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Ideology, Motivated Reasoning, and Cognitive Reflection

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Abstract

Decision scientists have identified various plausible sources of ideological polarization over climate change, gun violence, national security, and like societal risks. This paper describes a study of three of them: the predominance of heuristic-driven information processing by members of the public; ideologically motivated cognition; and personality-trait correlates of political conservatism. The results of the study suggest reason to doubt two common surmises about how these dynamics interact. First, the study presents both observational and experimental data inconsistent with the hypothesis that political conservatism is distinctively associated with closed-mindedness: conservatives did no better or worse than liberals on an objective measure of cognitive reflection; and more importantly, both demonstrated the same unconscious tendency to fit assessments of empirical evidence to their ideological predispositions. Second, the study suggests that this form of bias is not a consequence of over-reliance on heuristic or intuitive forms of reasoning; on the contrary, subjects who scored highest in cognitive reflection were the *most* likely to display ideologically motivated cognition. These findings corroborated the hypotheses of a third theory, which identifies ideologically motivated cognition as a form of information processing that promotes individuals' interests in forming and maintaining beliefs that signify their loyalty to important affinity groups. The paper discusses the normative significance of these findings, including the need to develop science communication strategies that shield policy-relevant facts from the influences that turn them into divisive symbols of political identity.

1. Introduction

Ideological polarization is a conspicuous but peculiar feature of American democracy. No one is surprised when conservatives and liberals fight over tradeoffs between wealth and equality or between security and liberty. Differences in the value attached to such goods *define* those political outlooks.

But ideological conflicts over policy aims seem less common, and certainly less spectacular, than ones over policy-relevant *facts*. Democrats (by and large) fervently believe that human activity is responsible for global warming, Republicans (by and large) that it is not (Pew Research Center 2012). Conservatives are confident that the wastes generated by nuclear power plants can be safely disposed of by deep geologic isolation; liberals dispute that (Jenkins-Smith, Silva, Nowlin & deLozier 2011). People who value equality and community believe that vaccinating schoolgirls against the human papillomavirus is essential to protecting women's health—and that permitting private citizens to carry concealed hand guns increases crime. Those who value hierarchy and individualism, in contrast, reply that universal HPV vaccination will *undermine* young girls' health by lulling them into unprotected sex, and that gun *control* increase crime by making it harder for law-abiding citizens to protect themselves (Kahan 2010).

Political polarization on empirical issues like these occurs not only despite the lack of any logical connection between the contending beliefs and the opposing values of those who espouse them. It also persists despite apparent scientific consensus on the answers to many of these disputed questions (Lewandowsky, Gignac, & Vaughan 2012; Kahan, Jenkins-Smith & Braman 2011).

Explaining this phenomenon is one of the aims of decision science. Using methods and concepts from social psychology, behavioral economics, and related disciplines, decision scientists have linked public controversy over risk and related policy-consequential facts to three principal dynamics.

The first is *heuristic-pervaded information processing*. Long prominent in the study of psychology, dual-process theories posit two modes of information-processing: a “fast, associative” one “based on low-effort heuristics”, and a “slow, rule based” one that relies on “high-effort systematic reasoning” (Chaiken & Trope 1999, p. ix). Many scholars attribute controversy over societal risks to the disposition

of members of the public to over-rely on the heuristic-driven, “System 1” (Stanovich and West 2000; Kahneman 2003) reasoning style. The centrality of visceral, emotion-guided modes of perception can cause laypeople to overestimate the incidence and harm associated with more sensational risks—such as terrorist acts and gun accidents—relative to more remote, less gripping hazards such as climate change and swimming pools. Expert opinion does not reliably correct these distortions because members of the public too often lack the time or ability to engage in the more effortful, more dispassionate “System 2” style of reasoning suited to understanding the technical evidence that experts use to assess risks (Loewenstein, Weber, Hsee & Welch 2001; Slovic, Finucane, Peters & MacGregor 2004; Sunstein 2003, 2007; Weber 2006).

The second dynamic associated with public conflict over societal risks is *motivated reasoning*. Motivated reasoning refers to the tendency of people to conform assessments of information to some goal or end extrinsic to accuracy (Kunda 1990; Balciotis 2008). The goal of protecting one’s identity or standing in an affinity group that shares fundamental values can generate motivated condition of evidence on contested facts of policy significance (Cohen 2003; Sherman & Cohen 2006). Even among modestly partisan individuals, shared ideological or cultural commitments are likely to be intertwined with membership in communities of one sort or another that furnish those individuals with important forms of support—emotional and psychic as well as material (Green, Palmquist & Schikler 2002). If a proposition about some policy-relevant fact comes to be commonly associated with membership in such a group, the prospect that one might form a contrary position can threaten one’s standing within it. Thus, as a form of “identity self-defense,” individuals are unconsciously motivated to resist empirical assertions—that the death penalty deters or does not deter murder, for example (Lord, Ross & Lepper 1979), or that gun control reduces or does or does not reduce crime (Taber & Lodge 2006)—if those assertions run contrary to the dominant belief within their groups (Cohen, Bastardi, Sherman, Hsu, McGoey, & Ross 2007).¹

¹ The contribution that group ties make to motivated cognition of policy-relevant facts, moreover, is only a particular instance of two more general and pervasive forms of motivated reasoning: the tendency of people to construe infor-

The third dynamic linked to conflict over societal risk is the association between *ideology and personality traits*. Refining the 1950s “authoritarian personality” theory of Adorno and his collaborators (1950), a substantial body of empirical study generated in the last decade has revived interest in, and compelled respectful scholarly engagement with, the hypothesis that right-wing ideology is a manifestation of settled intellectual traits such as dogmatism, aversion to complexity, and a craving for certainty or “closure” in argumentation. The cognitive style that comprises these dispositions, it is surmised, generates reflexive closed-mindedness toward empirical evidence hostile to the factual premises of policies that reflect ideologically conservative values or policy preferences (Jost, Glaser, Kruglanski & Sulloway 2003; Kruglanski 2004; van Hiel, Pandelaere & Duriez 2004; Feygina, Jost & Goldsmith 2010; Jost, Nosek & Gosling 2008; McCright & Dunlap 2012).

All of these positions are amply supported by empirical evidence, but relatively little testing has been done on how they relate to one another. More than one plausible account exists of how the various dynamics that connect ideology and factual perceptions interact (Jost, Hennes & Lavine in press). Empirical testing of these competing surmises is necessary, not only to advance understanding of ideological polarization over policy-relevant facts but also to guide practical action aimed at mitigating it.

This paper seeks to contribute to the necessary testing process. It starts by synthesizing three competing theories of how heuristic-driven reasoning, motivated cognition, and the personality correlates of conservative ideology interact. It then presents both observational and experimental data that bear on the relative strength of these three theories.

2. Three Theories of Public Conflict over Societal Risk

This section outlines three alternative theoretical accounts of how heuristic-pervaded information processing, motivated cognition, and the personality-trait correlates of conservatism relate to one another

mation in a manner that is self-flattering or self-serving (Dunning 2003, 1999); and their tendency to construe information—particularly about contingent, factual matters—in a manner that promotes their moral evaluations (Ditto, Pizarro & Tannenbaum 2009; Liu & Ditto 2012), particularly of behavior that deviates from social norms (Gutierrez & Giner-Sorolla 2007; Alicke 1992, 2000).

er. They are in the nature of analytical composites of related positions, disagreements among which inform the study design and hypotheses.

2.1. Bounded-Rationality Thesis (BRT)

BRT treats dual-process reasoning as foundational and uses motivated cognition to explain individual differences in risk perception. The predominance of heuristic-driven, System 1 reasoning styles among members of the general public, on this view, accounts for the failure of democratic institutions to reliably converge on the best available scientific evidence on issues like climate change. Dynamics of motivated cognition help to explain the ideological character of the resulting public controversy over such evidence. Many of the emotional resonances that drive system 1 risk perceptions, it is posited, originate in (or are reinforced by) the sorts of affinity groups that share cultural or ideological commitments. Where the group-based resonances that attach to putative risk sources (guns, say, or nuclear power plants) vary, then, we can expect to see systematic differences in risk perceptions across members of ideologically or culturally uniform groups (Lilienfeld, Ammirati, Landfield 2009; Redlawski 2002; Sunstein 2006b, 2007; Weber & Stern 2011).

2.2. Neo-authoritarian Personality Thesis (NPT).

NPT treats the personality correlates of *right-wing ideology* as foundational and links low-quality information processing and motivated cognition to them. Like BRT, NPT regards motivated cognition as a heuristic-driven form of reasoning. The mental dispositions that NPT research identifies with conservative ideology—dogmatism, need for closure, aversion to complexity, and the like—indicate a disposition to rely predominantly on System 1 rather than more effortful, System 2 forms of information processing. Accordingly, the impact of ideologically motivated cognition, even if not confined to conservatives, is disproportionately associated with that ideology, according to NPT, by virtue of the negative correlation between conservatism and the traits of open-mindedness, and critical reflection that would otherwise check and counteract it (Jost, Glaser, Kruglanski & Sulloway 2003; Kruglanski 2004; Thórisdóttir & Jost 2011; Feygina, Jost & Goldsmith 2010; Jost, Nosek & Gosling 2008).

It is primarily this strong prediction of *asymmetry* in motivated reasoning that distinguishes NPT from BRT (Jost, Hennes & Lavine in press). BRT does predict that motivated reasoning will be correlated with the disposition to use System 1 as opposed to System 2 forms of information processing. But nothing intrinsic to BRT furnishes a reason to believe that these dispositions will vary systematically across persons of diverse ideology.

2.3 Expressive Rationality Thesis (ERT)

Finally, ERT lays primary emphasis on identity-protective motivated reasoning, which it identifies as a form of information processing that promotes individual ends. When individuals display identity-protective motivated cognition, their processing of information will more reliably guide them to perceptions of fact congruent with their membership in ideologically or culturally defined affinity groups than to ones that reflect the best available scientific evidence (Kahan, Jenkins-Smith & Braman 2011). According to ERT, this form of information processing, when applied to the sorts of facts at issue in polarized policy disputes, will predictably make ordinary individuals better off (Kahan 2012a). Any mistake an individual makes about the science on, say, the reality or causes of climate change, the disposal of nuclear wastes, or the effectiveness of an assault-rifle ban in deterring mass shootings will not affect the level of risk for her or for any other person or thing he cares about: whatever she as a single individual does—as consumer, as voter, as participant in public discourse—will be too inconsequential to have an impact (Downs 1957). But insofar as opposing positions on these issues have come to express membership in and loyalty to opposing self-defining groups, a person’s formation of a belief out of keeping with the one that predominates in hers could mark her as untrustworthy or stupid, and thus compromise her relationships with others (Cohen 2003).

It is in this sense “expressively rational” (Akerloff & Kranton 2000; Hillman 2010) for *individuals* in that situation to assess information in a manner that aligns their beliefs with those that predominate in their group. Of course, this mode of engaging information might well be *collectively irrational*: when members of diverse groups employ it simultaneously, a democratic society is less likely to enact welfare-enhancing policies informed by the best available scientific evidence. But this externality will not by itself

reliably create any incentive or pressure for *individuals* to refrain from engaging information in the manner most conducive to formation of identity-congruent beliefs (Kahan, Peters, Wittlin, Slovic, Ouellette, Braman & Mandel 2012b).

Individuals disposed to resort to heuristic-driven, System 1 cognitive processing should not have too much difficulty fitting in. Conformity to peer influences, receptivity to elite cues, and sensitivity to intuitions calibrated by the same will ordinarily guide them reliably to stances that cohere with and express their group commitments (Zaller 1992; Gastil, Braman, Kahan & Slovic 2011).

But *if* individuals *are* adept at using more effortful, System 2 modes of information processing, then they ought to be even *better* at fitting their beliefs to their group identities. Their capacity to make sense of more complex forms of evidence (including quantitative data) will supply them with a special resource that they can use to fight off counterarguments or to identify what stance to take on technical issues more remote from ones that that figure in the most familiar and accessible public discussions (Chen, Duckworth & Chaiken 1999; Kahan et al. 2012b). Indeed, such an effect would complement findings that individuals who are more *politically sophisticated*—ones who are more interested in and know more about politics—reliably avail themselves of their greater political knowledge when affectively motivated to defend ideologically congruent beliefs (Taber & Lodge 2006).

The claim, it is important to stress, is not the (incoherent, not to mention psychologically implausible one) that such individuals will be consciously managing the content of their beliefs (Elster 1983). Rather it is the perfectly straightforward one that people can be expected to converge more readily on styles of information processing—conscious and unconscious—that generally (albeit not invariably) promote rather than frustrate their individual ends (Wilson 2002; Gigerenzer 2000, 2010). If it generally benefits individuals to be unconsciously motivated to form and maintain societal risk perceptions that foster their connection to identity-defining groups, individuals who are disposed and equipped to use high-level, conscious information processing can be expected to make the effort to do so more readily in defense of, than in opposition to, beliefs that predominate in their groups (Cohen 2003; cf. Taber & Lodge 2006).

ERT thus *inverts* the relationship that BRT posits between motivated cognition and dual-process reasoning. Whereas BRT views ideological polarization as evidence of a deficit in System 2 reasoning capacities, ERT predicts that the reliable employment of more effortful, conscious information processing will *magnify* the polarizing effects of identity-protective cognition (Kahan et al. 2012b).

ERT's understanding of the source of ideologically motivated reasoning also puts it into conflict with NPT. To begin, identity-protective cognition—the species of motivated reasoning that ERT understands to be at work in such conflicts—is not a distinctively political phenomenon (Dunning 2003). It is likely to be triggered by other important affinities, too—such as the institutional affiliations of college students or the team loyalties of sports fans (Hastorf & Cantril 1954). Unless there is something distinctive about “liberal” political groups that makes them less capable of underwriting community attachment than all other manner of group, it would seem odd for motivated reasoning to display the asymmetry that NPT predicts when identity-protective cognition operates on formation of policy-relevant factual beliefs.

ERT also calls into question the theoretical basis for NPT's expectation of asymmetry. Like BRT, NPT assumes motivated reasoning is a feature of low-effort, heuristic-driven System 1 information processing. ERT (also like BRT) is agonistic on whether low-level, System 1 reasoning dispositions will be correlated with ideological or other values. But because ERT asserts that the more effortful, conscious forms of reasoning characteristic of System 2 *magnify* identity-protective cognition, ERT does not see the correlations featured in NPT as implying that motivated reasoning should be disproportionately concentrated in conservatives.

3. Study Design

This section describes a study designed to test BRT, NPT, and ERT. The study included both an observational component, which measured the cognitive reasoning dissimulations of subjects of diverse ideologies, and an experimental one, which assessed the interaction between cognitive-reasoning dispositions, subjects' ideologies, and their display of ideologically motivated reasoning.

3.1. Sample

The subjects for the study consisted of a nationally diverse sample of 1750 U.S. adults. The subjects were recruited to participate by Polimetrix/YouGov, which administered the study via that firm's online testing facilities. The sample was 54% female, and the average age of the subjects was 52 years. Seventy-six percent of the subjects were white, and 11% African-American. Twenty-eight percent of the sample self-identified as Republican, 36% as Democrat, and 30% as independent. Twenty-five percent identified themselves as either "Liberal" or "very Liberal": 37% as "Conservative" or "very Conservative"; and 29% as "Moderate." The mean education level was "some college"; the mean annual income was \$40,000 to \$49,000. The study was administered in July 2012.

3.2. Observational study measures and hypotheses

a. Measures. Subjects furnished standard demographic data, including political affiliations and outlooks. Party self-identification ("dem_repub") was measured with a seven-point Likert item ("Strong Democrat, Democrat, Independent Lean Democrat, Independent, Independent Lean Republican, Republican, Strong Republican"). Political ideology ("libcon") was measured with a five-point Likert item ("Very liberal"; "Liberal"; "Moderate"; "Conservative"; "Very Conservative"). Responses to these two items formed a reliable aggregate Likert scale ($\alpha = 0.82$), which was labeled "Conserv_Repub" and transformed into a z-score to facilitate interpretation (Smith 2000).

Subjects also completed the Cognitive Reflection Test (CRT). The CRT is a three-question test that measures the disposition to engage in the conscious and effortful form of reasoning associated with System 1 as opposed to the heuristic-driven form of reasoning associated with System 2 (Frederick 2005). A performance-based measure of subjects' disposition to engage intellectual problems in a reflective and open-minded manner (Campitelli & Labollita 2010), the CRT has been shown to be superior to self-evaluation measures in predicting vulnerability to the various cognitive biases associated with low-level information processing (Toplak, West & Stanovich 2011; Hoppe & Kusterer 2011; Liberali, Reyna, Furlan & Pardo 2011).

The CRT is a demanding test, and it is not unusual for a high proportion of a general population sample to answer none of the questions correctly (Weller, Dieckmann, Tusler, Mertz, Burns & Peters 2012). The mean score for subjects in this study was 0.65 ($SD = 0.95$). The mean CRT score for the study sample was 0.65 ($SD = 0.95$).²

Item		% correct
WIDGETS	If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?	26%
BAT_BALL.	A bat and a ball cost \$1.10 in total. The bat costs \$1.00 more than the ball. How much does the ball cost?	13%
LILLYPAD.	In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?	25%

Table 1. Cognitive Reflection Test. “% correct” indicates the percentage of the sample answering the indicated item correctly.

b. Hypotheses. As will be explained presently, results from the observational component of the study furnish maximum insight in conjunction with those of the experimental component. Nevertheless, NPT suggests one fairly straightforward hypothesis relating to the observational study considered alone: that a “right-wing” outlook should be associated with a lower CRT score.

NPT is based on survey correlations between self-identifying as “Republican” or “conservative” with traits such as dogmatism, fear of complexity, and need for closure (Jost, Glaser, Kruglanski & Sulloway 2003). Because these reasoning traits are opposed to reflection and open-mindedness, one would expect right-wing disposition to be negatively correlated with CRT scores. The absence of such a finding would be surprising and would complicate interpretation of the finding that conservatism is negatively associated with the personality-trait tests featured in NPT.

Only a modest amount of work exists on the relationship between CRT and political ideology, but it is consistent with this hypothesis. Two studies report finding CRT scores to be slightly lower in self-

² CRT scores were computed by adding the number of correct responses to the three problems the test comprises (Frederick 2005; Weller, et al. 2012 Iyer, Koleva, Graham, Ditto & Haidt 2012; Gervais & Norenzayan 2012; Pennycook, Seli, Koehler & Fugelsang 2012).

identified conservatives than in self-identified liberals (Iyer, Koleva, Graham, Ditto & Haidt 2012; Pennycook, Seli, Koehler & Fugelsang 2012).

Nevertheless, these studies (like all studies, actually) cannot be viewed as definitive. In the first, subjects of all ideologies achieved remarkably high mean scores (Iyer et al. 2012, table 3)—ones higher than those recorded among students at elite universities such as Carnegie Mellon, Princeton, and Harvard (Frederick 2005, table 1). It is possible, then, that the sample (individuals who voluntarily accessed a web site for the purpose of getting evaluations of their moral personalities) could have been skewed heavily toward highly reflective individuals, complicating inferences about how ideology and the disposition to engage in reflection are related in the general population.

Iyer et al. also reported that *libertarians* are more reflective than either liberals or conservatives. This is an important finding that complicates any straightforward interpretation of how a reflective disposition and left-right ideology relate to one another.

In the second study (Pennycook et al. 2012, p. 5), liberals were significantly overrepresented and conservatives underrepresented relative to their numbers in the general population.³ It is thus conceivable that the recruitment procedure involved an element likely to discourage participation by more reflective conservatives (such as the ones whose conscious decisions to participate in psychological studies is correlated with their ideology).

Finally, one study that did use a sample stratified to reflect the national population found that strength of affiliation with *either* the Democrat or Republican party is *negatively* correlated with openness to new ideas (Gerber, Huber, Doherty & Dowling 2012). This result seems discordant with the suggestion that conservatism is uniquely associated with closed-mindedness.

In sum, the negative correlations between CRT and conservatism reported in Iyer et al. (2012) and Pennycook et al. (2012) are definitely plausible and consistent with the correlations between conser-

³ Pennycook et al. (2012, p. 5) report that 53% of the subjects in their sample self-identified as liberal and 25% identified as conservative. Stratified national surveys suggest that approximately 20% of the general population self-identifies as liberal and 40% as conservative (Gallup 2012).

vativism and the personality measures featured in the NPT scholarship. But it remains useful to explore the relationship between CRT and ideology in general population samples.

A finding that CRT scores correlate with ideology in the general population would have inconclusive significance for BRT and ERT. BRT does not suggest any basis to expect an ideological asymmetry in the dynamics that result in political conflict over policy-consequential facts, but does not necessarily rule it out. ERT, in contrast, does assert that such dynamics should be symmetric. However, it does not identify the source of ideological conflict over fact with the predominance of lower-level, System 1 forms of information processing.

3.3. Experimental study design and hypotheses

a. Overview. In the experimental component of the study, subjects' reported their own perceptions of the *validity* of the CRT upon completion of it. They did so by indicating (on a six-point Likert item) their level of agreement or disagreement with the statement "I think the word-problem test I just took [i.e., the CRT test] supplies good evidence of how reflective and open-minded someone is" (CRT_valid).⁴

Subjects responded to this item after being assigned to one of three experimental conditions. In the "control" condition, subjects were advised simply that "psychologists believe the questions you have just answered measure how reflective and open-minded someone is." In the "skeptic-is-biased" condition, subjects were told in addition that "in one recent study, a researcher found that people who *accept evidence of climate change* tend to get more answers correct than those who *reject* evidence of climate change," a "finding [that] would imply that those who believe climate change is happening are more open-minded than those who are skeptical that climate change is happening." In contrast, in the "nonskeptic-is-biased" condition, subjects were advised that "in one recent study, a researcher found that *people who reject evidence of climate change* tend to get more answers correct than those who *accept* evidence

⁴ The wording of the instructions supplied in each experimental condition is reproduced in the Appendix.

of climate change,” a “finding [that] would imply that those who are skeptical climate change is happening are more open-minded than those who believe that climate change is happening.”

The goal of this design was to investigate competing BRT, NPT, and ERT hypotheses relating to ideologically motivated reasoning. The expectation was that the design would provoke ideologically motivated reasoning—that left-wing subjects and right-wing ones would be inclined to credit or discount the validity of the CRT conditional on the experimental assignment—in a form amenable to testing hypotheses about motivated reasoning distinctive of BRT, NPT, and ERT, respectively.

b. Internal validity considerations. Testing for ideologically motivated cognition is not straightforward. The prior beliefs of subjects on opposing sides of an issue are likely to reflect their evaluation of varying forms of information of varying degrees of strength before the experiment. Accordingly, the persistence of ideologically congruent beliefs after exposure to counter-attitudinal information does not supply clear evidence that subjects failed to consider such information open-mindedly (Gerber & Green 1999; Druckman 2012).

An alternative means to test for ideologically motivated reasoning is to experimentally manipulate the motivational stake subjects have in crediting a single piece of evidence (Kahan, Hoffman, Evans, Braman & Rachlinski 2012a; Cohen 2003; Ditto & Lopez 1992; Ditto, Jemmot & Darley 1988). The hypothesis that subjects will display motivated reasoning implies that subjects will adjust the weight they assign the evidence depending on whether they have been assigned to the experimental condition that makes doing so congenial or uncongenial to their ideologies. If it can be shown, that subjects of diverse ideologies are opportunistically adjusting the weight they assign to a single piece of evidence conditional on its perceived congruence or incongruence with their ideologies, then their updating of their beliefs will necessarily be biased in the direction of persisting in ones that are congenial to their ideological commitments (Kahan, Jenkins-Smith & Braman 2011; cf. Rabin & Schrag 1999).

The design of the experimental component of the study reflected this strategy for testing motivated reasoning. Subjects were shown the same evidence of the relative open-mindedness and reflection of people holding beliefs associated with opposing ideological groups. The phenomenon of identity-

protective motivated cognition (Sherman & Cohen 2006; Cohen 2003) generated the hypothesis that subjects would treat that evidence—the groups’ respective CRT scores—as valid or invalid conditional on their membership in the ideological group whose members scored higher on the test.

Such a design also enables straightforward testing of any hypothesized asymmetry in motivated reasoning among subjects of opposing ideologies. The corroboration of motivated reasoning in this design consists of the *interaction* between the experimental manipulation and subjects’ ideology: the direction or magnitude of the weight assigned to the evidence must be found to be conditional on the experimental manipulation, which is hypothesized to determine the congruence or noncongruence of the evidence with subjects’ ideologies. The additional hypothesis that this effect will be asymmetric—that it will, say, be *greater* among more conservative than liberal subjects, as NPT implies (Jost, Glaser & Sulloway 2003; Jost, Hennes, Lavine in press; Kruglanski, Webster & Klem 1993)—is equivalent to predicting that the size of the interaction will *vary* conditional on ideology. Such a hypothesis can be tested by examining whether a polynomial model—one that posits a “curved” rather than a “linear” effect—confirms that the magnitude of the interaction varies in the manner predicted and furnishes a better fit than a model that treats such an effect as uniform across ideology (Cohen, Cohen, West & Aiken 2003; DeMaris 1992).

c. External validity considerations. At a very concrete level, the experiment presented in this paper might be viewed as a model of how ordinary people process information about studies like those that are featured in the NPT research (Mooney 2012). Such readers will have little to go on besides scholars’ or commentators’ representations that the tests of open-mindedness featured in such studies are valid. If such readers are inclined to credit such representations only when the studies’ results gratify their interest in forming and maintaining the belief that people who share their own ideology are more open-minded, then their assessments of that research will itself be biased by ideologically motivated reasoning.

But abstracting from the particulars, the study design can be thought of as modeling how ideologically motivated reasoning might bias considerations of empirical evidence generally. On policy debates over matters as diverse as climate change, gun control, the death penalty, and fiscal policy, ordinary citizens are presented with evidence, often in the form of second-hand characterizations of the findings of

“scientific studies.” If their assessments of the validity of such evidence is conditional on its fit with their ideological predispositions, then citizens will not converge on the best available evidence on but rather will polarize on policy-relevant facts (Kahan, Jenkins-Smith & Braman 2011; Ross & Lepper 1979)

c. Hypotheses. Presumably, individuals who are ideologically motivated have a stake in believing that people who share their ideologies are more open-minded and reflective than those who do not. Here subjects were presented evidence relevant to that issue: the respective performance on an “open-mindedness test” of people who either *accepted* or *rejected* a position strongly associated with membership in the subjects’ own ideological groups. The subjects were in fact supplied relatively spare information about the validity of CRT: only the representation that psychologists view it as valid, plus the subjects’ own experience in having just taken it. The prospect that they would engage in motivated reasoning, though, supplied a basis for them to treat that evidence as establishing the test’s validity conditional on whether doing so would gratify or disappoint their stake in believing that members of their ideological group were more open-minded than members of an opposing one (Cohen 2003; cf. Ditto & Lopez 1992; Ditto, Jemmott & Darley 1988).

All three of the synthesis theories—NPT, BRT, and ERT—predict motivated reasoning in this study. They generate different hypotheses, however, about the form that such reasoning will take.

NPT implies that the observed motivated reasoning should be asymmetric with respect to the subjects’ ideologies. Reflecting their disposition to dogmatism and closed-mindedness, relatively right-wing subjects, NPT predicts, should be more inclined to see CRT as a valid test in the nonskeptic-is-biased condition than in the skeptic-is-biased condition. NPT depicts more liberal or left-wing individuals as relatively more open-minded and reflective and thus less subject to motivated cognition. Accordingly, in the study, NPT should predict that relatively left-wing subjects’ assessments of the validity of CRT should be comparable in both the skeptics-biased and non-skeptic-is-biased condition. This finding would be a particularly compelling affirmation of NPT, moreover, in conjunction with a finding in the observational component of the study that right-wing dispositions correlate with a lower CRT score.

BRT understands motivated reasoning to be an artifact of the disposition to use low-level, System 1 information processing. Unlike NPT, BRT does not (or does not necessarily) predict that motivated reasoning will be ideologically asymmetric. But BRT does predict that it will be higher among subjects who score relatively low in CRT than it will be in those who score relatively high.

ERT supports predictions strikingly different from those of either NPT or BRT. Not only does ERT fail to predict ideological asymmetry in motivated reasoning. It predicts that the tendency of both right-wing and left-wing subjects to credit the “validity” of CRT conditional on the ideological congeniality of doing so will *increase* with the CRT scores of subjects with those ideologies. *All* subjects, ERT posits, will have a rational stake in forming ideologically congenial assessments of the validity of the CRT. Nevertheless, their *success* in achieving this end will depend on their comprehension of the questions being posed and their appreciation of what differing answers signify about the open-mindedness of individuals who share their ideologies. Because subjects who are high in CRT assess information more methodically and reflectively, they are less likely to *misunderstand* the question, and thus less likely to avoid the unconscious pressure to fit their assessments of the evidence at hand to the conclusion that fits their expressive interests.

3.4. Statistical power and missing data

Certain of the competing hypotheses associated with the three theories turned on whether or not an observational correlation or experimental effect would be observed. The strength of inferences drawn from “null” findings depends heavily on statistical power. The large size of the sample furnished adequate power to detect even small effect sizes (e.g., $r = .10$) with a probability well over .80 at $p \leq .05$ (Cohen 1988). As a result, findings of nonsignificance could be equated with lack of effect with low risk of Type II error (Streiner 2003).

It was anticipated that multivariate regression analysis would be used to estimate the impact of the experimental treatments and test for their significance. To assure full exploitation of the power asso-

ciated with the large sample size, missing data were replaced by multiple imputation (King, Honaker, Joseph & Scheve 2001; Rubin 2004).⁵

4. Results

4.1. Observational component

Subjects' CRT scores were regressed against political orientations and other individual characteristics known to be associated with CRT performance, including gender, race, education, income, and religiosity (which was measured with a composite Likert scale that aggregated self-reported church attendance, frequency of prayer, and perceived importance of God, $\alpha = 0.82$). The coefficient for Conserv_Repub was positive—indicating that CRT scores increase as subjects become progressively more right-wing in their orientation—but nonsignificant both when treated as a zero-order predictor ($b = 0.07$, $p = 0.14$) and when included in a model that controlled for other characteristics ($b = 0.05$, $p = 0.33$).

	Model 1	Model 2
Conserv_Repub	0.07 (0.05)	0.05 (0.97)
male		0.68 (6.60)
white		0.72 (5.41)
education		0.31 (8.39)
income		0.06 (3.32)
religiosity		-0.20 (-3.63)
$LR \chi^2$	2.2(1)	264.5(6)
$\Delta LR \chi^2$		262.2(5)

Table 2. Ordered logistic regression analysis of CRT scores. $N = 1750$. Outcome variable is CRT score. Predictor estimates are ordered-logit coefficients with z -test statistic indicated parenthetically. Bolded typeface indicates predictor coefficient, model $LR \chi^2$, or incremental change in model $LR \chi^2$ is significant at $p < 0.05$. Model with reference to which the incremental change in $LR \chi^2$ is calculated is indicated parenthetically

The Conserv_Repub scale is a more reliable measure of the subjects' ideological dispositions than either of its components alone, and thus supports more reliable inferences about the relationship between political outlooks and CRT scores (Gliem & Gliem 2003; Nunnally & Bernstein 1994). Nevertheless, to promote comparability of the results reported in this study and ones that use only a single political

⁵ The experiment was first analyzed without imputed data, using listwise deletion for observations containing missing data (Kahan 2012a). The results did not differ materially from those reported.

orientation measure, the relationships between subjects' scores and aspects of each component of Conserv_Repub were also examined.

The correlation with self-reported liberal-conservative ideology (libcon) was negative—indicating a decline in score as conservatism increases. The size of the effect, however, was only trivially different from zero and statistically nonsignificant ($r_s = -0.02$, $p = 0.45$). When the subjects who self-identified as “Moderates” were excluded, and the remainder split into groups who identified as either “Very liberal” or “Liberal,” on the one hand, or “Very conservative” or “Conservative,” on the other, there was a slightly larger but still statistically nonsignificant difference ($\Delta M = 0.09$, $t = 1.41$, $p = 0.16$) in the mean scores of “liberals” ($M = 0.75$, $SEM = 0.05$) and “conservatives” ($M = 0.67$, $SEM = 0.04$).

The correlation with self-reported party affiliation ($r_s = 0.08$, $p < 0.01$) was positive and significant, indicating that CRT scores increased with the strength of subjects' identification with the Republican party on dem_repub, the 7-point Likert measure of partisan identification. When subjects who self-identified as either “Independents” or “Independents” who “lean” either Democrat or Republican were removed, and the remainder split into ones who identified as either “Democrat” or “Republican,” the difference in the mean score of “Republicans” ($M = 0.66$, $SEM = 0.04$) and “Democrats” ($M = 0.52$, $SEM = 0.03$) was also statistically significant ($\Delta M = 0.14$, $t = 2.48$, $p < 0.05$). The gap between “Republicans” ($M = 0.71$, $SEM = 0.04$) and “Democrats” ($M = 0.59$, $SEM = 0.03$) remained statistically significant ($\Delta M = 0.13$, $t = 2.54$, $p < 0.05$) when the scores of subjects who identify as “Independents” but “lean” toward one or the other of the major parties were treated as partisans (Petrocik 2009).

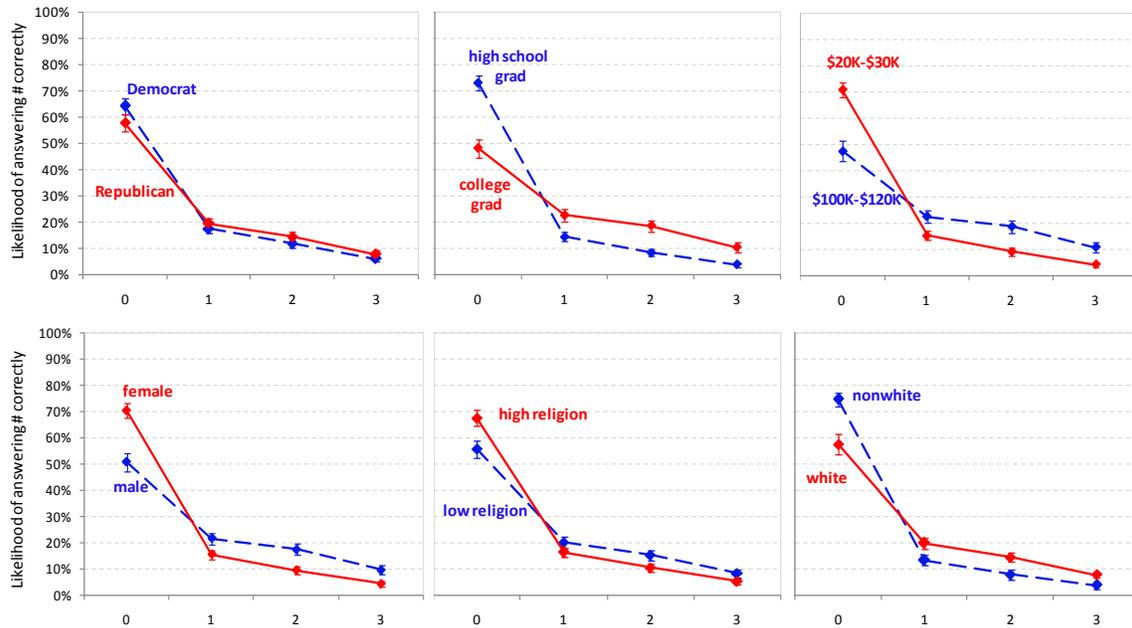


Figure 1. Predicted CRT performance. Probabilities determined via Monte Carlo simulation (based on ordered logit regression in which indicated characteristic is the predictor and score on CRT the outcome variable). Y-axis indicates predicted likelihood of answering either 0, 1, 2 or 3 questions correctly. For “Democrat” and “Republican,” predictor values are set at 2 and 6, respectively, on the 7-point partisan self-identification scale; for “religion,” predictor is set at +1 SD for “high” and -1 SD for “low” on composite religiosity scale. CIs reflect 0.95 level of confidence.

To gauge the practical importance of the difference in the CRT scores of Republicans and Democrats, it is useful to compare it to the difference in scores of other groups known to vary in CRT performance. A set of ordered logistic regression models was constructed in order to facilitate the comparison and also to promote insight into the nature of the differences in the compared groups. In the model based on self-identified party affiliation, the difference in performance was associated almost entirely with the likelihood of getting zero answers correct, which the model estimated to be 64% ($\pm 3\%$, $CL = 0.95$) for a Democrat ($dem_repub = 2$) and 58% ($\pm 3\%$) for a Republican ($dem_repub = 6$). This effect was considerably smaller and less uniform than ones associated with education, gender, and race. It was comparable in effect to the one observed with religion (Figure 1).

Based on work relating personality-trait and self-reported measures of cognitive style to ideology, NPT predicted that CRT scores would be *negatively* correlated with right-wing ideology. This hypothesis was not confirmed.

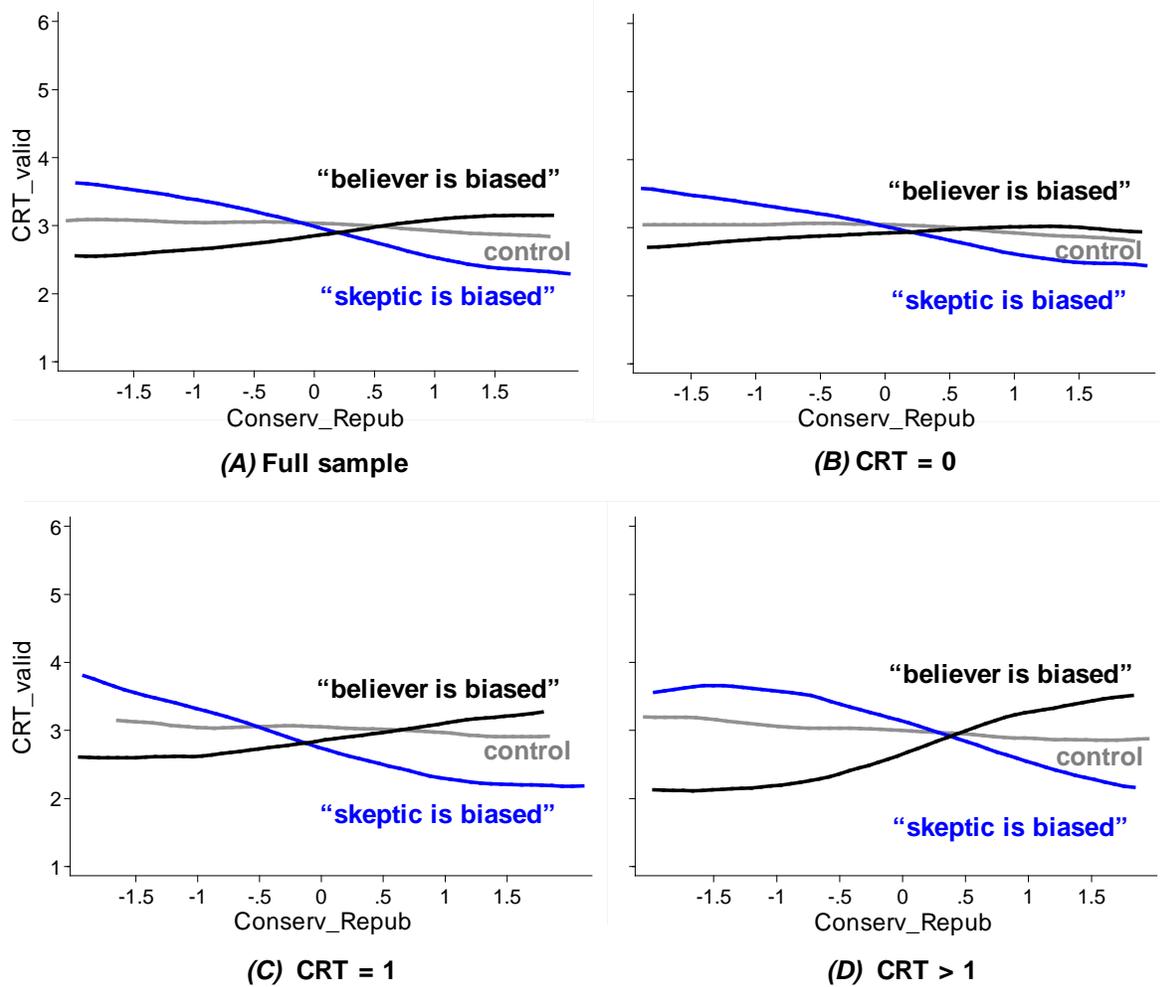


Figure 2. Graphical summary of experimental results. Locally weighted regression, applied separately for each experimental condition, plots the relationship between the political outlooks and responses to CRT_valid. Panel (A) plots responses for all study subjects. Panels (B), (C), and (D) plot results only for study subjects with CRT scores of 0, 1, and 2 or 3, respectively. Conserv_Repub, the scale used to measure the subjects’ political outlooks, is centered at the point corresponding to a subject who self-identified as a “moderate” on the 5-point liberal-conservative ideology scale and as an “Independent” (who declined when “pushed” to “lean” toward either party) on the 7-point partisan-self-identification scale. Individuals who identified themselves as either “liberal” and “Democrat” or as “conservative” and “Republican” would have scored -0.95 and 0.95 on Conserv_Repub, respectively. The extreme values on the scale— -1.65 and 1.65, respectively—correspond to the scores of individuals who identified themselves as “Very liberal” and “Strong Democrat” and “Very conservative” and “Strong Republican,” respectively.

4.2. Experimental component

a. Ideologically motivated reasoning generally. As hypothesized by all three theories, subjects displayed ideologically motivated reasoning in their assessments of the validity of the CRT (Figure 2). In the control condition, right-wing and left-wing subjects (identified by their scores relative to the mean on Conserv_Repub), formed comparable judgments of the validity of the CRT as a measure of how “reflec-

tive and open-minded” people are ($M = 3.0$, $SEM = 0.2$, for both; $\Delta M = 0.08$, $t = 0.59$, $p = 0.56$). Those assigned to the “skeptic-is-biased” condition, in contrast, divided on ideological lines: right-wing subjects were *less* inclined to treat the CRT as valid ($M = 2.4$, $SEM = 0.2$), and left-wing ones *more* inclined to do so ($M = 3.5$, $SEM = 0.2$), when told that climate-change skeptics generally score lower on the test. This effect was reversed in the “believer-is-biased” condition: told that climate skeptics generally score higher on the test, relatively right-wing subjects were now *more* inclined ($M = 3.1$, $SEM = 0.2$), and relatively left-wing ones *less*, to judge the CRT to be valid ($M = 2.6$, $SEM = 0.2$).

The significance of this effect was confirmed by multivariate regression (Table 3, Model 1). The analysis showed there was no meaningful main effect associated with being assigned to the “skeptic-is-biased” condition ($b = -0.04$, $p = 0.68$), and a small, marginally significant negative effect associated with being assigned the “believer-is-biased” condition ($b = -0.17$, $p = 0.10$), relative to being assigned to the control condition. In the control condition, a progressively more right-wing ideology had a slightly negative but nonsignificant effect ($b = -0.12$, $p = 0.11$). The significant *interaction* of the ideology measure with each experimental-assignment predictor, however, confirmed that, relative to their counterparts in the control condition, subjects’ inclination to view the CRT as valid *decreased* in the “skeptic-is-biased condition” ($b = -0.51$, $p < 0.01$), and *increased* in the “believer-is-biased” condition ($b = 0.37$, $p < 0.01$), as their ideologies became more right-wing.

b. Symmetry. The mean scores of subjects on the experimental outcome variable (CRT_valid) did not suggest that the observed motivated-reasoning effect was asymmetric with respect to subjects’ political outlooks. On the contrary, liberal Democratic subjects were inclined to discount the validity of the CRT in the “believer-is-biased” condition relative to the “skeptic-is-biased” condition ($\Delta M = 0.86$, $t = 6.37$, $p < 0.01$) by an amount slightly but nonsignificantly larger ($\Delta M = 0.11$, $t = 0.57$, $p = 0.57$) than the amount by which conservative Republican ones were inclined to discount it in “skeptic-is-biased” condition relative to the “believer-is-biased” one ($\Delta M = 0.75$, $t = 5.39$, $p < 0.01$).

To perform a more exacting test of whether the motivated-reasoning effect observed in the experiment was symmetric or asymmetric with respect to subjects’ ideological dispositions, a quadratic regres-

sion model was fit to the data (Table 3, Model 2). The model included terms designed to assess whether, as NPT would predict, the impact of the experimental treatment became stronger as subjects' became more right-wing. The addition of these terms did not result in a significant improvement in fit relative to the model that treated the impact of the experimental treatment as uniform with respect to subjects' ideologies ($\Delta LR \chi^2 = 3.41(3)$, $p = 0.33$). Thus, contrary to NPT, and consistent with BRT and ERT, the experimental component results were more consistent with a finding of *symmetry* than one of *asymmetry* with respect to ideologically motivated reasoning.

	Model 1		Model 2		Model 3	
Conserv_Repub	-0.12	(-1.60)	-0.11	(-1.44)	-0.12	(-1.58)
Skeptic-is-biased	-0.04	(-0.41)	-0.08	(-0.51)	-0.04	(-0.39)
Believer-is-biased	-0.17	(-1.65)	-0.33	(-2.12)	-0.16	(-1.54)
Con_Rep_x_skeptic	-0.50	(-4.64)	-0.51	(-4.72)	-0.50	(-4.63)
Con_Rep_x_believer	0.38	(3.59)	0.37	(3.48)	0.37	(3.47)
Con_Rep ²			-0.10	(-1.19)		
Con_Rep ² _x_skeptic			0.04	(0.36)		
Con_Rep ² _x_believer			0.16	(1.37)		
zCRT					0.04	(0.51)
C_R_x_zcrt					-0.01	(-0.13)
zCRT_x_skeptic					-0.06	(-0.58)
zCRT_x_believer					-0.05	(-0.76)
Con_Rep_x_zCRT_x_skeptic					-0.03	(-0.31)
Con_Rep_x_zCRT_x_believer					0.30	(2.95)
<i>LR</i> χ^2	90.52(5)		93.93(8)		106.95(11)	
$\Delta LR \chi^2$ (relative to model 1)			3.41(3)		16.43(6)	

Table 3. Ordered logistic regression analysis of experimental component. $N = 1750$. Outcome variable is CRT_valid. Predictor estimates are ordered-logit coefficients with z-test statistic indicated parenthetically. Bolded typeface indicates predictor coefficient, model $LR\chi^2$, or incremental change in model $LR\chi^2$ is significant at $p < 0.05$. “Skeptic-is-biased” and “Believer-is-biased” are dummy variables that reflect the experimental assignment (unassigned = 0; assigned = 1). CRT score (“zCRT”) and Conserv_Repub are both centered at 0 to promote ease of interpretation.

c. Interaction with CRT. The final experimental hypotheses were BRT’s prediction that ideological polarization should abate as individuals become more disposed to use System 2 processing and ERT’s prediction that it should increase. To test these rival hypotheses, subjects’ CRT scores along with appropriate interaction terms were added to the regression model

The results are reported in Table 3, Model 3. Overall model fit improved significantly ($\Delta LR \chi^2 = 16.43(6)$, $p = 0.01$). The coefficient for the interaction term added to assess the relationship between CRT scores and assignment to the “believer-is-biased” condition, was positive and significant ($b = 0.30$, $p < 0.01$). Thus, in the “believer-is-biased” condition, subjects of opposing ideologies polarized to a greater extent as their CRT scores increased. The coefficient for the interaction term added to assess the relationship between CRT scores and assignment to the “skeptical-is-biased” condition was only trivially different from zero and nonsignificant ($b = -0.03$, $p = 0.76$). Thus, in the “skeptical-is-biased” condition, the degree of ideological polarization did not meaningfully vary in relation to subjects’ CRT scores.

Aside from the motivated reasoning effect, little of interest occurred. There was a negative but statistically nonsignificant relationship between right-wing orientation and discounting the CRT in the control condition (Conserv_Repub: $b = -0.12$, $p = 0.11$). Being assigned to the skeptical-is-biased condition ($b = -0.04$, $p = 0.68$) did not meaningfully influence subjects’ perceptions of the CRT independently of their political outlooks. Controlling for outlooks, being assigned to the believer-is-biased condition ($b = -0.17$, $p = 0.10$) predicted a small and marginally significant tendency to discount the CRT.

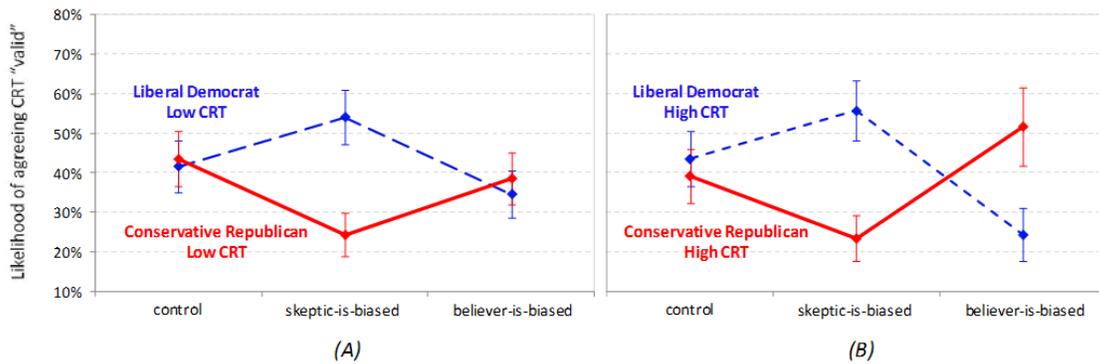


Figure 3. Interaction between CRT and experimental treatment. Derived via Monte Carlo simulation (King, Tomz & Wittenberg 2000) from regression model reported in Table 3, Model 3. Point estimates indicate predicted probability of agreeing either “slightly,” “moderately,” or “strongly” with CRT_valid. The predictor values for “Liberal Democrat” and “Conservative Republican” are -1 and +1 respectively on Conserv_Repub. The predictor values for “low” and “high CRT” are 0 and “1.6,” respectively. CIs reflect 0.95 level of confidence.

Graphic illustration enables practical assessment of this analysis. In Figure 3, the likelihood of deeming the CRT to be valid is estimated both for a “Liberal Democrat” and a “Conservative Republican” getting 0 answers correct (the score for subjects in the bottom half of the sample distribution) and for a

“Liberal Democrat” and a “Conservative Republican” getting “1.6” answers correct, a score that is one standard deviation above the mean and that would place those individuals in between the 80th and 90th percentile for the sample. As can be seen, the impact of CRT performance on motivated reasoning is concentrated in the “believer -is-biased condition”: the difference in predicted probability for high-CRT partisans in that condition is 22 percentage points ($\pm 8\%$, $CL = 0.95$) *greater* than the difference in probability for low-CRT partisans, whose likelihoods of judging the CRT as “valid” do not meaningfully differ in that condition.

This result is with consistent ERT and inconsistent with both BRT and NPT. Whereas the latter both see ideologically motivated reasoning as a consequence of a disposition to use heuristic-driven, System 1 information processing, ERT sees ideologically motivated reasoning as rationally suited (in this context, at least) to an individual’s well-being. The effect of motivated reasoning should, on this account, be expected to increase in tandem with CRT performance by virtue of the contribution higher-level reasoning can make to the fitting of complex forms of information to a persons’ motivating predispositions. The interaction between CRT scores, ideology, and the experimental treatment can be seen as implying that the ideological significance of the information on the relative performance of climate skeptics and believers was likely to be understood equally well by low-scoring and high-scoring subjects in the “skeptical-is-biased” condition, but more likely to be appreciated by high-scoring ones in the “believer-is-biased” condition.

5. Discussion

5.1. Summary of results

The motivation (consciously, at least) for this study was to assess three dynamics understood to be relevant to political contestation over risk and policy-relevant facts: heuristic-driven reasoning, motivated cognition, and ideologically grounded personality traits. All of these dynamics have been empirically supported in previous studies; the goal of this study was to test competing theories about how the three *relate* to one another and what their interaction contributes to political polarization.

The study results were inconsistent with two of these theories. The “Bounded irrationality thesis”—BRT—asserts that public conflict over risk and other policy relevant facts is a consequence of the predominance of heuristic-driven, System 1 information processing, which interferes with the public’s understanding of complicated evidence and motivates it to assess evidence consistently with ideological predispositions (Sunstein 2006b; Weber & Stern 2011). The experimental component of the study, however, demonstrated that in fact the disposition to engage conscious and effortful System 2 information processing—as measured by the CRT—actually *magnifies* the impact of motivated reasoning.

The study results were also inconsistent with the “Neo-authoritarian Personality Thesis” or NPT. NPT attributes public conflict over policy-relevant facts to an affinity between conservative ideology and traits such as dogmatism and aversion to complexity, which fuel the motivated rejection of evidence incompatible with conservative policy aims (Jost, Glaser, Kruglanski & Sulloway 2003; Jost, Hennes & Lavine in press).

The study findings pose three distinct challenges to NPT. First, the study found no meaningful correlation between right-wing ideology and CRT performance, an objective measure of open-mindedness and reflection that has been shown to be one of the strongest predictors of high-level information processing (Campitelli & Labollita 2010; Toplak, West & Stanovich 2011; Hopee & Kusterer 2011)). Second, and even more important, the finding that CRT performance *magnifies* ideologically motivated reasoning suggests that there is little basis for treating *low* scores on any valid measure of the disposition to use conscious, effortful information processing as predictive of a greater vulnerability to ideologically motivated reasoning. Thus, if polarization over risk and other policy-relevant facts is indeed fueled by ideologically motivated cognition—as it widely understood to be (Myers, Maibach, Roser-Renouf, Akerlof & Leiserowitz 2012; Taber & Lodge 2006)—then the link between such conflict and the personality correlates of conservatism featured in the NPT research would seem to be attenuated.

Third and finally, this study used an experimental design and a statistical-testing strategy specifically fitted to evaluating the NPT assumption that the force of ideological motivated reasoning varies in intensity across the right-left political spectrum (Jost, Glaser, Kruglanski & Sulloway 2003; Jost, Hennes

& Lavine in press). It found that when assessing evidence of the other group's propensity to consider evidence in an open-minded and reflective way, liberals and conservatives were *uniformly* prone to ideologically motivated reasoning.

Only the third theory—the “Expressive Rationality Thesis” or ERT—was fully supported by the study. That theory alone predicted *both* that ideologically motivated reasoning would be symmetric *and* that it would be amplified by higher CRT scores. Those hypotheses reflect a theory that sees ideologically motivated cognition not as a reasoning deficiency but as a reasoning adaptation suited to promoting the interest that individuals have in conveying their membership in and loyalty to affinity groups central to their personal wellbeing (Cohen 2003; Akerlof & Karanton 2000; Hillman 2010). Because individuals make use of this form of information-processing to protect their stake in all manner of groups—including ones not connected to politics (Sherman & Cohen 2006)—there is no reason to expect it to be more pronounced among people who subscribe to any particular ideology. In addition, because this dynamic is *rational*—that is, because it reliably guides individuals to assign information the significance that advances their personal ends, albeit not their collective ones (Kahan et al. 2012b)—there is good reason to expect it to be used with even greater determination and consistency by individuals disposed to engage in conscious, effortful forms of information processing (Chen, Duckworth & Chaiken 1999). The experiment results corroborate this expectation.

5.2. Implications for understanding dual-process and motivated reasoning

Many commentators have assumed (not implausibly) that ideologically motivated cognition is a manifestation of “hot” or heuristic-driven System 1 reasoning processes amenable to being overridden by “cold,” or reflective System 2 ones (Jost, Hennes & Lavine in press; Westen, Blagov, Harenski, Kilts & Hamann 2006; Redlawski 2002; Sunstein 2005). But in work that actually predates the adaptation of this framework to the study of risk perception, at least some dual-process theorists took the position that motivated reasoning should be expected to characterize higher-level, systematic forms of cognition as well, particularly when the motivated use of conscious and effortful processing could be expected to ad-

vance an agent's ends in maintaining his or her connection to an identity-defining group (Cohen 2003; Chen & Chaiken 1999; Chaiken & Maheswaran 1994).

Chaiken and her collaborator's findings inform the "expressive rationality" hypothesis tested in this paper. That same hypothesis figured in a previous observational study, which found that cultural polarization over climate-change and nuclear-power risks are greatest among individuals who are higher in scientific literacy and in Numeracy, a technical reasoning measure of which CRT is a subcomponent (Kahan et al. 2012b). The experimental results of the present study help corroborate the inference that the correlations reported in that earlier study are property attributed to the power of motivated cognition to penetrate the forms of information processing associated with Kahneman's System 2.

It should be stressed, however, that this result is *not* in tension with dual-process reasoning theories generally, but only with a particular surmise about how a particular cognitive dynamic should be assimilated to such theories. Indeed, the finding that the disposition to make use of System 2 magnifies ideologically motivated reasoning also fits perfectly well—indeed reinforces—recent dual process research in political psychology. This work finds that the effect of affectively triggered sources of motivated reasoning is most pronounced in politically sophisticates, precisely because those individuals can be expected to use their greater political knowledge to resist ideologically incongruent evidence (Taber & Lodge 2006). A greater capacity for cognitive reflection would presumably improve the success of such individuals in recognizing the occasions for and effective use of such knowledge. Indeed, the relationship between political sophistication and cognitive reflection is an important topic for future research.

5.3. Implications for Neo-authoritarian Personality research

This study raises two general issues for research associated with NPT. First, the finding that conservative ideology is *not* negatively correlated with CRT is contrary to what one might have expected based on that work. This finding should thus be viewed as supplying impetus to investigate the relationship between CRT—and the sorts of reasoning dispositions for which it is clearly a compelling and valid measure—and the measures of closed-mindedness featured in the Neo-authoritarian personality research.

Second, this study raises doubts about the relevance of the Neo–authoritarian personality work to political polarization over risk and related facts. The proposition that this form of conflict reflects the impact of ideologically motivated cognition is amply supported. The assumption that the personality traits featured in the Neo–authoritarian Personality research have any connection to ideologically motivated cognition is not.

5.4. Implications for counteracting ideologically motivated reasoning

The goal of empirically investigating the sources of political conflict over risk and other policy-consequential facts is not merely to explain this phenomenon but also to aid in discovery of devices that might help to counteract it. The study described in this paper makes a contribution to that end as well.

It does this primarily by helping to inform hypotheses about how such dynamics might be combated. Many scholars have suggested “debiasing” strategies aimed at correcting the distorting effect of System 1 reasoning on public perceptions of risk (Campitelli & Labollita 2010; Jolls & Sunstein 2006). Because such distortions are real—and substantially interfere with human wellbeing in myriad domains—pursuit of System-1 debiasing techniques is unquestionably important. Nevertheless, if, as the present study implies, ideologically motivated cognition is *not* a consequence of an over-reliance on heuristic reasoning, then System 1 debiasing strategies should not be expected to abate polarization over climate change, nuclear power, gun control, the HPV vaccine or like issues (Kahan 2010).

What is needed instead are interventions that remove the *expressive incentives* individuals face to form perceptions of risk and related facts on grounds unconnected to the truth of such beliefs (Lessig 1995). Extending the analysis of previous papers, this one has suggested that ideologically motivated reasoning is in fact *expressively rational* at the individual level, because it conveys individuals’ membership in and loyalty to groups on whom they depend for various forms of support, emotional, material, and otherwise (Cohen 2003; Hillman 2010; Akerlof & Kranton 2000).

This account, however, presupposes that beliefs on risks and related facts bear *social meanings*—that they are, in fact, generally understood (tacitly, at least) to cohere with outlooks and other characteristics that identify the individuals who espouse them as reliably committed to one group *rather than* another.

er (Cohen 2003). Not all risks and policy-relevant facts have this quality; indeed, relatively few do, and on the vast run of ones that do not (e.g., pasteurization removes infectious agents from milk; fluoridation of water fights tooth decay; privatization of the air-traffic control system would undermine air safety), we do not observe significant degrees of ideological or cultural polarization.

There is little reason to believe, moreover, that the meanings of highly contested facts are insusceptible of revision in a manner that would disconnect particular positions on them from membership in identity-defining groups (Nisbet & Mooney 2007). One can understand the historical shift in public opinion toward the risks posed by cigarettes (including third-party ones from passive smoke exposure or from the societal expenditures necessary to treat individuals with lung cancer) as having been mediated by informational campaigns aimed at altering the positive meanings that dismissing evidence of the health hazards of smoking expressed in certain subcommunities (United States Public Health Service 2000; Gusfield 1993).

The ERT account of ideological polarization, then, underscores the value of forming and testing hypotheses about how to regulate the social meaning of risks and related policy-relevant facts. Indeed, research focusing on forecasting techniques for identifying technologies vulnerable to polarizing meanings, on governmental processes for protecting the “science communication environment” from influences that cause such meanings to take hold, and on framing and other strategies for cleaning up that environment once it has been contaminated with polarizing meanings, is already well underway (Corner, Whitmarsh & Xenias 2012; Druckman & Bolsen 2012, 2011; Ferrari 2009; Lupia in press; Nisbet & Scheufele 2009; Anderson, Brossard, Scheufele, Xenos & Ladwig 2013;).

6. Conclusion: The tragedy of the science communications commons

What this paper has characterized as the “expressive rationality” of ideologically motivated reasoning is intrinsic to a collective action problem (Lessig). When societal risks become suffused with antagonistic social meanings, it is (often if not always, and with respect to many if not all issues) *individually rational* for ordinary members of the public to attend to information in a manner that reliably connects them to the positions that predominate in their identity-defining groups. Nevertheless, if ideologically di-

verse individuals all follow this strategy simultaneously, they will be *collectively worse off*, since under these conditions, democratic institutions are less likely to converge, or to converge as rapidly as they otherwise would, on policies that reflect the best available evidence on how to protect everyone from harm. But because what any ordinary individual believes about policy will not make a difference, the *collective irrationality* of ideologically motivated reasoning does not create any reliable pressure or mechanism to induce individual to process information in a different, and morally and politically superior, way.

Overcoming ideological polarization on risk and related facts thus demands collective action specifically geared at dissolving this “tragedy of the science communications commons” (cf. Hardin 1968). Supplying the knowledge needed to guide such action is the contribution that decision science is uniquely poised to make.

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Appendix. Experimental Stimulus

A. *RANDOMLY ASSIGN to condition 1 or 2 or 3.*

1. control condition

Psychologists believe the questions you have just answered measure how reflective and open-minded someone is.

2. Skeptic-is-biased condition

Psychologists believe the questions you have just answered measure how reflective and open-minded someone is.

In one recent study, a researcher found that people who accept evidence of climate change tend to get more answers correct than those who reject evidence of climate change. If the test is a valid way to measure open-mindedness, that finding would imply that those who believe climate change is happening are more open-minded than those who are skeptical that climate change is happening.

3. Nonskeptic-is-biased condition

Psychologists believe the questions you have just answered measure how reflective and open-minded someone is.

In one recent study, a researcher found that people who reject evidence of climate change tend to get more answers correct than those who accept evidence of climate change. If the test is a valid way to measure open-mindedness, that finding would imply that those who are skeptical that climate change is happening are more open-minded than those who believe climate change is happening.

B. CRT_valid. How strongly do you agree or disagree with this statement? [strongly Disagree, moderately disagree, slightly disagree, slightly agree, moderately agree, strongly agree]

I think the word-problem test I just took supplies good evidence of how reflective and open-minded someone is.

Ideology, motivated reasoning, and cognitive reflection

Dan M. Kahan*

Abstract

Decision scientists have identified various plausible sources of ideological polarization over climate change, gun violence, national security, and like issues that turn on empirical evidence. This paper describes a study of three of them: the predominance of heuristic-driven information processing by members of the public; ideologically motivated reasoning; and the cognitive-style correlates of political conservatism. The study generated both observational and experimental data inconsistent with the hypothesis that political conservatism is distinctively associated with either unreflective thinking or motivated reasoning. Conservatives did no better or worse than liberals on the Cognitive Reflection Test (Frederick, 2005), an objective measure of information-processing dispositions associated with cognitive biases. In addition, the study found that ideologically motivated reasoning is not a consequence of over-reliance on heuristic or intuitive forms of reasoning generally. On the contrary, subjects who scored highest in cognitive reflection were the *most* likely to display ideologically motivated cognition. These findings corroborated an alternative hypothesis, which identifies ideologically motivated cognition as a form of information processing that promotes individuals' interests in forming and maintaining beliefs that signify their loyalty to important affinity groups. The paper discusses the practical significance of these findings, including the need to develop science communication strategies that shield policy-relevant facts from the influences that turn them into divisive symbols of political identity.

Keywords:

1 Introduction

Ideological polarization is a conspicuous but peculiar feature of American democracy. No one is surprised when conservatives and liberals fight over tradeoffs between wealth and equality or between “law and order” and civil liberties. Differences in the value attached to such goods *define* those political outlooks.

Much more perplexing, however, are the ubiquity and ferocity of ideological conflicts over *facts* that turn on empirical evidence. Democrats (by and large) fervently believe that human activity is responsible for global warming, Republicans (by and large) that it is not (Pew Research Center, 2012). Conservatives are confident that the wastes generated by nuclear power plants can be safely disposed of by deep geologic isolation; liberals dispute that (Jenkins-Smith, Silva, Nowlin & deLozier, 2011). People who value equality and community believe that vaccinating schoolgirls against the human papillomavirus is essential to protecting women's health—

and that permitting private citizens to carry concealed hand guns increases crime. Those who value hierarchy and individualism, in contrast, reply that universal HPV vaccination will *undermine* young girls' health by lulling them into unprotected sex, and that gun *control* increases crime by making it harder for law-abiding citizens to protect themselves (Kahan, Braman, Cohen, Gastil & Slovic, 2010; Kahan, 2010).

Political polarization on empirical issues like these occurs not only despite the lack of any logical connection between the contending beliefs and the opposing values of those who espouse them. It also persists despite apparent scientific consensus on the answers to many of these disputed questions (Lewandowsky, Gignac, & Vaughan, 2012; Kahan, Jenkins-Smith & Braman, 2011).

Decision science suggests a range of potential explanations for why dueling assertions of fact occupy frontline positions in U.S. culture wars. It is well established that members of the public rely on heuristics or mental shortcuts that can generate systematic biases in their perceptions of risk and similar facts. They also tend to seek out and assess evidence in biased patterns that reinforce the positions that they, or those who share their ideological predispositions, already hold. Some psychologists maintain, too, that these effects are intensified by dogmatism, aversion to complexity, and like traits that correlate with political conservatism and that make politically conservative individuals distinctively resistant to revising their beliefs based on empirical evidence.

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All of these positions are firmly rooted in empirical study, but relatively little testing has been done on how they relate to one another. More than one plausible account exists of how the various dynamics that connect ideology and factual perceptions interact. Empirical testing of these competing surmises is necessary, not only to advance understanding of ideological polarization over policy-relevant facts but also to guide practical action aimed at mitigating it.

This paper reports the results of a study designed to contribute to the necessary testing process. Using both observational and experiment testing methods, the study examined alternative hypotheses relating to how three psychological dynamics—*dual process reasoning*, *the cognitive style associated with conservatism*, and *motivated cognition*—combine to generate polarization over risks and other policy consequential facts.

2 Empirical and theoretical background

Scholars have identified three important influences that contribute to public controversy over factual questions that turn on scientific and related forms of empirical evidence. This part briefly describes these influences and identifies alternative conjectures about how they interact with one another.

The first dynamic associated with public controversy over policy-relevant facts is *heuristic-driven information processing*. Long prominent in the study of psychology, dual-process theories posit two modes of information-processing: a “fast, associative” one “based on low-effort heuristics”, and a “slow, rule based” one that relies on “high-effort systematic reasoning” (Chaiken & Trope, 1999, p. ix). Many scholars attribute controversy over societal risks to the disposition of members of the public to over-rely on the heuristic-driven, “System 1” (Stanovich & West, 2000; Kahneman, 2003) reasoning style. The centrality of visceral, emotion-guided modes of perception can cause laypeople to overestimate the incidence and harm associated with more sensational risks—such as terrorist acts and gun accidents—relative to more remote, less gripping hazards such as climate change and swimming pools. Expert opinion does not reliably correct these distortions because members of the public too often lack the time or ability to engage in the more effortful, more dispassionate “System 2” style of reasoning suited to understanding the technical evidence that experts use to assess risks (Loewenstein, Weber, Hsee & Welch, 2001; Sunstein, 2003, 2006a, 2007; Weber, 2006).

The second dynamic that generates conflict over risk issues is *motivated reasoning*. Motivated reasoning refers

to the tendency of people to conform assessments of information to some goal or end extrinsic to accuracy (Kunda, 1990; Balci & Dunning, 2008; Dunning, 1999; Ditto, Pizarro & Tannenbaum, 2009).

The goal of protecting one’s identity or standing in an affinity group that shares fundamental values can generate motivated cognition relating to policy-relevant facts (Cohen, 2003; Sherman & Cohen, 2006). Even among modestly partisan individuals, shared ideological or cultural commitments are likely to be intertwined with membership in communities of one sort or another that furnish those individuals with important forms of support—emotional and psychic as well as material (Green, Palmquist & Schikler, 2002). If a proposition about some policy-relevant fact comes to be commonly associated with membership in such a group, the prospect that one might form a contrary position can threaten one’s standing within it. Thus, as a form of “identity self-defense,” individuals are unconsciously motivated to resist empirical assertions—that the death penalty deters or does not deter murder, for example (Lord, Ross & Lepper, 1979), or that gun control reduces or does or does not reduce crime (Taber & Lodge, 2006)—if those assertions run contrary to the dominant belief within their groups (Cohen, Bastardi, Sherman, Hsu, McGoe, & Ross, 2007; Liu & Ditto, 2013; Munro & Ditto, 1997).

The third influence linked to such controversies is the association between *ideological or cultural values and cognitive-reasoning styles*. Refining the 1950s “authoritarian personality” theory of Adorno and his collaborators (1950), a substantial body of empirical study generated in the last decade has revived interest in, and compelled respectful scholarly engagement with, the hypothesis that right-wing ideology is a manifestation of settled intellectual traits such as dogmatism, aversion to complexity, and a craving for certainty or “closure” in argumentation. The cognitive style that comprises these dispositions, it is surmised, generates reflexive closed-mindedness toward empirical evidence hostile to the factual premises of policies that reflect ideologically conservative values or policy preferences (Jost, Glaser, Kruglanski & Sulloway, 2003; Jost, Nosek & Gosling, 2008; Feygina, Jost & Goldsmith, 2010).

While all of these positions are amply supported by empirical evidence, how they interact to generate polarization over empirical evidence relevant to societal risks and like facts has not been systematically explored (Jost, Hennes & Lavine, in press). Multiple alternative relationships are all plausible.

It would not be surprising, for example, to discover that the impact of heuristic-driven reasoning is the most decisive one. The predominance of System 1 reasoning among members of the general public, on this view, would account for the failure of democratic institutions to

reliably converge on the best available scientific evidence on issues like climate change. Dynamics of motivated cognition would in turn help to explain the ideological character of the resulting public controversy over such evidence. Many of the emotional associations that drive System 1 risk perceptions, it is posited, originate in (or are reinforced by) the sorts of affinity groups that share cultural or ideological commitments (Leiserowitz, 2005; Sunstein, 2007). Where the group-based associations that attach to putative risk sources (guns, say, or nuclear power plants) vary, then, we can expect to see systematic differences in risk perceptions across members of ideologically or culturally uniform groups (Weber & Stern, 2011; Lilienfeld, Ammirati, & Landfield, 2009; Sunstein, 2006b; Marx, Weber, & Orlove, Leiserowitz, Krantz, Roncoli, & Phillips, 2007; Westen, Blagov, Harenski, Kiltz, & Hamann, 2006). For expositional convenience, this account of how heuristic information processing, ideological predispositions, and motivated reasoning interact will be referred to as the “Bounded Rationality Position” (**BRP**).

An alternative position might see the reasoning-style correlates of right-wing ideology as the most consequential for disputes over decision-relevant science. Like BRP, this position would regard motivated cognition as a heuristic-driven form of reasoning. The mental dispositions that researchers have identified with conservative ideology—dogmatism, need for closure, aversion to complexity, and the like—are understood to indicate a disposition to rely predominantly on System 1 rather than more effortful System 2 forms of information processing (Stanovich, 2011, pp. 34-35). Accordingly, the impact of ideologically motivated cognition, even if not confined to conservatives, would be disproportionately associated with that ideology by virtue of the negative correlation between conservatism and the traits of open-mindedness and critical reflection that would otherwise check and counteract it (Jost, Hennes, Lavine, in press; Nam, Jost & van Bavel, 2013).

Because it predicts that motivated reasoning will be uneven across the ideological spectrum, this account can, for expositional convenience, be referred to as the “Ideological Asymmetry Position” (**IAP**). Relatively little experimental work specifically testing IAP exists at this point. It is mixed, with some scholars reporting results that suggest conservative subjects display greater resistance to engaging counter-attitudinal evidence than liberals do (Nam et al., 2013), but others finding that motivated reasoning can skew perceptions—including ones formed on the basis of brute sense impressions (Kahan, Hoffman, Evans, Rachlinski, & Braman, 2012)—symmetrically across groups of diverse cultural and political orientations (Crawford & Xhambazi in press; Crawford, 2012).

Finally, another position might treat identity-protective motivated reasoning as primary in significance. When individuals display identity-protective cognition, their processing of information will more reliably guide them to perceptions of fact that are congruent with their membership in ideologically or culturally defined affinity groups than to ones that reflect the best available scientific evidence (Kahan et al., 2011). Nevertheless, this form of information processing, when applied to the sorts of facts at issue in polarized policy disputes, will often make ordinary individuals better off, in terms of self-interest (Kahan, Peters, Wittlin, Slovic, Ouellette, Braman, & Mandel, 2012). Any mistake an individual makes about the science on, say, the reality or causes of climate change, the disposal of nuclear wastes, or the effectiveness of an assault-rifle ban in deterring mass shootings will not affect the level of risk for her or for any other person or thing she cares about: Whatever she, as a single individual, does and can do—as consumer, as voter, as participant in public discourse—will be too inconsequential to have an impact (Downs, 1957). But, insofar as competing positions on these issues have come to express membership in and loyalty to opposing social groups, a person’s formation of a belief out of keeping with the one that predominates in hers could mark her as untrustworthy or stupid, and thus compromise her relationships with others (Cohen, 2003). These consequences could substantially diminish her welfare—materially and psychologically (Sherman & Cohen, 2002; Akerlof & Kranton, 2000; Hillman, 2010).

If we imagine that socially adaptive pressures will favor reasoning styles that maximize this form of “expressive utility” (Gigerenzer, 2000), we might, on this account, expect the use of more effortful, System 2 forms of information processing to *magnify*, not mitigate, ideological differences. Individuals disposed to resort to heuristic-driven, System 1 cognitive processing should not have too much difficulty fitting in: Conformity to peer influences, receptivity to elite cues, and sensitivity to intuitions calibrated by the same will ordinarily guide them reliably to stances that cohere with and express their group commitments (Zaller, 1992; Gastil, Braman, Kahan & Slovic, 2011). But *if* individuals *are* adept at using more effortful, System 2 modes of information processing, then they ought to be even *better* at fitting their beliefs to their group identities. Their capacity to make sense of more complex forms of evidence (including quantitative data) will supply them with a special resource that they can use to fight off counterarguments or to identify what stance to take on technical issues more remote from ones that that figure in the most familiar and accessible public discussions (Chen, Duckworth & Chaiken, 1999). More importantly still, it will make them more likely to *understand* the significance of competing

claims, and related forms of evidence, for the status of their group, and thus be more likely to experience unconscious motivations to form identity-congruent assessments of them.

This account—which for convenience can be labeled the “Expressive Utility Position” (EUP)—*inverts* the relationship that BRP posits between motivated cognition and dual-process reasoning. Whereas BRP views ideological polarization as evidence of a deficit in System 2 reasoning capacities, EUP predicts that the reliable employment of more effortful, conscious information processing will *magnify* the polarizing effects of identity-protective cognition (Kahan, Peters et al. 2012).

EUP also is inconsistent with IAP. Both BRP and IAP assume motivated reasoning reflects a deficit in the capacity or disposition to engage in effortful information processing of the sort characteristic of System 2. EUP (like BRP) is agonistic on whether reliance on heuristic, System 1 reasoning dispositions will be correlated with ideological or other values. But because EUP asserts that the more effortful, conscious forms of reasoning characteristic of System 2 *magnify* identity-protective cognition, EUP does not see the correlations featured in IAP as implying that motivated reasoning should be disproportionately concentrated in conservatives.

3 Study: sample, design, and hypotheses

A study was designed to investigate how heuristic-driven information processing, the reasoning-style correlates of conservatism, and motivated cognition interact. The study included both an observational component, which measured the cognitive reasoning dispositions of subjects of diverse ideologies; and an experimental one, which assessed the interaction between cognitive-reasoning dispositions, subjects’ ideologies, and their display of ideologically motivated reasoning. The design of both components was crafted to pit hypotheses distinctive of BRP, IAP, and EUP against one another.

3.1 Sample

Subjects for the study consisted of a nationally diverse sample of 1750 U.S. adults. The subjects were recruited by YouGov, a firm that uses on-line sampling methods suited for academic, political, and commercial public opinion research. The sample was stratified to reflect demographic characteristics, including political outlooks and affiliations, representative of the United States general population. The sample was 54% female, and the average age of the subjects was 52 years. Seventy-six

percent of the subjects were white, and 11% African-American. Twenty-eight percent of the sample self-identified as Republican, 36% as Democrat, and 30% as independent. Twenty-five percent identified themselves as either “Liberal” or “very Liberal”: 37% as “Conservative” or “very Conservative”; and 29% as “Moderate.” The mean education level was “some college”; the mean annual income was \$40,000 to \$49,000. The study was administered in July 2012.

3.2 Observational component

a. Measures. Subjects furnished standard demographic data. Party self-identification (“dem_repub”) was measured with a seven-point item (“Strong Democrat, Democrat, Independent Lean Democrat, Independent, Independent Lean Republican, Republican, Strong Republican”). Political ideology (“libcon”) was measured with a five-point item (“Very liberal”; “Liberal”; “Moderate”; “Conservative”; “Very Conservative”).

Responses to these two items (standardized and summed (Smith, 2000)) formed a reliable aggregate scale ($\alpha = 0.82$). The scale was constructed so that its center was equivalent to a “neutral” political orientation. This was accomplished by centering the standardized scale components at their ordinal midpoints (“4” for dem_repub, and “3” for libcon) rather than their means and centering the composite scale formed by their sum at its midpoint as opposed to its mean. Labeled “Conserv_Repub,” the scale was centered at “0” to facilitate ease of interpretation, and oriented so that negative values denoted a disposition toward Democratic Party affiliation, and liberal ideology and positive values a disposition toward Republican Party affiliation and conservative ideology.

Subjects also completed the Cognitive Reflection Test (CRT). The CRT is a three-question test that is designed to measure the disposition to engage in the conscious and effortful form of information processing associated with System 2 as opposed to the heuristic-driven form associated with System 1 (Frederick, 2005). A performance-based measure, the CRT has been shown to be a strong predictor of cognitive biases associated with over-reliance on heuristics (Hoppe & Kusterer, 2011)—indeed, a stronger one than numerous self-report measures of critical reasoning (Toplak, West & Stanovich, 2011; Liberali, Reyna, Furlan & Pardo, 2011).

The CRT is a demanding test, and it is not unusual for a high proportion of a general population sample to answer none of the questions correctly (Weller, Dieckmann, Tusler, Mertz, Burns & Peters, 2012; Campitelli & Labollita, 2010). The mean score for subjects in this study was 0.65 ($SD = 0.95$).

Table 1: Cognitive Reflection Test. “% correct” indicates the percentage of the sample answering the indicated item correctly.

Item	% correct
WIDGETS If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?	26%
BATBALL A bat and a ball cost \$1.10 in total. The bat costs \$1.00 more than the ball. How much does the ball cost?	13%
LILYPAD In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?	25%

b. Hypotheses. As will be explained presently, results from the observational component of the study furnish maximum insight in conjunction with those of the experimental component. However, IAP suggests one fairly straightforward hypothesis relating to the observational study considered alone: that a “right-wing” outlook should be associated with a lower CRT score.

IAP is based on survey correlations between self-identifying as “Republican” or “conservative” and traits such as dogmatism, fear of complexity, and need for closure (Jost et al., 2003). Because these reasoning traits are opposed to reflection and related forms of critical thinking, one might expect a right-wing disposition to be negatively correlated with performance on the CRT. Indeed, researchers who study cognition routinely treat CRT scores as a performance-based alternative to or “behavioral” corroborator of the same self-report measures featured in research that identifies conservative ideology as distinctively hostile to reflective engagement with counter-attitudinal evidence (Stanovich, West & Toplak, 2011, p. 348 n.5; Pennycook Cheyne, Barr, & Koehler, 2013; Boschetti, Richer, Walker, Price, & Dutra, 2012; Iyer, Koleva, Graham, Ditto, & Haidt, 2012; Pennycook, Seli, Koehler, & Fugelsang, 2012).

Researchers investigating parallel claims about religiosity—that it is either a consequence or a cause of aversion to complexity, fear of uncertainty, and resistance to reflectively engaging with counter-attitudinal evidence—have reported finding that religiosity is negatively correlated with CRT (Pennycook et al., 2013; Shenhav, Rand & Greene, 2011; Pennycook Cheyne,

Seli, Koehler & Gugelsang, 2012; Gervais & Norenzayan, 2012). A finding that conservative ideology is negatively associated with CRT as well would thus help corroborate the literature on which IAP is based.

Only a modest amount of work exists on the relationship between CRT and political ideology, but it is consistent with the IAP hypothesis. Two studies report finding CRT scores to be slightly lower in self-identified conservatives than in self-identified liberals (Iyer et al., 2012; Pennycook et al., 2012).

Both of these studies, however, were based on non-representative samples. The subjects in the study reported in Iyer et al. (2012) were recruited from visitors to a web site that features research on the relationship between political outlooks and cognitive styles. As an incentive to participate, subjects were told they would be supplied with a permanently maintained moral personality “profile” that would enable them to compare their scores on various measures to those of other participants, past and future. One might expect subjects visiting such a site and responding to such an offer to overrepresent highly reflective individuals. Indeed, study subjects of all ideologies achieved remarkably high mean CRT scores (Iyer et al., 2012, Table 3)—ones that not only exceeded those observed in general population samples but that matched or exceeded those recorded among students at elite universities such as Carnegie Mellon, Princeton, and Harvard (Frederick, 2005, Table 1). Thus, one could reasonably question whether data from a sample this distinctive supports inferences about the relationship between cognitive style and political outlooks in the public at large.

The sample in Pennycook et al. (2012) consisted of members of Amazon.com’s “Mechanical Turk” workforce. Such samples, which are assembled without any recruitment or stratification procedures to assure representativeness, have been reported to be highly skewed toward liberal respondents (Richey & Taylor, 2012). The sample in Pennycook et al. (2012, p. 5) reflected such a skew.¹ It is at least possible that a sample drawn from this source, members of whom engage in myriad highly routinized tasks for an average wage of \$1.40 per hour (Jaquet, 2011), might underrepresent reflective conservatives. Researchers have also reported that many Mechanical Turk study subjects have been exposed to objective performance measures like those featured in CRT on multiple occasions (Chandler, Mueller, & Paolacci, 2013), an experience that might render their scores unreliable. Finally, there is reason to believe that Mechanical Turk workers routinely misrepresent their national-

¹Pennycook et al. (2012, p. 5) report that 53% of the subjects in their sample self-identified as liberal and 25% identified as conservative. Stratified national surveys suggest that approximately 20% of the general population self-identifies as liberal and 40% as conservative (Gallup, 2012).

ity: Researchers report that “substantial” numbers of Mechanical Turk workers recruited for studies open only to U.S. “workers” nevertheless participate in them through foreign internet service providers (Shapiro, Chandler & Mueller, 2013). For these reasons, one might also reasonably question whether studies based on Mechanical Turk workers support reliable inferences about cognitive style and ideology in the U.S. general population.

In sum, the negative correlations between CRT and conservatism reported in Iyer et al. (2012) and Pennycook et al. (2012) are definitely plausible and very much consistent with the reported correlations between conservatism and cognitive style in the scholarship that supports IAP. But it remains useful to explore the relationship between CRT and ideology in samples recruited and stratified to assure national representativeness. The absence of such a finding would be surprising and would complicate interpretation of the finding that conservatism is negatively associated with various subjective measures of heuristic information processing.

A finding that CRT scores correlate with conservative ideology in the general population would have inconclusive significance for BRP and EUP. BRP does not suggest any basis to expect an ideological asymmetry in the dynamics that result in political conflict over policy-consequential facts, but does not necessarily rule it out. EUP, in contrast, does assert that such dynamics should be symmetric. However, it does not identify the source of ideological conflict over fact with the predominance of heuristic-driven, System 1 forms of information processing.

3.3 Experimental component

a. Stimuli and measures. In the experimental component of the study, subjects reported their own perceptions of the *validity* of the CRT upon completion of it. They did so by indicating (on a six-point item) their level of agreement or disagreement with the statement “I think the word-problem test I just took [i.e., the CRT test] supplies good evidence of how reflective and open-minded someone is” (CRT_valid).²

Subjects responded to this item after being assigned to one of three experimental conditions. In the “control” condition, subjects were advised simply that “psychologists believe the questions you have just answered measure how reflective and open-minded someone is.” In the “skeptic-is-biased” condition, subjects were told in addition that “in one recent study, a researcher found that people who *accept evidence of climate change* tend to get more answers correct than those who *reject evidence of climate change*,” a “finding [that] would imply

that those who believe climate change is happening are more open-minded than those who are skeptical that climate change is happening.” In contrast, in the “believer-is-biased” condition, subjects were advised that “in one recent study, a researcher found that *people who reject evidence of climate change* tend to get more answers correct than those who *accept evidence of climate change*,” a “finding [that] would imply that those who are skeptical climate change is happening are more open-minded than those who believe that climate change is happening.”

b. Hypotheses. Because open-mindedness is a positive characteristic, individuals presumably have an emotional stake in believing that people who subscribe to their own ideology are more open-minded and reflective, or at least not less, than those who subscribe to an opposing one. Here subjects were presented evidence relevant to that issue: the respective performance on an “open-mindedness test” of people who either *accepted* or *rejected* a position strongly associated with membership in the subjects’ own ideological groups. The subjects were in fact supplied relatively sparse information about the validity of CRT: only the representation that psychologists view it as valid, plus the subjects’ own experience in having just taken it. The prospect that they would engage in motivated reasoning, though, supplied a basis for believing they would treat that evidence as establishing the test’s validity conditional on whether doing so would gratify or disappoint their stake in believing that members of their ideological group were more open-minded than members of an opposing one (Cohen, 2003).

At a very concrete level, this design can be viewed as a model of how ordinary people process information about studies of the ideological correlates of cognitive reasoning styles (e.g., Mooney 2012). Such readers will have little to go on besides scholars’ or commentators’ representations that the tests of open-mindedness featured in such studies are valid. If such readers are inclined to credit such representations only when the studies’ results gratify their interest in forming and maintaining the belief that people who share their own ideology are more open-minded, then their assessments of that research will itself be biased by ideologically motivated reasoning.

But, abstracting from the particulars, the study design can be also thought of as modeling how ideologically motivated reasoning might bias considerations of empirical evidence generally. On policy debates over matters as diverse as climate change, gun control, the death penalty, and fiscal policy, ordinary citizens are presented with evidence, often in the form of second-hand characterizations of the findings of “scientific studies”. If their assessments of the validity of such evidence is conditional on its fit with their ideological predispositions, then citizens will not converge on the best available evidence but rather will

²The wording of the instructions supplied in each experimental condition is reproduced in the Appendix.

polarize on policy-relevant facts (Lord, Ross & Lepper 1979; Kahan, Jenkins-Smith & Braman, 2011).

BRP, IAP, and EUP all predict motivated reasoning in this study. They generate different hypotheses, however, about the form that such reasoning will take.

IAP predicts that the observed motivated reasoning should be stronger in conservative subjects. Reflecting their disposition toward dogmatism and closed-mindedness, relatively right-wing subjects should be more inclined to see CRT as a valid test in the believer-is-biased condition than in the skeptic-is-biased condition. Scholars who have presented evidence of the cognitive-style correlates of ideology depict more liberal or left-wing individuals as more open-minded and reflective and thus less subject to motivated cognition. Accordingly, in the study, this work would predict that relatively left-wing subjects' assessments of the validity of CRT should be comparable in both the skeptics-biased and believer-is-biased condition. This finding would be a particularly compelling affirmation of IAP, moreover, in conjunction with a finding in the observational component of the study that right-wing dispositions correlate with a lower CRT score.

BRP understands motivated reasoning to be an artifact of the disposition to use low-level, System 1 information processing. Unlike IAP, BRP does not (or does not necessarily) predict that motivated reasoning will be ideologically asymmetric. But BRP does predict that it will be higher among subjects who score relatively low in CRT than it will be in those who score relatively high. On this account, any ideological polarization observed in the skeptic-is-biased and believer-is-biased conditions should dissipate as CRT increases.

EUP supports predictions strikingly different from those of either IAP or BRP. Not only does EUP fail to predict ideological asymmetry in motivated reasoning. It predicts that the tendency of both right-wing and left-wing subjects to form ideologically congruent assessments of the "validity" of CRT will *increase* with their CRT scores. *All* subjects, EUP posits, will experience psychological pressure to fit their perceptions of the CRT's validity to their interest in believing that members of their group are more open-minded about evidence on climate change. Nevertheless, their *success* in achieving this end will depend on their comprehension of the questions being posed and their appreciation of what differing answers signify about the open-mindedness of individuals who share their ideologies. Because subjects who are high in CRT assess information more methodically and reflectively, they are less likely to *misunderstand* the question, and thus less likely to *avoid* the unconscious pressure to fit their assessments of the evidence at hand to the conclusion that fits their expressive interests.

Table 2: Ordered logistic regression analysis of CRT scores. $N = 1750$. Outcome variable is CRT score. Predictor estimates are ordered-logit coefficients with z -test statistic indicated parenthetically. Bolded typeface indicates predictor coefficient, model $LR\chi^2$, or incremental change in model $LR\chi^2$ is significant at $p < 0.05$.

	Model 1	Model 2
Conserv_Repub	0.07 (1.45)	0.05 (0.97)
male		0.68 (6.60)
white		0.72 (5.41)
education		0.31 (8.39)
income		0.06 (3.32)
religiosity		-0.15 (-3.63)
$LR\chi^2$	2.1 (1 df)	261.9 (6 df)
$\Delta LR\chi^2$		259.8 (5 df)

3.4 Statistical power and missing data

Certain of the competing hypotheses associated with BRP, IAP, and EUP turned on whether or not an observational correlation or experimental effect would be observed. The strength of inferences drawn from "null" findings depends heavily on statistical power. The large size of the sample furnished adequate power to detect even small effect sizes (e.g., $r = 0.10$) with a probability well over 0.80 at $p \leq .05$ (Cohen, 1988). As a result, findings of nonsignificance could be equated with lack of effect with low risk of Type II error (Streiner, 2003). To assure full exploitation of the power associated with the large sample size, missing data were replaced by multiple imputation (King, Honaker, Joseph & Scheve, 2001; Rubin, 2004).³

4 Results

4.1 Observational component

Subjects' CRT scores were regressed (Table 2) against political orientations and other individual characteristics known to be associated with CRT performance, including gender, race, education, income, and religiosity (which was measured with a composite scale that aggregated self-reported church attendance, frequency of prayer, and perceived importance of God, $\alpha = 0.82$). The coefficient for Conserv_Repub was positive—indicating that CRT scores increase as subjects become progressively more

³The experiment was first analyzed without imputed data, using listwise deletion for observations containing missing data (Kahan 2012a). The results did not differ materially from those reported.

right-wing in their orientation—but nonsignificant both when treated as a zero-order predictor ($b = 0.07, p = 0.15$) and when included in a model that controlled for other characteristics ($b = 0.05, p = 0.33$). The other characteristics, in contrast, all showed significant, independent effects on CRT scores (Table 2).

The Conserv_Repub scale is a more reliable measure of the subjects' ideological dispositions than either of its components alone, and thus supports more reliable inferences about the relationship between political outlooks and CRT scores (Gliem & Gliem, 2003). Nevertheless, to promote comparability of the results reported in this study and ones that use only a single political orientation measure, the relationships between subjects' scores and aspects of each component of Conserv_Repub were also examined.

The correlation with self-reported liberal-conservative ideology (libcon) was negative—indicating a decline in score as conservatism increases. The size of the effect, however, was only trivially different from zero and statistically nonsignificant ($r_s = -0.02, p = 0.45$). When the subjects who self-identified as “Moderates” were excluded, and the remainder split into groups who identified as either “Very liberal” or “Liberal,” on the one hand, or “Very conservative” or “Conservative,” on the other, there was a slightly larger but still statistically nonsignificant difference ($\Delta M = 0.09, t = 1.41, p = 0.16$) in the mean scores of “liberals” ($M = 0.75, SEM = 0.05$) and “conservatives” ($M = 0.67, SEM = 0.04$).

The correlation with self-reported party affiliation ($r_s = 0.08, p < 0.01$) was positive and significant, indicating that CRT scores *increased* with the strength of subjects' identification with the Republican party on dem_repub, the 7-point measure of partisan identification. When subjects who self-identified as either “Independents” or “Independents” who “lean” either Democrat or Republican were removed, and the remainder split into ones who identified as either “Democrat” or “Republican,” the difference in the mean score of “Republicans” ($M = 0.66, SEM = 0.04$) and “Democrats” ($M = 0.52, SEM = 0.03$) was also statistically significant ($\Delta M = 0.14, t = 2.48, p < 0.05$). The gap between “Republicans” ($M = 0.71, SEM = 0.04$) and “Democrats” ($M = 0.59, SEM = 0.03$) remained statistically significant ($\Delta M = 0.13, t = 2.54, p < 0.05$) when the scores of subjects who identify as “Independents” but “lean” toward one or the other of the major parties were treated as partisans (Petrocik, 2009).

Based on work relating personality-trait and self-reported measures of cognitive style to ideology, IAP predicted that CRT scores would be *negatively* correlated with right-wing ideology. This hypothesis was not confirmed.

4.2 Experimental component

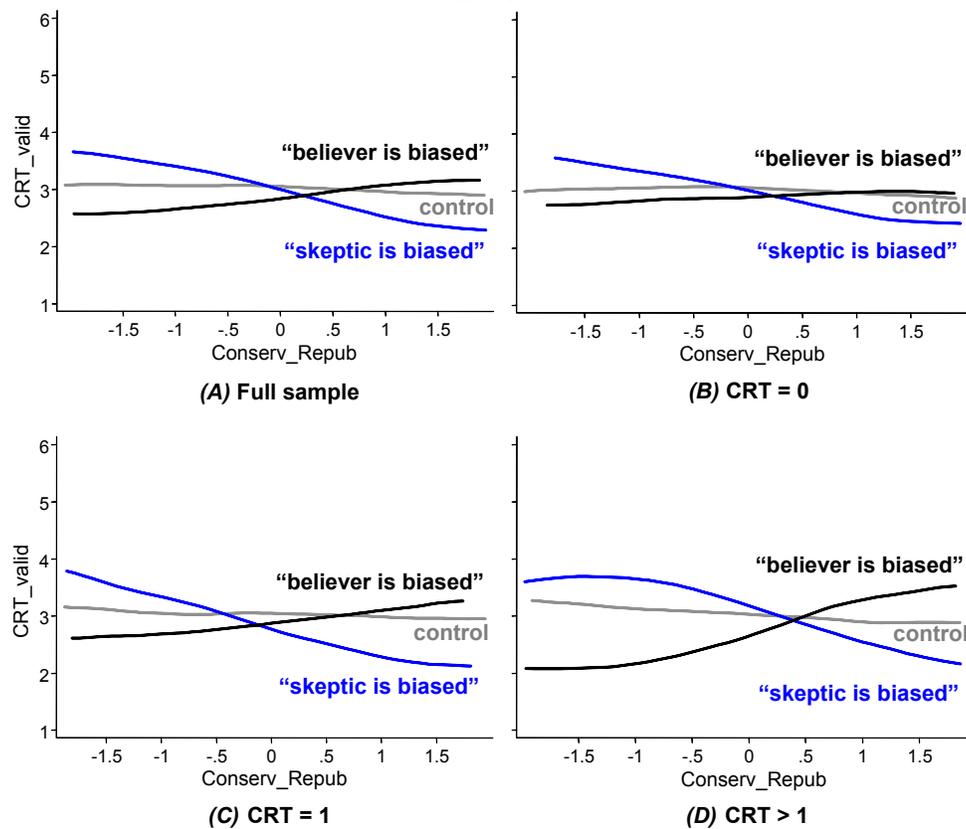
a. Ideologically motivated reasoning generally. Consistent with BRP, IAP, and EUP, subjects displayed ideologically motivated reasoning in their assessments of the validity of the CRT (Figure 1, Panel (A)). In the control condition, right-wing and left-wing subjects (identified by their scores relative to the mean on Conserv_Repub), formed comparable judgments of the validity of the CRT as a measure of how “reflective and open-minded” people are ($M = 3.0, SEM = 0.2$, for both; $\Delta M = 0.08, t = 0.59, p = 0.56$). Those assigned to the “skeptic-is-biased” condition, in contrast, divided on ideological lines: right-wing subjects were *less* inclined to treat the CRT as valid ($M = 2.4, SEM = 0.2$), and left-wing ones *more* inclined to do so ($M = 3.5, SEM = 0.2$), when told that climate-change skeptics generally score lower on the test. This effect was reversed in the “believer-is-biased” condition: told that climate skeptics generally score higher on the test, relatively right-wing subjects were now *more* inclined ($M = 3.1, SEM = 0.2$), and relatively left-wing ones *less*, to judge the CRT to be valid ($M = 2.6, SEM = 0.2$).

b. Symmetry. Figure 1 plots subject responses using a locally weighted regression smoother. This technique, which traces the profile of the data in detail without making any particular assumptions about their distribution, is an appropriate device both for graphical summary assessments of the raw data and for determining the appropriate form (linear or curvilinear) of the statistical model to apply in analyzing them (Jacoby, 2000).

Visual inspection of Figure 1 does not suggest that the observed motivated-reasoning effect increased as subjects became more right-wing. Indeed, liberal Democratic subjects were inclined to discount the validity of the CRT in the “believer-is-biased” condition relative to the “skeptic-is-biased” condition ($\Delta M = 0.86, t = 6.37, p < 0.01$) by an amount slightly but nonsignificantly larger ($\Delta M = 0.11, t = 0.57, p = 0.57$) than the amount by which conservative Republican ones were inclined to discount it in “skeptic-is-biased” condition relative to the “believer-is-biased” one ($\Delta M = 0.75, t = 5.39, p < 0.01$).⁴

⁴To perform a more exacting test of whether the motivated-reasoning effect observed in the experiment was symmetric or asymmetric with respect to subjects' ideological dispositions, a quadratic regression model was fit to the data. Formed by adding to Model 1 of Table 3 terms that squared the value of the subjects' scores on Conserv_Repub, the resulting model reflected the assumption that the motivated-reasoning elicited by the experimental treatment would be stronger as subjects' outlooks approached one extreme of the disposition measured by Conserv_Repub (either the “right-” or the “left-wing” end) than it would be as that disposition approached the opposite extreme. The added terms had coefficients that were trivially different from zero and nonsignificant, and the addition of them did not result in a significant improvement in fit (Kahan 2012a).

Figure 1: Graphical summary of experimental results. Locally weighted regression, applied separately for each experimental condition, plots the relationship between the political outlooks and responses to CRT_valid. Panel (A) plots responses for all study subjects. Panels (B), (C), and (D) plot results only for study subjects with CRT scores of 0, 1, and 2 or 3, respectively. Conserv_Repub, the scale used to measure the subjects' political outlooks, is centered at the point corresponding to a subject who self-identified as a "moderate" on the 5-point liberal-conservative ideology scale and as an "Independent" (who declined when "pushed" to "lean" toward either party) on the 7-point partisan-self-identification scale. Individuals who identified themselves as either "liberal" and "Democrat" or as "conservative" and "Republican" would have scored -0.95 and 0.95 on Conserv_Repub, respectively. The extreme values on the scale—-1.65 and 1.65, respectively—correspond to the scores of individuals who identified themselves as "Very liberal" and "Strong Democrat" and "Very conservative" and "Strong Republican," respectively.



c. Interaction with CRT. The final experimental hypotheses were BRP's prediction that ideological polarization should abate as individuals become more disposed to use System 2 processing and EUP's prediction that motivated reasoning would instead increase. As is evident in Panels (B)–(D) of Figure 1, the tendency of subjects (varying in political dispositions) to form ideologically congenial assessments of the validity of the Cognitive Reflection Test became progressively *more pronounced* as subjects' CRT scores increased. The effect appears most dramatic in the "believer-is-biased" condition.

To confirm and test the statistical significance of this effect, a regression model reflecting the interaction of CRT and subjects' ideological dispositions was fit to the data. The results are reported in Table 3, Model

2. This model fit the data significantly better than one lacking terms reflecting the hypothesized interaction ($\Delta LR \chi^2 = 12.64(6), p = 0.01$). The coefficient for the interaction term added to assess the relationship between CRT scores and assignment to the "believer-is-biased" condition (Con_Rep_x_zCRT_x_believer), was positive and significant ($b = 0.30, p < 0.01$). Thus, in the "believer-is-biased" condition, subjects of opposing ideologies polarized to a greater extent as their CRT scores increased. The coefficient for the interaction term added to assess the relationship between CRT scores and assignment to the "skeptical-is-biased" condition (Con_Rep_x_zCRT_x_skeptic) was only trivially different from zero and nonsignificant ($b = -0.03, p = 0.76$). Thus, in the "skeptical-is-biased" condition, the de-

Table 3: Ordered logistic regression analysis of experimental component. $N = 1750$. Outcome variable is CRT_valid. Predictor estimates are ordered-logit coefficients with z -test statistic indicated parenthetically. Bolded typeface indicates predictor coefficient, model $LR\chi^2$, or incremental change in model $LR\chi^2$ is significant at $p < 0.05$. “Skeptic-is-biased” and “Believer-is-biased” are dummy variables that reflect the experimental assignment (unassigned = 0; assigned = 1). CRT score (“zCRT”) and Conserv_Repub are both centered at 0 to promote ease of interpretation.

	Model 1	Model 2
Conserv_Repub	-0.12 (-1.60)	-0.12 (-1.58)
Skeptic-is-biased	-0.02 (-0.29)	-0.03 (-0.27)
Believer-is-biased	-0.18 (-1.74)	-0.17 (-1.63)
Con_Rep_x_skeptic	-0.50 (-4.63)	-0.50 (-4.62)
Con_Rep_x_believer	0.38 (3.59)	0.37 (3.47)
zCRT		0.04 (0.53)
C_R_x_zcrt		-0.05 (-0.76)
zCRT_x_skeptic		-0.01 (-0.12)
zCRT_x_believer		-0.07 (-0.65)
Con_Rep_x_zCRT_x_skeptic		-0.03 (-0.31)
Con_Rep_x_zCRT_x_believer		0.30 (2.95)
$LR\chi^2$	89.96 (5 df)	102.60 (11 df)
$\Delta LR\chi^2$		12.64 (6 df)

gree of ideological polarization did not meaningfully vary in relation to subjects’ CRT scores.

Graphic illustration enables practical assessment of this interaction effect. Figure 2 plots the predicted probability that subjects of opposing political outlooks with either “low” or “high” in CRT scores would agree (either slightly, moderately, or strongly) that the CRT is a valid measure of open-mindedness in each of the experimental conditions. The estimates were formed using regression Model 2 in Table 3. For “Liberal Democrat” and “Conservative Republican,” the value assigned to Conserv_Repub was set at the level a subject would have scored had she selected either “liberal” and “Democrat” or “conservative” and “Republican” on the 5-point liberal-conservative ideology and 7-point partisan self-identification items, respectively. For “low CRT,” the value assigned to the CRT predictor was 0 correct, a score that would place those individuals in the bottom 60% within the sample. For “high CRT,” the predictor was set at 2 correct, a score matched or exceeded by 20% of the sample.

As can be seen, the impact of CRT performance on motivated reasoning is concentrated in the “believer-is-biased” condition. The difference in predicted probability of judging the CRT to be “valid” in that condition is 28 percentage points ($\pm 19\%$, $CL = 0.95$) greater for high-CRT partisans than it is for low-CRT partisans, whose likelihoods of judging the CRT to be “valid” do not meaningfully differ in that condition. Both high-scoring and low-scoring partisans are highly likely to disagree about the validity of the CRT in the “skeptic-is-biased” condition. The likelihood that high-scoring ones will disagree is higher than is the likelihood that low-scoring ones in that condition will, but the difference is modest and not significant at 0.95 level of confidence (8%, $\pm 11\%$).

These results are more consistent with EUP than BRP. Whereas the former predicted that motivated reasoning would abate as CRT increases, the latter predicted that it would not but would instead intensify. Such intensification did occur, but only in one of the experimental conditions.

5 Discussion

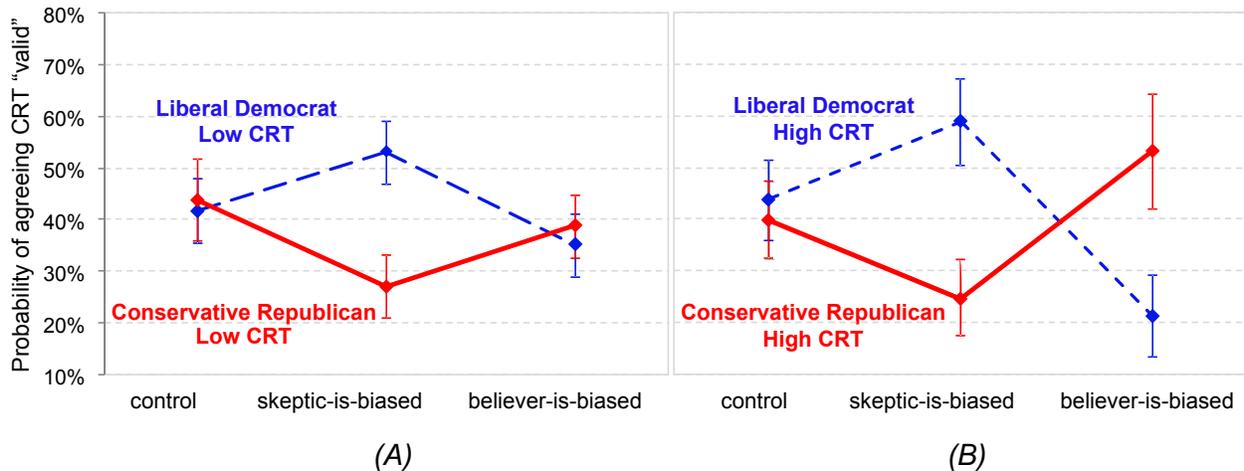
5.1 Summary of results

The motivation (consciously, at least) for this study was to assess three dynamics understood to be relevant to political contestation over facts that turn on scientific or related forms of empirical evidence: heuristic-driven reasoning, the cognitive-style correlates of political conservatism, and motivated cognition. For that purpose, the study measured the cognitive reflection of individuals of diverse ideologies and also tested how willing they were to entertain evidence that those who disagreed with their ideological group’s position on a charged issue—climate change—were themselves open-minded and reflective.

The study considered three conjectures about how heuristic-driven reasoning, ideological predispositions, and motivated reasoning relate to one another. The first—the “Bounded Rationality Position” or BRP—asserts that public conflict over risk and other policy relevant facts is a consequence of the predominance of heuristic-driven, System 1 information processing, which interferes with the public’s understanding of complicated evidence and motivates it to assess evidence consistently with cultural or ideological predispositions (e.g., Marx et al. 2007; Weber & Stern, 2011).

The study did not support BRP. On the contrary, the experimental component of the study demonstrated that the disposition to engage in conscious and effortful System 2 information processing—as measured by the Cognitive Reflection Test (CRT)—actually *magnifies* the impact of motivated reasoning.

Figure 2: Interaction between CRT and experimental treatment. Derived via Monte Carlo simulation (King, Tomz & Wittenberg, 2000) from regression model reported in Table 3, Model 2. Point estimates indicate predicted probability of agreeing either “slightly,” “moderately,” or “strongly” with CRT_valid. The predictor values for “Liberal Democrat” and “Conservative” Republican are -0.95 and +0.95 respectively on Conserv_Repub. The predictor values for “low” and “high CRT” are 0 and “2,” respectively. CIs reflect 0.95 level of confidence.



The study results were also inconsistent with the “Ideological Asymmetry Position” or IAP. IAP attributes public conflict over policy-relevant facts to an affinity between conservative ideology and traits such as dogmatism and aversion to complexity, which fuel the motivated rejection of evidence incompatible with conservative policy aims (Jost et al., 2003).

The study findings pose two distinct challenges to IAP. First, the study found no meaningful correlation between right-wing ideology and CRT performance, an objective measure of reflection that has been shown to be one of the strongest predictors of conscious, effortful information processing. The CRT is routinely treated as a “stronger” performance-based alternative to (Pennycook et al. 2013) or “behavioral” corroborator of (Iyer et al., 2012) Need for Cognition, Need for Closure, dogmatism, fear of complexity and like measures (Stanovich, West & Toplak, 2011; Boschetti et al., 2012), which are the basis of the research that finds conservatives to be distinctively resistant to counter-attitudinal evidence. The CRT has been used to test and generate evidence supportive of the parallel claim that religiosity is associated with resistance to scientific and other forms of empirical evidence. It is thus puzzling that CRT did *not* correlate negatively with conservatism (and indeed correlated *positively* with self-identification with the Republican Party) in the large nationally representative sample used in this study. This result is at odds with those based on nonrepresentative samples.

Second, this study used an experimental design and a statistical-testing strategy specifically fitted to evaluating

the assumption that the force of ideological motivated reasoning varies in intensity across the right-left political spectrum. It found that, when assessing evidence of the other group’s propensity to consider evidence in an open-minded and reflective way, liberals and conservatives were *uniformly* prone to ideologically motivated reasoning. This result reinforces those observed in other studies that have reported finding that motivated reasoning is symmetric across groups of opposing political and cultural outlooks.⁵

The study also examined one other account of political polarization over risk and related policy-relevant facts: the “Expressive Utility Position” or EUP. The study results were largely in accord with this view.

EUP alone predicted both that ideologically motivated reasoning would be symmetric and that it would be amplified by higher CRT scores. Those hypotheses reflect a theory that sees ideologically motivated cognition not as a

⁵In order for this result to support the inference that motivated reasoning is symmetric with respect to ideology in general, it must be assumed that “liberal Democrats” and “conservative Republicans” have a comparable identity-protective stake in their positions on the particular issue on which subjects were exposed to counter-attitudinal evidence in this study. If, say, liberal Democrats are more intensely committed to being perceived as “open-minded” and “reflective” on climate change than conservative Republicans, then one might expect the former to feel more threatened by counter-attitudinal evidence and hence more pressured to dismiss such evidence in a reflexive or dogmatic fashion. The design of the study cannot rule this possibility out. But while such an explanation would “fit” the results of the study, it would not be particularly supportive of the “asymmetry thesis” premise (Jost et al., 2003; Nam et al., 2013) that conservatives are peculiarly vulnerable to ideologically motivated reasoning.

reasoning deficiency but as a reasoning adaptation suited to promoting the interest that individuals have in conveying their membership in and loyalty to affinity groups central to their personal wellbeing. Because individuals make use of this form of information-processing to protect their stake in all manner of groups—including ones not connected to politics (Sherman & Cohen, 2006; Hastorf & Cantril, 1954)—there is no reason to expect it to be more pronounced among people who subscribe to any particular ideology. In addition, because this dynamic reliably guides individuals to assign information the significance that advances their personal ends (albeit not their collective ones (Kahan, 2012b)), there is good reason to expect it to be used with even greater precision and accuracy by individuals disposed to engage in conscious, effortful forms of information processing.

The only discrepancy between the study results and EUP was the limited scope of the interaction between cognitive reflection and motivated reasoning. Higher CRT scores meaningfully amplified motivated reasoning in only one of the two experimental conditions that presented evidence that was expected to polarize (and did polarize) subjects of opposing political outlooks.

While not hypothesized, this result is not incompatible with EUP. The charge that “climate-change skeptics” are “closed minded” and “biased” is likely more familiar to people than the charge that “climate-change believers” are. The wording of the information furnished to subjects was in fact fairly dense. If subjects low in CRT had difficulty with it or were reluctant to expend the mental effort to parse it, they would have been *more* likely to *misunderstand* it when it conveyed the less familiar claim (“believers are closed minded”) than when it conveyed the more familiar one (“skeptics are closed minded”). Subjects with higher CRT scores were more likely to grasp the surprising meaning conveyed by the instruction in the “believer-is-biased” condition, making them more prone than low-scoring ones in that condition to form an appraisal of the test’s validity that conformed to their ideological predispositions.

5.2 Implications for ongoing study of dual-process and motivated reasoning

The status of motivated reasoning within dual process reasoning theories has not been studied extensively by social psychologists. Many commentators have assumed—not implausibly—that ideologically motivated cognition is a manifestation of unconscious, heuristic-driven reasoning processes amenable to being overridden by dispositions that promote reflection and critical engagement with counter-attitudinal evidence (e.g., Lilienfeld et al.

2009; Sunstein, 20006b; Westen et al., 2006). The results of this study cast doubt on this claim.

It should be stressed, however, that this result is *not* in tension with dual-process reasoning theories generally, but only with a particular surmise about how a particular cognitive dynamic should be assimilated to such theories. Indeed, in work that actually predates the adaptation of the now-familiar “System 1/System 2” framework, at least some dual-process theorists took the position that motivated reasoning should be expected to characterize higher-level, systematic forms of cognition as well, particularly when the motivated use of conscious and effortful processing could be expected to advance an agent’s ends in maintaining his or her connection to an identity-defining group (Cohen, 2003; Chen & Chaiken, 1999; Chaiken & Maheswaran, 1994; Giner-Sorrolla & Chaiken, 1997). The current study, by generating evidence that the disposition to engage in effortful information processing can amplify motivated reasoning, is more consistent with the latter position.

Indeed, these findings informed the “expressive utility position” tested in the study. That same hypothesis, moreover, figured in a previous observational study, which found that cultural polarization over climate-change and nuclear-power risks are greatest among individuals who are higher in scientific literacy and in numeracy, a technical-reasoning measure of which CRT is a subcomponent (Kahan, Peters et al. 2012). The experimental results of the present study help corroborate the inference that the correlations reported in that earlier study are properly attributed to the power of motivated cognition to penetrate the forms of information processing associated with Kahneman’s “System 2” form of reasoning.

Of course, the findings of this single study do not conclusively demonstrate that the disposition to engage in reflective rather than heuristic-information processing invariably magnifies ideologically motivated reasoning. Empirical studies, when valid, merely supply more evidence to believe or disbelieve a hypothesis, the truth of which must be assessed on the basis of all the valid evidence at hand and thereafter reassessed on the basis of any evidence generated by future valid studies (Popper, 1959).

Specific to this particular study, there are many reasons not to consider the issue of ideologically motivated reasoning and reflective information-processing to be “closed”. The most important of these is continuing debate over the adequacy of existing measures of reflective information-processing and critical-thinking dispositions generally. One issue concerns the relative validity of self-reporting measures (such as “Need for Cognition” and “Need for Closure”), on the one hand, and objective measures such as the CRT, on the other.

Another concern is the strength of CRT relative to alternative objective measures. Because CRT is such a demanding test—because it is not uncommon, in a general population sample, for over a third of the sample to get *zero* answers correct, and for less than 10% to answer all three questions correctly—CRT is of limited value in explaining variance among a large portion of the population. Numeracy is superior to CRT in this respect, and is a stronger predictor of vulnerability to cognitive biases, likely for this reason (Liberali et al., 2011; Weller et al., 2012). But as indicated, numeracy too has been found to predict greater, not diminished, political polarization over risks like the ones associated with climate change and nuclear power (Kahan, Peters et al., 2012).

Exactly what both CRT and numeracy measure, however, is also contested (Liberali et al., 2011). In particular, whether either measures critical reflection directly or instead only indirectly—as a correlate of a more general proficiency in mathematical computation or even a general form of intellectual capacity—continues to be debated. Some researchers have concluded that CRT is diagnostic of all manner of critical thinking (Toplak, West & Stanovich, 2011), including the motivation to re-examine existing beliefs (Campitelli & Labollita, 2010; Stanovich, West & Toplak, 2011) associated with the Actively Open-minded Thinking construct (AOT; Baron, 2008) or reflection/impulsivity (Baron, Badgio & Gaskins, 1986). But whether CRT indeed measures willingness to revise strongly held beliefs, or does so as well as a measure specifically geared toward AOT, is not resolved. Necessarily unresolved, too, then, is whether a study of motivated reasoning that investigated its interaction with a suitable AOT scale (e.g., Haran, Ritov & Mellers, 2013) would find that the form of critical thinking that scale measures likewise magnifies ideologically motivated reasoning in the manner that CRT, numeracy, science literacy (Kahan, Peters et al., 2012), and political knowledge (Arceneaux & Johnson, 2013; Taber & Lodge, 2006) all do or instead diminishes it (Baron, 1995).

It thus makes sense to continue intensive study of the relationship between ideological polarization and information processing using a variety of measures, a strategy that recognizes the role that convergent validity always plays in insuring against the necessary imperfection of any single measure or method in the social sciences. Indeed, if a variety of measures and methods *do* converge on the conclusion that ideologically motivated reasoning is impervious to the habits of mind most strongly associated with valid, evidence-based inference, such a program of study is the one most likely to broaden insight into how the conditions that generate an influence this inimical to reason might be counteracted (Fernbach, Rogers, Fox & Sloman, 2013; Lavine, Johnston & Steenbergen, 2012).

5.3 Implications for counteracting ideologically motivated reasoning

The goal of empirically investigating the sources of political conflict over risk and other policy-consequential facts is not merely to explain this phenomenon but also to aid in discovery of devices for mitigating it. The study described in this paper makes a contribution to that end as well.

It does this primarily by helping to inform hypotheses about how such dynamics might be combated. Many scholars have suggested “debiasing” strategies aimed at correcting the distorting effect of System 1 reasoning on public perceptions of risk (Lilienfeld et al., 2009; Jolls & Sunstein, 2006). Because such distortions are real—and substantially interfere with human wellbeing in myriad domains—pursuit of System 1 debiasing techniques is unquestionably important. Nevertheless, if, as the present study implies, ideologically motivated cognition is *not* a consequence of an over-reliance on heuristic reasoning, then System 1 debiasing strategies should not be expected to abate polarization over climate change, nuclear power, gun control, the HPV vaccine or like issues (Kahan, Slovic, Braman & Gastil, 2006).

What is needed instead are interventions that remove the *expressive incentives* individuals face to form perceptions of risk and related facts on grounds unconnected to the truth of such beliefs (Lessig, 1995). Extending the analysis of previous papers, this one has suggested that ideologically motivated reasoning is in fact *expressively rational* at the individual level, because it conveys individuals’ membership in and loyalty to groups on whom they depend for various forms of support, emotional, material, and otherwise (Hillman, 2010; Akerlof & Kranton, 2000).

This account, however, presupposes that beliefs on risks and related facts bear *social meanings*—that they are, in fact, generally understood (tacitly, at least) to convey that the individuals who espouse them are committed to one group *rather than* another (Cohen, 2003). Not all risks and policy-relevant facts have this quality; indeed, relatively few do, and on the vast run of ones that do not (e.g., that pasteurization removes infectious agents from milk; that fluoridation of water fights tooth decay; that privatization of the air-traffic control system is inimical to air safety), we do not observe significant degrees of ideological or cultural polarization.

There is little reason to believe, moreover, that the meanings of highly contested facts are unsusceptible of revision in a manner that would disconnect particular positions on them from membership in identity-defining groups. One can understand the historical shift in public opinion toward the risks posed by cigarettes (including third-party ones from passive smoke exposure or from the

societal expenditures necessary to treat individuals with lung cancer) as having been mediated by informational campaigns aimed at altering the positive meanings that dismissing evidence of the health hazards of smoking expressed in certain subcommunities (United States Public Health Service, 2000; Gusfield 1993).

The expressive account of ideological polarization, then, underscores the value of forming and testing hypotheses about how to regulate the social meaning of risks and related policy-relevant facts. Indeed, research focusing on forecasting techniques for identifying technologies vulnerable to polarizing meanings, on governmental processes for protecting the “science communication environment” from influences that cause such meanings to take hold, and on framing and other strategies for cleaning up that environment once it has been contaminated with polarizing meanings (Kahan, 2012b), is already well underway (Corner, Whitmarsh & Xenias, 2012; Druckman & Bolsen, 2012, 2011, Nisbet & Scheufele, 2009).

5.4 Conclusion: The tragedy of the science communications commons

What might be characterized as the “expressive rationality” of ideologically motivated reasoning (Kahan, Peters et al., 2012) is intrinsic to a collective action problem (Lessig, 1995). When societal risks become suffused with antagonistic social meanings, it is (often if not always, and with respect to many if not all issues) *individually rational* for ordinary members of the public to attend to information in a manner that reliably connects them to the positions that predominate in their identity-defining groups. Nevertheless, if ideologically diverse individuals all follow this strategy simultaneously, they will be *collectively worse off*, since under these conditions, democratic institutions are less likely to converge, or to converge as rapidly as they otherwise would, on policies that reflect the best available evidence on how to protect everyone from harm. But because what any ordinary individual believes about policy will not make a difference, the *collective irrationality* of ideologically motivated reasoning does not by itself create any reliable pressure or mechanism to induce individuals to process information in a different, and morally and politically superior, way.

Overcoming ideological polarization over societal risks and related facts thus demands collective action specifically geared at dissolving this “tragedy of the science communications commons” (following Hardin, 1968). Supplying the knowledge needed to guide such action is a contribution that decision science is uniquely poised to make.

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Appendix. Experimental stimuli

A. RANDOMLY ASSIGN to condition 1 or 2 or 3.

1. Control condition

Psychologists believe the questions you have just answered measure how reflective and open-minded someone is.

2. Skeptic-is-biased condition

Psychologists believe the questions you have just answered measure how reflective and open-minded someone is.

In one recent study, a researcher found that people who accept evidence of climate change tend to get more answers correct than those who reject evidence of climate change. If the test is a valid way to measure open-mindedness, that finding would imply that those who believe climate change is happening are more open-minded than those who are skeptical that climate change is happening.

3. Believer-is-biased condition

Psychologists believe the questions you have just answered measure how reflective and open-minded someone is.

In one recent study, a researcher found that people who reject evidence of climate change tend to get more answers correct than those who accept evidence of climate change. If the test is a valid way to measure open-mindedness, that finding would imply that those who are skeptical that climate change is happening are more open-minded than those who believe climate change is happening.

B. ALL CONDITIONS CRT_valid

How strongly do you agree or disagree with this statement? [strongly Disagree, moderately disagree, slightly disagree, slightly agree, moderately agree, strongly agree]

I think the word-problem test I just took supplies good evidence of how reflective and open-minded someone is.