. Still, it mattered whether the conclusion was valid or invalid. Again,

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your responses are recorded correctly. Therefore, please respond with *conclusion [in]correct.*" Because only four participants missed at least one of the attention checks, we report the analysis with the whole sample in an intention-to-treat manner.

participants' judgments were more accurate for valid than invalid syllogisms (see Table S9).

Adding the conclusions' veracity (i.e., whether it is a true or false statement) as a predictor to the model with validity improved model fit, $\chi^2(2) = 491.72$, $p < .001$. Like in Study 2, validity heightened accuracy, but the effect of veracity was negative. Crucially, the interaction term was positive, meaning that true conclusions were more likely to be classified correctly when the conclusions were valid. However, when the conclusions were invalid, true conclusions were less likely to be classified correctly. This time, all individual predictors in the final model were significant (see Model C3 in Table S9).

Political syllogisms

When we analyzed the accuracy for political syllogisms, we again adjusted for participants' accuracy for neutral syllogisms. This time, all predictors but viewpoint were significant. Most importantly, the three-way interaction between ideology, validity, and viewpoint turned out to be significant. Adding ideology and its two-way interactions with validity and viewpoint to the model did not improve model fit, $\chi^2(3) = 3.65$, $p = .302$, but adding the three-way interaction did, $\chi^2(1) = 76.74$, $p < .001$. However, adding the monetary bonus and its interactions did not improve the model, $\chi^2(8) = 9.20$, $p = .325$, see Table S10, implying that the monetary bonus did not affect the accuracy for political syllogisms. To further investigate the significant three-way interaction between ideology, validity, and viewpoint, we split the political syllogisms regarding their validity.

Valid Conclusions. When looking at valid political conclusions only, participants' accuracy for neutral conclusions, their self-reported political ideology, and the conclusion's viewpoint were significant predictors for classifying the conclusion's validity correctly. More importantly, however, the interaction between ideology and viewpoint was significant and significantly improved model fit, $\chi^2(1) = 28.56$, $p < .001$, see Table S11. Figure 4 (left side) depicts this interaction by showing how the effect of a conservative conclusion on participants' accuracy for valid conclusions varies across the ideological spectrum. As in Studies 1 and 2, the effect of a valid conservative conclusion was negative for liberal and positive for conservative participants.

Invalid Conclusions. When looking at invalid political conclusions, participants' accuracy for neutral conclusions was the strongest predictor for judging them correctly, but the participants' self-reported political ideology was also significant. Notably, the interaction between ideology and viewpoint was significant and improved model fit, $\chi^2(1) = 39.39$, $p < .001$, see Table S12. Figure 4 (right side) depicts this interaction by showing how the effect of a conservative viewpoint on the participants' accuracy for invalid conclusions varies across the ideological spectrum. More specifically, it is positive on the liberal side and negative on the conservative side of the ideological spectrum. This pattern of results replicates Studies 1 and 2, showing that
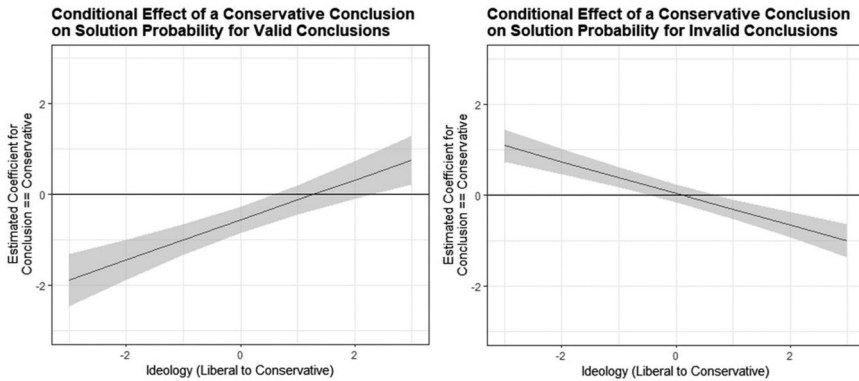
Figure 4. Study 3: conditional effect of the conclusion's viewpoint on the accuracy for valid (left panel) and invalid (right panel) syllogisms across the ideological spectrum.
Note. Positive values signify higher accuracy. In both cases, the presented effect is the effect of the conclusion expressing a conservative viewpoint.

liberals are more likely to mark correctly an invalid conservative statement as incorrect. In contrast, conservatives are less likely to do so and vice versa.

Discussion

In this third study, we were able to replicate and extend the findings of Studies 1 and 2. In an even larger sample of more than 400 participants, the pattern of findings turned out to hold. Again, the results suggest that the effects of liberal versus conservative ideology on syllogistic reasoning performance are indeed symmetrical. Both ideologies negatively affect logical reasoning performance in the same way: Valid conclusions contrary to one's ideological orientation are incorrectly seen as invalid, and invalid conclusions that align with one's ideological orientation are wrongly seen as valid. Most importantly, this study directly tested the effects of monetary bonuses: Participants exhibited similar performances independent of the chance to double their pay. Participants performed similarly in the presence and the absence of a monetary bonus incentivizing accuracy but thereby the forgoing of one's political ideology.

Study 4: Environmentalism and logical reasoning performance in German students

Until now, our findings may appear limited because we only looked at one specific ideology, political ideology, among one group of respondents, U.S. residents. Furthermore, like previous research on ideological reasoning and ideological belief bias, Studies 1 and 2 were online studies tapping into the large pool of AMT participants. Study 3 extended this by sampling

participants from another online research platform, Cloudresearch's Connect. In contrast, laboratory studies on ideological reasoning are scarce (Study 1 of Calvillo et al., 2020, being an exception). Furthermore, little is known about potential correlates of ideological reasoning besides self-reported political ideology.

We designed Study 4 to address these issues and extend the literature on ideological reasoning by focusing on an ideology that was not the focus of previous research: environmentalism. Furthermore, we extend the research on ideological reasoning by shifting to German university students as participants. While Part 1, where we assessed participants' environmentalism, was still conducted online, they were subsequently invited to a laboratory to perform the syllogistic reasoning task in a controlled setting. We continued to incentivize correct answers to ensure that any observed association between environmentalism and syllogistic reasoning performance is at least as robust as the relationship between self-reported political ideology and syllogistic reasoning performance. And by choosing environmentalism as the ideology of interest, we used a highly relevant and polarizing topic, as evidenced by the recent emergence of international environmentalist movements like Fridays for Future. Such movements draw the active and passive support of many young people (Koos & Naumann, 2019), with many of them being university students (de Moor et al., 2020) and for which the environment has become a key concern (Wallis & Loy, 2021). This has led to environmentalism becoming one of the main driving forces of political participation, as, for instance, indicated by the strong support of young voters for the environmentalist Green Party in German elections (e.g., being the strongest party among voters aged between 18 and 24 in federal elections; Bundeswahlleiter, 2022).

Method

Participants and design

We advertised Part 1 to all subject pool participants of a German university, and everyone who participated in it could participate in Part 2, the laboratory study. In the laboratory experiment, 101 of the 226 participants of Part 1 took part (see Figure 1). Of these 101 participants, 97 (96%) completed all syllogisms without technical errors. In line with the previous studies, we excluded two participants who marked every conclusion as correct[3]. Table 1 provides an overview of the demographic composition of the remaining 95 university students. Participants were compensated separately for Part 1 (course credit or 10% chance of 10.00 €) and received 4.00 €or course credit for their participation in the subsequent 20 min laboratory experiment; also, they earned a bonus of 0.10 €per correctly

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[3]The significantly smaller proportion of participants who marked every conclusion as correct in Study 4 compared to Studies 1–3 may reflect an increased compliance in laboratory studies.

classified syllogism. The design of the experiment was self-reported environmentalism as independent continuous between-subjects variable × 3 within (content: neutral vs. conclusions regarding environmentalism vs. conclusions regarding immigration[4]) × 2 within (validity: conclusion is valid vs. conclusion is invalid) × 2 within (viewpoint/veracity: anti-environmentalist/true vs. pro-environmentalist/false).

Procedure

Two weeks before the laboratory experiment (Part 2), Part 1 was advertised among the local subject pool. Successful participation in Part 1 was required to see Part 2. In Part 2, participants worked on each presented syllogism one by one before being debriefed, compensated, and thanked for their participation.

Part 1

Part 1 was modeled on Studies 1–3. So, like before, participants reported their political ideology and demographics and then indicated their environmentalism. Using seven-point bipolar scales for all the following questions, we instructed participants deliberately to leave out questions they did not want to answer because of personal reasons or a lack of relevant knowledge to prevent participants from answering in a socially desirable manner or choosing the scale's midpoint when they were unsure about a topic.

Participants indicated their general environmentalism, ranging from *not at all environmentalist* to *very environmentalist* ($M = 5.39$, $SD = 0.95$), the ideology's importance, ranging from *not at all important* to *very important* ($M = 5.72$, $SD = 1.35$), and then whether they *completely favored* or were *totally against* twelve specific statements related to environmentalism. Six of the twelve statements expressed a pro-environmentalist viewpoint, while the other six expressed anti-environmentalist viewpoints. For instance, participants were asked whether they favor abolishing climate-unfriendly state subsidies (pro-environmentalist) or the continuing use of pesticides in agriculture (anti-environmentalist). Cronbach's α for the 12-item environmentalism scale was .773. The 12-item scale correlated significantly with the general self-reported environmentalism, $r(95) = .403$, $p < .001$, and how important the topic is for the participant, $r(95) = .389$, $p < .001$.

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[4]We included syllogisms with xenophobic conclusions and a measure of attitudes toward immigration as a proxy for endorsing the ideology of xenophobia. Though we expected university students to be anti-xenophobic, this combination would test whether the absence or rejection of an ideology produces similar results to endorsing an ideology when it comes to ideological reasoning performance. However, participants endorsed environmentalism to a more substantial degree than they rejected xenophobia. There were no subsequent effects of the attitudes toward immigration on ideological reasoning performance for xenophobic syllogisms. Descriptions of the attitude measure, the syllogisms, and the corresponding results are in the supplemental material, as is a discussion of the results.

Part 2: Syllogisms

Participants were presented with 36 syllogisms in random order. We used translated versions of the neutral syllogisms used in Studies 2 and 3. We each chose six of the twelve topics assessed in Part 1 for the syllogisms related to environmentalism. The selection was mainly due to how easily the statements could be translated into syllogisms. We balanced validity and viewpoint/veracity across all syllogisms; all participants saw the same number of valid, invalid, true, false, pro-, and anti-environmentalist conclusions (see Table 4 for examples).

   Bonus Payment. Participants had to judge whether a conclusion necessarily followed from its premises or not by marking it as *correct* or *incorrect*, respectively. Each accurately classified item increased the participants' payment by 0.10 €. This allowed participants to almost double their pay if they judged all 36 syllogisms correctly. Participants' bonuses in Study 4 ranged from 1.40 €to 3.60 €, $M=2.65$ €, $SD=0.61$ €.

Results

We again tested the influence of neutral and ideological contents on performance in syllogistic reasoning tasks across the ideological spectrum (see Table 5). We found that participants' accuracy for neutral syllogisms

Table 4. Examples of environmentalism syllogisms varying in validity.

Environmentalism – pro-environmentalist	
Valid	**Invalid**
(1) *All coal-fired power plants are wuns.*	(1) *All significant enrichments for Germany are huls.*
(2) *All wuns are not sustainable.*	(2) *All huls are organic farms.*
(3) *Therefore, all coal-fired power plants are unsustainable.*	(3) *Therefore, organic farms are significant enrichments for Germany.*

Table 5. Mean percentage of correctly classified syllogisms as a function of self-reported ideology, syllogism content, syllogism viewpoint, and syllogism validity in Study 4.

	Self-reported ideology							
	very pro						very anti	*total*
Neutral							–	*76%*
valid							–	*89%*
invalid							–	*63%*
	n=6	**n=43**	**n=36**	n=5	n=4	n=1	n=0	
Environmentalism	67%	75%	74%	70%	67%	67%	–	*73%*
valid pro	83%	92%	95%	87%	75%	100%	–	*92%*
invalid pro	39%	53%	44%	40%	50%	33%	–	*48%*
valid anti	83%	87%	94%	87%	92%	100%	–	*89%*
invalid anti	61%	68%	63%	67%	50%	33%	–	*65%*

Note. No participants identified as very anti-environmentalist in Study 3.

was not correlated with environmentalism or self-reported political ideology. However, because of considerable homogeneity in attitudes, comparisons between both ends of the spectrum were not feasible. An overwhelming majority of participants fell on the pro-environmentalist side of the spectrum (taken from the midpoint). When reducing the sample to only one side of the ideological spectrum, the results suggested ideological reasoning among the 85 pro-environmentalists. This means that environmentalist participants were better at classifying valid pro-environmentalist and invalid anti-environmentalist statements. Overall, accuracy was once again higher for valid syllogisms than for invalid ones.

As in the previous studies, we began our analysis with a model predicting the accuracy for neutral syllogisms. For these neutral syllogisms, the model with validity, veracity, and self-reported ideology (either environmentalism or political ideology) rendered no significant effects of ideology nor any interactions with ideology; adding ideology to any model did not improve its fit, $\chi^2(4) \leq 8.03$, $p \geq .090$. This means that (self-reported) ideology does not affect conclusions in neutral syllogisms. However, the model without ideology renders significant effects of validity and veracity, as well as the interaction between the two. Again, participants were more accurate in judging valid than invalid syllogisms and less likely to classify invalid syllogisms with true compared to false conclusions correctly. This was qualified by the interaction between the two, indicating that while the effect of veracity was negative for invalid, it was positive for valid conclusions (see Table S13).

Environmental syllogisms

The homogeneity in environmentalism (see Table 5) put our statistical models to the test; all but 10 participants indicated to be pro-environmentalist (i.e., below the midpoint). Because of that, meaningful statistical comparisons between both sides of the spectrum were not feasible. To counteract this, we reduced our sample to only pro-environmentalist participants ($n = 85$, 89% of the sample). We then ran models without ideology but with viewpoint and validity and again adjusted for participants' accuracy for neutral syllogisms. Please note that the effect of viewpoint already tested our assumption that participants exhibit ideological reasoning in this case. All predictors were significant (see Table S14). Most importantly, the two-way interaction between validity and viewpoint turned out to be significant, and adding it to a model without the two-away interaction significantly increased model fit, $\chi^2(1) = 15.49$, $p < .001$. More specifically, while participants were less likely to correctly classify a pro-environmentalist conclusion (vs. an anti-environmentalist conclusion) when it was invalid, they were much more likely to classify it correctly when it was valid.

To further investigate this significant two-way interaction, we split the environmental syllogisms regarding their validity. When looking at only valid conclusions, participants' accuracy for neutral conclusions was a

significant predictor. More importantly, the conclusion's viewpoint was also a significant positive predictor, meaning that pro-environmentalist participants were more accurate for valid syllogisms with pro-environmentalist statements as their conclusion. In other words, they were more likely to mark statements that matched their ideology as *correct*, correctly so in case of actually valid syllogisms. This becomes even more clear when looking at only invalid conclusions. Again, participants' accuracy for neutral conclusions was a significant predictor. More importantly, the viewpoint was also significant but, this time, a negative predictor, meaning that pro-environmentalist participants were less likely to classify invalid syllogisms with pro-environmentalist conclusions correctly (see Table S15). In other words, they were again more likely to mark statements that matched their ideology as *correct*, albeit incorrectly so in case of actually invalid syllogisms.

Discussion

In Study 4, we were able to replicate and extend the findings of our previous studies to a laboratory assessment with German students. We first replicated that none of the ideologies correlates with performance regarding neutral syllogisms, and that monetary incentives do not shield from the ideological reasoning effect. Moreover, we could replicate the ideological reasoning effect for environmentalist syllogisms. We found the usual pattern of being more likely to classify correctly valid syllogisms that match one's ideology (i.e., were pro-environmentalist) or invalid syllogisms that run counter to one's ideology (i.e., were anti-environmentalist).

General discussion

Self-reported political ideology and environmentalism did not correlate with the accuracy of classifying ideologically neutral syllogisms. It only did so with the performance in ideologically loaded syllogisms. For instance, people with liberal viewpoints were more likely to classify valid and ideology-consistent syllogisms correctly but less likely to classify valid but ideology-inconsistent syllogisms correctly. Importantly, we found the same pattern for people with conservative viewpoints and a similar pattern for German participants with an environmentalist ideology. One might want to argue that our research participants may have ignored the task instructions when confronted with political syllogisms. However, this seems unlikely because ideological syllogisms were presented among neutral syllogisms for which ideology had no effect. Moreover, adding a monetary bonus in Studies 2 and 4 meant that ignoring task instructions incurred costs. Study 3 tested the impact of incentivizing accurate judgments by experimentally varying the monetary bonuses; still, the presence versus absence of monetary bonuses did not affect participants' syllogistic reasoning performance.

In sum, our findings underline that ideology negatively affects performance in a logical reasoning task when the task content is ideologically charged. Further, we observed a symmetrical pattern in Studies 1, 2, and 3. We found that individuals on the liberal side of the spectrum fall prey to this handicap just as much as individuals on the conservative side.

Regarding future studies, it could be that whenever people encounter conclusions that support or question their ideological beliefs, they do not *want* to engage in proper syllogistic reasoning but rather in partisan cheerleading (e.g., Peterson & Iyengar, 2021). Partisan cheerleading describes the deliberate distortion of responses to signal support for one's (ideological) side that may plague opinion polls (Bullock & Lenz, 2019). For instance, when asked about the economy, members of the party in government and members of opposition parties often give very different assessments. Therefore, answering affirmatively to conclusions that match one's viewpoints in the syllogistic reasoning task could also be due to partisan cheerleading. However, research on partisan cheerleading using monetary incentives to bridge this divide shows that incentives were largely effective (Peterson & Iyengar, 2021; Prior et al., 2015). This contrasts with our findings that monetary incentives could not attenuate the effects of ideology on syllogistic reasoning performance.

Taken together, perceiving the world in a way that supports the arguments people already believe in (e.g., motivated reasoning; Kunda, 1990) can have dramatic consequences for society. For instance, recent research investigated ideologically concordant fake news sharing among partisans (Guay et al., 2022). In contrast to our results on the ineffectiveness of monetary incentives, however, the authors find that prompts encouraging accuracy had an effect by reducing the proportion of shared articles that are fake. In all three of our studies using monetary incentives, monetary incentives did not have the same effect as participants still fell prey to the contents of syllogisms.

In sum, the stronger people adhered to a particular (political) ideology, the less they could reason logically in ideologically loaded syllogisms. That is, they aligned their conclusions with their beliefs. Further, it shows that this is the case even if solving the task has no political or ideological purpose (mere syllogistic reasoning) and participants are incentivized to classify the syllogisms accurately and not fall prey to their ideological reasoning. These findings have emerged in an online and in a controlled laboratory setting. Moreover, in Studies 2–4, participants were less likely to correctly judge valid syllogisms with objectively false conclusions than those with objectively true conclusions which is in line with findings of previous research (e.g., Calvillo et al., 2020; Evans et al., 1983; Oakhill et al., 1989). Calvillo et al. (2020) used an almost identical task, interspersing neutral and ideological syllogisms and found accuracy for objectively true conclusions to be higher than for objectively false conclusions.

As we advance, one might be interested in what interventions can overcome the detrimental interplay between ideology and logical

reasoning performance. Teaching self-regulation strategies such as self-affirmation (Steele, 1988), mental contrasting (Oettingen, 2012), or forming implementation intentions (Gollwitzer, 2014) may allow individuals to shield their logical reasoning better. For instance, considering our finding that ideological reasoning occurred together with better performance for neutral conclusions that were false, participants may form a specific if-then plan (i.e., an implementation intention) to handle ideological syllogisms in a more neutral manner. One should note, however, that this might only help with valid conclusions that support the opposite side of one's ideology but might backfire when it comes to invalid conclusions that were more readily and correctly judged when matching the opposite ideology.

Conclusion

We present four studies that tested the interplay between self-reported ideology and accuracy in logical reasoning performance. Studies 1, 2, and 3 show that at both ends of the political spectrum in the U.S., people's logical reasoning was negatively affected when politically loaded syllogisms had to be judged according to their validity, even though the political content was irrelevant for this task. We found this effect in a convenience sample (Study 1) and in more ideologically balanced samples (Studies 2 & 3). Study 3 additionally revealed that ideological reasoning effects persisted in the presence and absence of monetary bonuses for accurate logical reasoning. Furthermore, Study 4 showed a similar ideological reasoning effect regarding environmentalism in German university students. A monetary bonus for correct responses could not alleviate the negative influence of liberal and conservative ideologies (Studies 2 & 3) or environmentalism (Study 4). Finally, all assessed ideologies did not affect the participants' accuracy for neutral syllogisms suggesting that there are no differences in general logical reasoning aptitude across the ideological spectra.Notes

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