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Science Curiosity and Political Information Processing

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This article describes evidence suggesting that science curiosity counteracts politically biased information processing. *This finding is in tension with two bodies of research. The first casts doubt on the existence of "curiosity" as a measurable disposition. The other suggests that individual differences in cognition related to science comprehension—of which science curiosity, if it exists, would presumably be one—do not mitigate politically biased information processing but instead aggravate it. The article describes the scale-development strategy employed to overcome the problems associated with measuring science curiosity. It also reports data, observational and experimental, showing that science curiosity promotes open-minded engagement with information that is contrary to individuals' political predispositions. We conclude by identifying a series of concrete research questions posed by these results.*

KEY WORDS: science curiosity, motivated reasoning, polarization

A Surprising Discovery About Politically Motivated Reasoning

In less than two decades, *politically motivated reasoning* has assumed an imperial reach over the study of mass political opinion formation. It has driven to the periphery theories emphasizing rational choice dynamics, heuristic information processing, public-spirited idealism, and popular disengagement (see generally Jost, Hennes, & Lavine, 2013). It has colonized countless individual topics from group polarization to source-credibility effects (Bolsen, Druckman, & Cook, 2015; Taber, Cann &

Kucsova, 2009), from biased information search (Arceneaux & Johnson, 2013; Lodge & Taber, 2013) to the effects of factual misinformation (Flynn, Nyhan, & Reifler, in press).

The final frontier that scholars have yet to fully chart, however, concerns individual differences. *Who* is most vulnerable to the tendency to selectively attend to information in patterns that reflect their commitment to ideologically and like-defined groups, and who is the least vulnerable (Taber & Young, 2013)?

In this article, we report a curious finding about politically motivated reasoning. Data we have collected suggest that this form of reasoning appears to be negated by science curiosity.

There might not be anything surprising about this finding but for its tension with two well-established bodies of research. The first suggests that science curiosity, as a heterogeneous disposition to seek out and consume scientific information for personal pleasure, probably doesn't exist (Loewenstein, 1994). The second documents that reasoning dispositions relevant to comprehension of science tend to *magnify* rather than dampen partisans' assessment of empirical information on policy-relevant facts (Kahan, in press-b).

The data we will describe were gathered as part of an exercise to demonstrate the utility of the new "science of science communication" (Fischoff & Scheufele, 2013; Kahan, 2015b) for the craft of science filmmaking. The "science curiosity" measure was a tool developed to measure a distinctive appetite for consuming science-related media for personal edification; it involves a scale that combines self-report with behavioral and performance measures (Kahan, Carpenter, & Landrum, 2015) and that has now been behaviorally validated in multiple trials. The initial evidence that it also predicts resistance to biased political information processing was not anticipated, but once observed, it was tested in an information-search experiment, which furnished additional support for that conclusion.

Together, the data we've collected furnish a strong basis for viewing science curiosity as an important individual difference in cognitive style that interacts in a distinctive way with political information processing. We share the results in the hope that others will find them as intriguing as we do and be motivated by curiosity to probe their robustness, their psychological underpinnings, and their implications for science communication, as we ourselves plan to do.

Background: Two "Well-Established" Research Findings—and Their Implications for Curiosity and Political Information Processing

As indicated, the research findings we report here are worthy of note because of their apparent tension with seemingly well-established research conclusions. The first is that there doesn't seem to be any measurable trait of curiosity. The second is that reasoning dispositions integral to science comprehension tend to *magnify* rather than suppress politically biased information processing. We briefly review the bodies of research supporting these propositions.

Science Curiosity: The Missing Scientific Reasoning Disposition

As conceptualized here, *science curiosity* is a general disposition, variable in intensity across persons, that reflects the motivation to seek out and consume scientific information for personal pleasure. The project to establish such a disposition has foundered repeatedly on the shoals of psychometric validity. Existing measures, developed predominantly but not exclusively with student samples, focus heavily on self-report measures (agree or disagree: "I am curious about the world in which we live"; "I find it boring to hear about new ideas"; "I get bored when watching science programs on TV," etc.; Fraser, 1978). Administered in long, dense batteries of items, such measures pose an obvious risk of—indeed, positively invite—social desirability bias. Many fail to display the basic rudiments of

internal validity such as unidimensionality and measurement reliability. In addition, even where reported covariance data support the inference that the proposed instrument is measuring something, the question of external validity—that is, whether the phenomenon that is *being* measured *is* science curiosity—is typically neglected or identified as a topic "for another day" (Blaloc et al., 2008; Osborne, Simons, & Collins, 2003).

Based on the unhappy history of science and related curiosity measures, Loewenstein (1994) suggests that curiosity of the sort of interest here likely doesn't exist, or if it does, it defies valid measurement. In his influential review article, he proposes that science curiosity be regarded not as a fixed *trait* that varies across persons but instead only as an occurrent *state* that varies within individuals over time in response to episodic external stimuli.

System 2 Motivated Reasoning

A species of the general propensity to conform information processing to unconsciously favored conclusions (Kunda, 1990), politically motivated reasoning (PMR) refers to the tendency of individuals to fit their assessments of evidence to beliefs that cohere with their political identities. PMR does not promote convergence on factually accurate beliefs. In Bayesian terms, it involves determining the *likelihood ratio* or weight to be assigned new evidence based *not* on its conformity to valid truth-seeking criteria but rather on its congeniality to one's political predispositions (Figure 1). If partisans with opposing predispositions appraise evidence in this fashion, they will not overcome their disagreement about policy-relevant facts even when they are furnished the same information (Kahan, in press-b).

A popular account seeks to assimilate PMR to *bounded rationality*. Rooted in dual process-reasoning theory, the concept of bounded rationality attributes the eclectic inventory of decision-making biases that compromise truth-convergent Bayesian information processing to overreliance on heuristic-driven "System 1" as opposed to conscious, effortful "System 2" reasoning (e.g., Kahneman, 2003). According to this account, PMR—like confirmation bias, denominator neglect, the availability heuristic, and the like—originates in a deficit either in the capacity or in the motivation to correct intuitions and preconceptions based on available information (Jost et al., 2013; Lodge & Taber, 2013; Sunstein, 2006, 2007; Weber & Stern, 2011).

While plausible, this view of PMR is inconsistent with a growing body of empirical evidence. Multiple observational studies have found that the individuals most proficient in System 2 reasoning are in fact the *most* politically polarized on facts relating to gun control, climate change, and other contested issues. Indeed, experiments have shown that individuals frequently *use* their System 2 reasoning proficiency to extract information supportive of their political identities and to rationalize away the rest (Bolsen et al., 2015; Hamilton, Cutler, & Schaefer, 2012; Kahan, 2015a; Kahan, Peters et al., 2012; Kahan, 2013; Kahan, Peters, Dawson, & Slovic, in press).

The proposition that PMR originates in bounded rationality arguably reflects an error about what people are *doing* with their reason when they display this form of information processing. On culturally contested societal risks such as climate change, fracking, or nuclear waste disposal, individuals get no benefit from forming "correct" understandings of the best available evidence: Their decision making cannot affect the behavior that gives rise to these risks or the adoption of policies to abate them. Accordingly, any mistakes individuals may make in their capacity as, say, consumers or voters irrelevant to the level of risk they or others face. But since positions on these issues are symbols of group membership and loyalty, the reputational *cost* to individuals if they form beliefs out of line with those of other individuals with whom they share important ties is likely to be high. Under these conditions, individuals can be expected to form habits of mind that favor giving information the effect most reliably suited to summoning affective stances expressive of their identities on societal risks. In sum, it is perfectly *rational* under these conditions to use one's reasoning capacities to form beliefs that are identity affirming whether or not they are accurate (Kahan in press-a).

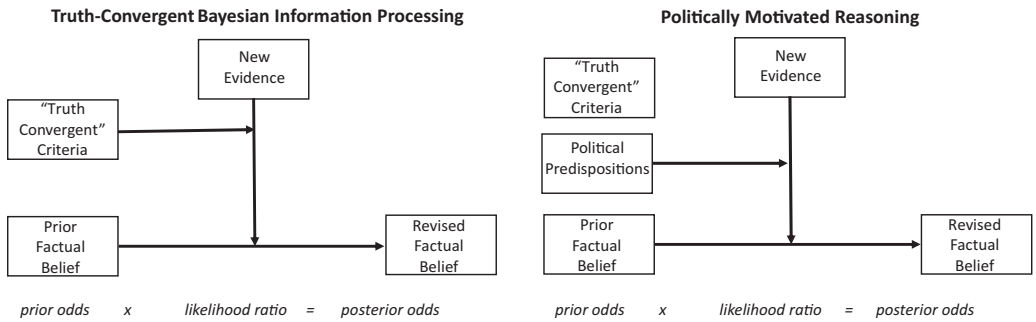

Figure 1. Unbiased versus politically biased information processing.

Because it is rational under these circumstances for individuals to form this expressive mode of information processing, they are likely to marshal all their cognitive resources to do so. As a result, proficiency in the reasoning dispositions associated with System 2 information processing *magnifies* rather than dissipates PMR (Kahan, Peters et al., 2012). One can call this general dynamic "Motivated System 2 Reasoning" (MS2R).

Defying Research Expectations: Science Curiosity and Politically Motivated Reasoning

If one combines these two bodies of research, the proposition that one should expect to observe science curiosity negating politically motivated reasoning is likely to seem quixotic. The history of failed attempts to measure curiosity is what accounts for the now prevailing view that it doesn't exist—that curiosity is best understood as a situation-specific state rather than a dispositional trait that varies across individuals.

In addition, even if science curiosity did exist as a disposition, there would be reason to expect it to *magnify* rather than *neutralize* PMR. As education researchers have long surmised, it is plausible to view the motivation to seek out information for its own sake as conducive to a higher level of science comprehension. But consistent with MS2R, higher proficiency in science comprehension accentuates identity-affirming rather than truth-convergent forms of political information processing. So presumably that is what science curiosity, if one were to establish its existence, would tend to do.

But in fact, we found a disposition that answers to our description of science curiosity. What's more, we found that it *does* dampen forms of information processing characteristic of PMR. We now turn to our results.

Measuring Science Curiosity

Scale Development Strategy

The research we describe was conducted within the context of a more general project to investigate the utility of empirical methods for improving the craft of science filmmaking. A recurring issue for science filmmakers is whether they are producing films in a manner that maximizes the appeal of them to all the individuals who in fact have an appetite to learn about science for its own sake—the natural audience, as it were, for such material.

A dispositional "science curiosity" measure is a tool that can be used to facilitate this assessment. If a film appeals to individuals with a high level of science curiosity generally but does not appeal to some particular segment of them in particular, then a filmmaker can infer that some aspect of the film—one unrelated to its science content—is making it uncongenial to a segment of potential viewers

who could be getting value from it. Experimentation, informed by the science-curiosity measure, can be used to try to identify and correct this defect in the film (Kahan et al., 2015).

This practical aim dictated that we focus on a tightly conscribed conception of science curiosity: an appetite to seek out and consume information in *science films* and related media for personal pleasure. We anticipated that this focus would help us to negotiate at least some of the obstacles that had constrained previous efforts to measure curiosity. The absence of a concrete object even for "science curiosity," we suspected, had impeded articulation of a well-formed curiosity construct and hence development of items for measuring the same.

We also adopted a scale-development strategy responsive to deficiencies in previous efforts to measure science curiosity. We did not dispense with self-report measures but did supplement them with behavioral and objective-performance ones that we believed would furnish more trustworthy indicators of the underlying disposition and that could be used to identify which self-report measures genuinely possessed predictive validity (Kahan et al., 2015).

To minimize social-desirability bias in the self-report items, the instrument was disguised as a general "social marketing" survey. Items relating to science interest were thereby camouflaged by being seeded in large blocks of "personal interest" items relating to sports, finance, politics, popular entertainment, and other issues. This format reduced the risk that subjects would discern that our goal was to assess their enjoyment of science and hence the incentive they faced to feign such a trait.[1]

Finally, we externally validated the resulting instrument. In separate studies, we assessed the power of our Science Curiosity Scale (SCS) to predict engagement with science and nonscience films. Such engagement, moreover, was measured not solely with self-report items but with objective indicators such as film viewing time and postviewing information search (Kahan et al., 2015).

Specifics

Internal validity. As indicated, we administered to our subjects—samples of 2,500 and 3,000 tested in separate data collections[2]—a mix self-report, behavioral, and objective items. The self-report items relating specifically to science were embedded in blocks or modules, each consisting of multiple items relating to an array of "topics" that, introductory material emphasized, "some people are interested in, and some people are not." The self-report "behavioral" measures were likewise embedded in blocks of items relating to a diverse range of activities (e.g., the reading of books on topics such as history, religion, or politics as well as science within the last 12 months; or attending professional or collegiate sporting events or gun shows as well as science museums and lectures). Subjects in the two studies also participated in an information-search exercise in which they were instructed to pick one category from a topical menu of new stories from which a story would be randomly selected for them to read and then answer questions (Figure 2).

SCS displayed highly satisfactory psychometric properties. The 12 items the scale comprises displayed a unidimensional factor structure. The resulting scale also furnished a highly reliable measure of the underlying science-curiosity disposition. Scored with item response theory, the scale, in both study administrations, had a variable reliability coefficient of over 0.80 across nearly the entire range of the latent disposition (Figure 3).

External validity. In addition, SCS measures what it is supposed to: engagement with science filmmaking. This was confirmed in two separate data collections, in which subjects' reactions to one of three separate science videos or to a nonscience video were measured. The science videos consisted of 10–11-minute excerpts from three high-quality science documentaries: *Your Inner Fish*, a multipart

[1] The SCS instrument is reproduced in Appendix S1 in the online supporting information.

[2] The study samples were recruited by YouGov, Inc., which also administered the study to the subjects via its online testing facilities. For information on YouGov's sampling and stratification methods, see Ansolabehere and Rivers (2013).

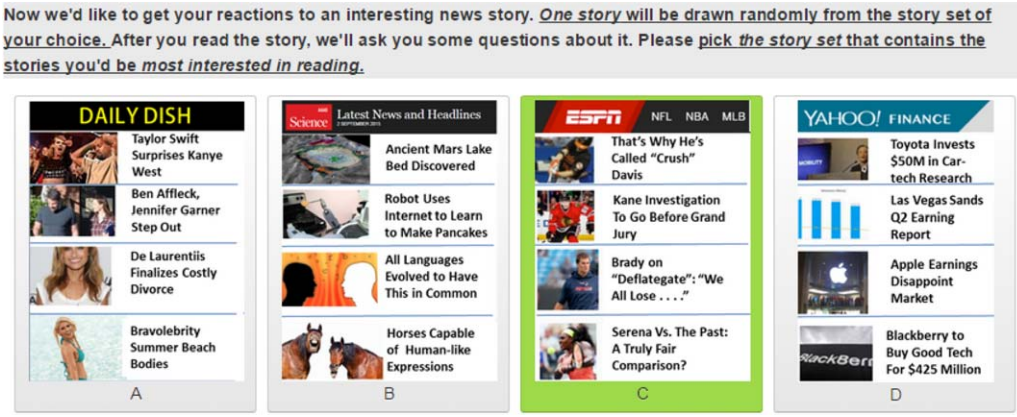

Figure 2. "Story-set selection task." Subjects were instructed to pick one of four news story sets, from which a story would then be selected for them to read and answer questions on. The task was conceived of as a performance-based measure of interest in science. [Color figure can be viewed at wileyonlinelibrary.com]

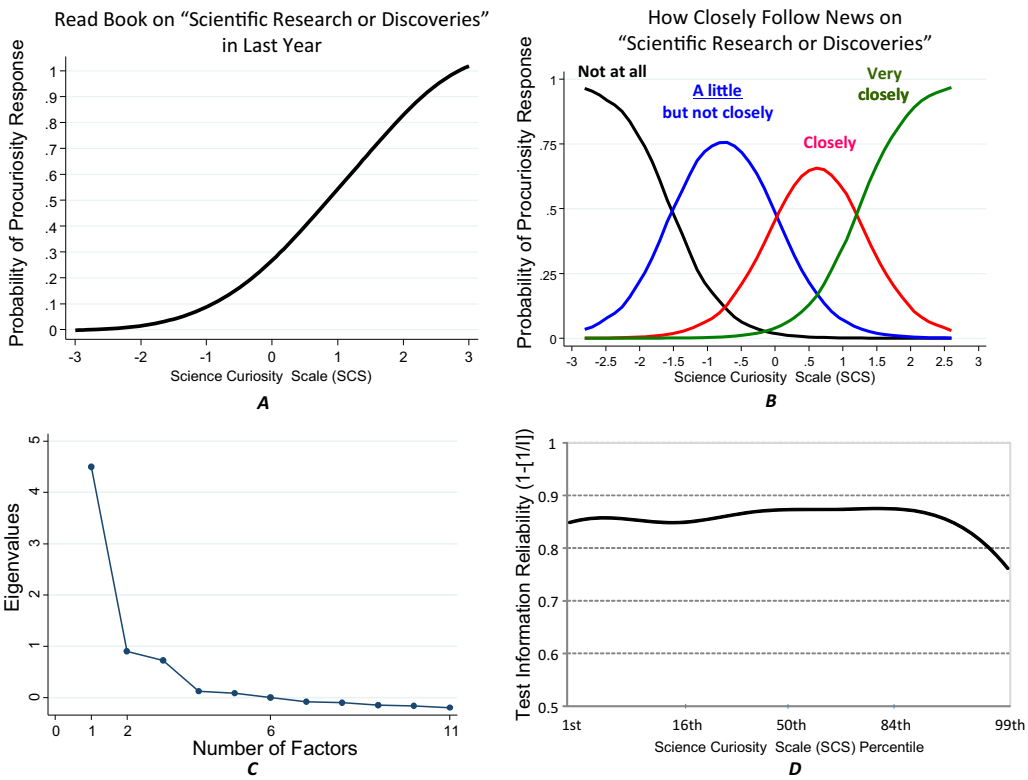

Figure 3. Science Curiosity Scale (SCS). Based on 2PL Item Response Theory model. SCS scores are standardized (with the mean centered at 0 and units measured in standard deviations). Panels *A* and *B* reflect representative "item response profiles": The relative probability of the indicated response, conditional on a specified level of the latent science-curiosity disposition, is used to estimate subjects' SCS scores. Panel *C* reflects the unidimensionality of the scale based on an analysis of the item (polychoric) covariance matrix. Panel *D* indicates the reliability or measurement precision of the SCS instrument at various levels of science curiosity (DeMars, 2010). [Color figure can be viewed at wileyonlinelibrary.com]

series on evolution that aired on PBS in 2014; *Darwin's Dangerous Idea*, the first episode in another multipart series on evolution that also aired on PBS in 2001; and *Mass Extinction: Life on the Brink*, a multipart series on extinction that aired on the Smithsonian Channel in 2015. The nonscience show consisted of a nine and-one-half-minute excerpt from an episode of "Hollywood Rundown," a popular celebrity-gossip program aired on YouTube.

Engagement with these features was measured with a scale comprising a mix of items ("Engagement Index," $\alpha = 0.77$). These included items soliciting self-reported interest in and attention to the videos. Also included were objective measures of engagement. One of these was viewing time: Half the respondents assigned to view each video were instructed that they could turn off the video whenever they chose.[3] Another was postviewing information search: the submission of information necessary to obtain the remainder of the shows from which the video excerpts were extracted.

SCS furnished a powerful explanation of variance in engagement with the three featured science videos. Progressively higher scores on SCS predicted higher levels of engagement as measured by the composite Engagement Index and by the individual objective measures of minutes viewed and postviewing information seeking (Figure 4, Figure 5, and Tables S1 and S2 in the online supporting information).[4]

Although it is implausible to imagine that there would be no correlation between science curiosity and other forms of curiosity, it would be even more implausible to think that a valid measure of science curiosity would predict interest in *everything*, including a feature as manifestly unrelated to science as the "Daily Hollywood Rundown" episode featured in the second study. In fact, there was no meaningful correlation between scores on SCS and Engagement Index scores (Figure 5).

Compared to ordinary science intelligence. Science curiosity—generally or as measured here—ought to have some relationship to science comprehension. It is difficult to experience the pleasure of contemplating scientific insight if one is utterly devoid of any capacity for making sense of scientific evidence. Similarly, if one is aggressively uncurious about scientific insights, one is less likely to acquire the knowledge or the experience-based habits of mind necessary to reason well about scientific insights.

Nevertheless, the two dispositions shouldn't be viewed as one and the same. Many people who can detect covariance and successfully compute conditional probabilities—analytical tasks essential to making sense of empirical evidence—are nevertheless uninterested in science for its own sake. More importantly still, many people who are only modestly proficient in these technical aspects of assessing empirical evidence *are* interested—passionate, even—about science. In sum, one would expect a science-curiosity measure, if valid, to be modestly correlated with but definitely not equivalent to a valid science-comprehension measure.

SCS has these properties. The association between SCS and the Ordinary Science Intelligence (OSI) assessment (Kahan, 2016) was $r = 0.26$ in our two data collections. To make this effect more practically meaningful, the relationship between these measures implies that individuals in the top quartile of SCS are over four times more likely than those in the bottom quartile to score in 90th percentile or above on the OSI assessment (Figure 6). This is a degree of association consistent with the expectation that higher science curiosity contributes materially to higher science comprehension. Nevertheless, in both studies science comprehension *lacked* meaningful predictive power in relation to engagement with the three science videos featured in our two studies (Figure 7). In other words, SCS measures a disposition that is apparently integral to the kind of proficiency in scientific reasoning

[3] To make viewing time a commensurable scale component for measuring engagement with all the videos, subjects were assigned a score based on which viewing-time quartile fell into the video in question.

[4] Multivariate regression outputs appear in Appendix S2 in the online supporting information and are cited in the text by references to "Table S*x*."

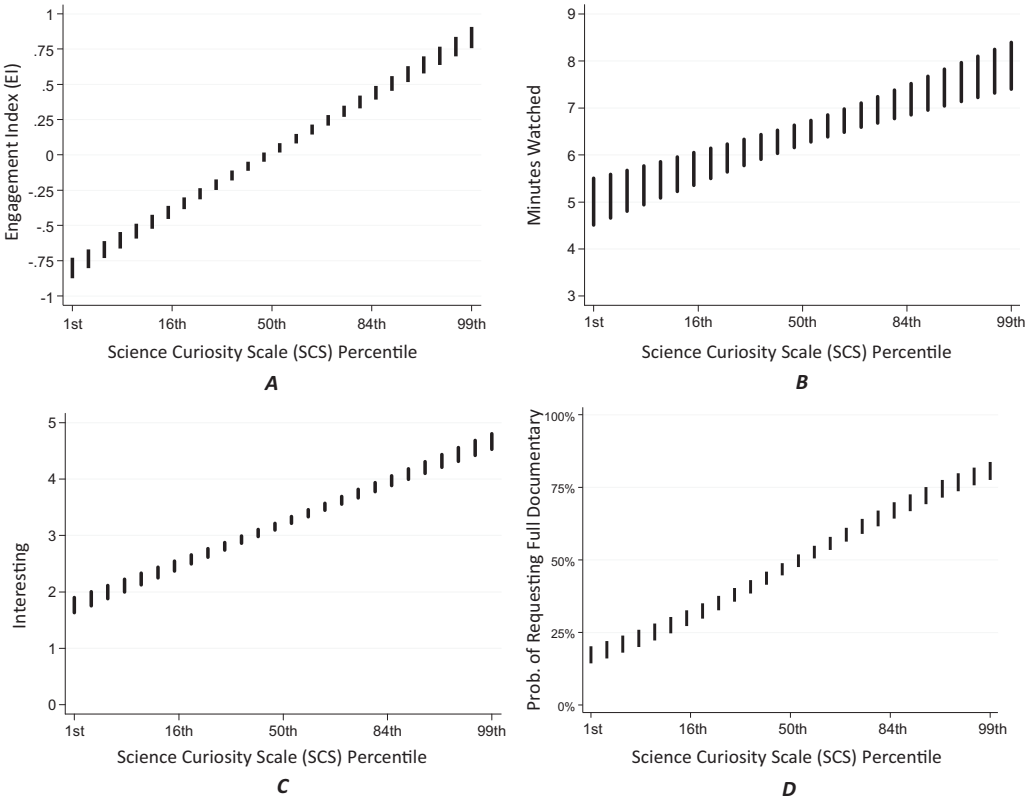

Figure 4. Engagement with *Your Inner Fish* excerpt as a function of science curiosity. Derived from regression models reported in Table S1, Models 1, 3, 5, and 7. Bars are 0.95 CIs.

measured by OSI, yet generates a form of behavior—the self-motivated consumption of science information for its own sake—that is unassociated with science comprehension by itself.

Science Curiosity and Political Polarization

Overview

We present two sources of data to support the inference that science curiosity, as we've measured it, offsets PMR. The first consists in observational data, which showed that increased science curiosity had the same impact on subjects' climate change and other risk perceptions regardless of the subjects' political outlooks. The second form of data is experimental: They demonstrate that subjects higher in curiosity exhibited a higher degree of willingness to examine surprising information contrary to their political predispositions than did ones who were lower in curiosity.

Observational Data

Societal risk perceptions tend to cohere in patterns that can be treated as indicators of diverse cultural outlooks (Leiserowitz, 2005). We collected such data in our first study in the expectation that it would be useful for identifying sources of cultural variance in engagement with science videos among subjects otherwise comparable in science curiosity (Kahan et al., 2015).

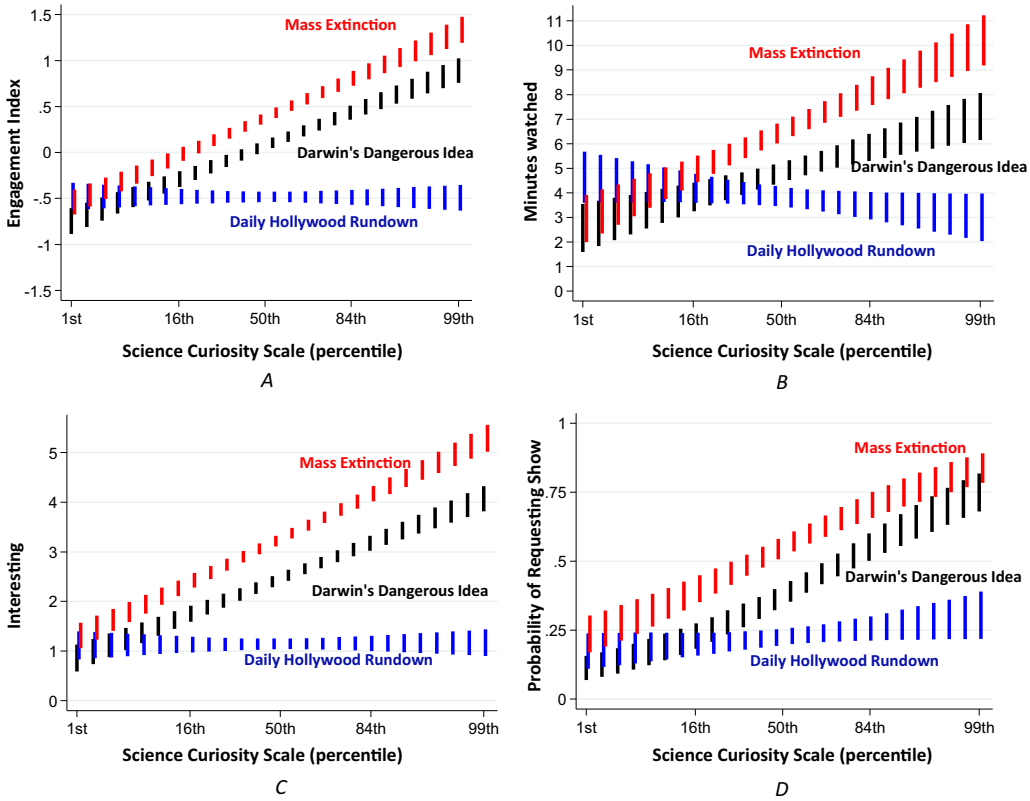

Figure 5. Engagement with *Mass Extinction, Darwin's Dangerous Idea, and Hollywood Rundown* excerpts as a function of science curiosity. Derived from regression analyses reported in Table S2, Models 1, 3, 5, and 7. Bars are 0.95 CIs. [Color figure can be viewed at wileyonlinelibrary.com]

For this purpose, we used the "Industrial Strength Risk Perception Measure" (Kahan, 2015_a). A simple Likert item that solicits appraisals of the "seriousness" of societal risks on a 0–7-point scale, ISRPMs have been externally validated and correlate highly with more particular perceptions of both facts and policy preferences relating to the indicated societal risk (Dohmen et al., 2011; Ganzach, Ellis, Pazy, & Ricci-Siag, 2008; Weber, Blais, & Betz, 2002).

ISRPM items faithfully register "motivated System 2 reasoning," or MS2R. As Numeracy, cognitive reflection, science comprehension, and like measures of reasoning proficiency increase, so does the degree of political or cultural polarization in ISRPMs for contested issues (Kahan, 2015b; Kahan, Peters et al., 2012). We observed this effect in our first study (Figure 8).

But those same subjects did *not* polarize as their SCS scores increased. On the contrary, increases in SCS had the *same effect* on subjects regardless of their political outlooks (Figure 8).

There remained a partisan effect: Right-leaning respondents were generally less concerned than left-leaning ones, regardless of science curiosity. But increasing SCS scores moved subjects' global-warming risk perceptions in the same direction—up—regardless of partisanship. This result was in marked contrast to increases in OSI, which were associated with greater concern for left-leaning subjects and greater skepticism for right-leaning ones (Figure 8).

We observed a similar effect in relation to acceptance of human-caused climate change. Consistent with numerous other studies (e.g., Kahan, 2016), our data showed that right-leaning subjects were substantially less likely to believe that human activity is causing global temperatures to rise than were left-

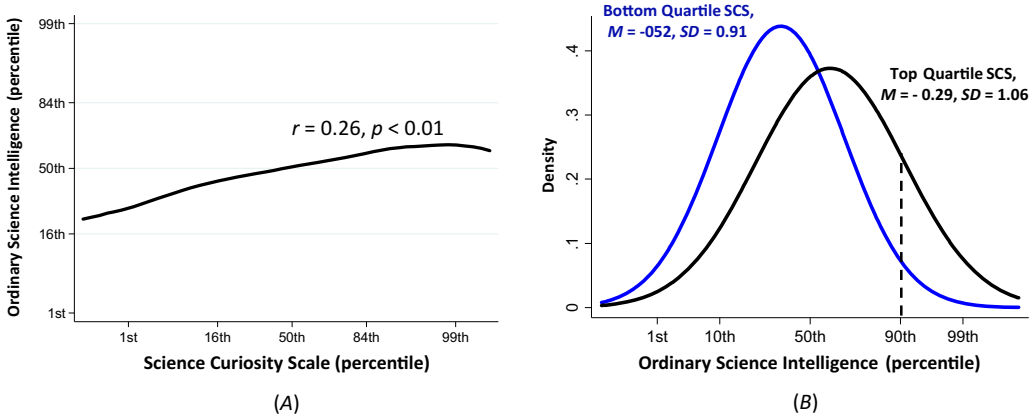

Figure 6. Relationship of science curiosity to science comprehension. Plotted line in panel (*A*) is locally weighted regression. In panel (*B*), ratio of area under the top-quartile curve to area under the bottom-quartile curve in the region to the right of the vertical dotted line reflects relative probability of scoring at or above the 90th percentile on the OSI assessment conditional on scoring in the top quartile as opposed to the bottom quartile on the Science Curiosity Scale. [Color figure can be viewed at wileyonlinelibrary.com]

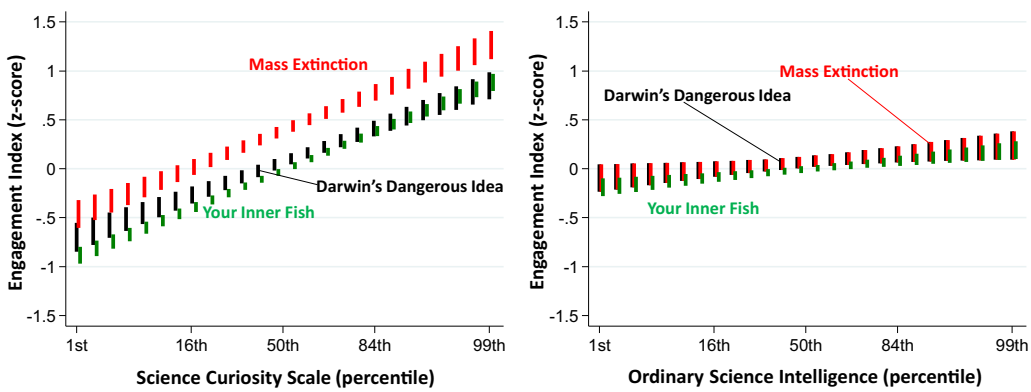

Figure 7. SCS versus OSI. Derived from regression analyses reported in Table S1 Model 2 and Table S2 Model 2. Bars denote 0.95 CIs. [Color figure can be viewed at wileyonlinelibrary.com]

leaning ones *and* that this differential grew substantially as respondents' science-comprehension scores increased. Higher levels of science curiosity, in contrast, were associated with greater acceptance of human-caused climate change among *both* right-leaning and left-leaning study subjects (Figure 9).

All other elements of science comprehension—including ones such as cognitive reflection, numeracy (Kahan, Peters, Dawson, & Slovic, in press), and knowledge of basic scientific facts (Hamilton, Cutler & Schaefer, 2012; Kahan & Peters et al., 2012), not to mention simple educational attainment (Hamilton, 2011)—have all previously been observed to *magnify* political polarization. This result, we've explained, is plausibly attributed to MS2R—the recruitment of conscious, effortful information processing to protect the interest individuals have in forming beliefs that affirm their political identities (Kahan 2013; Kahan et al. in press). Because science curiosity plays a role in promoting science comprehension too (Figure 6), it would stand to reason that it would be associated with the enlargement of polarization.

It didn't; on the contrary, with respect to the most contested risks, SCS *counteracted* the MS2R effect associated with science comprehension. Within the sample as a whole, higher OSI scores were

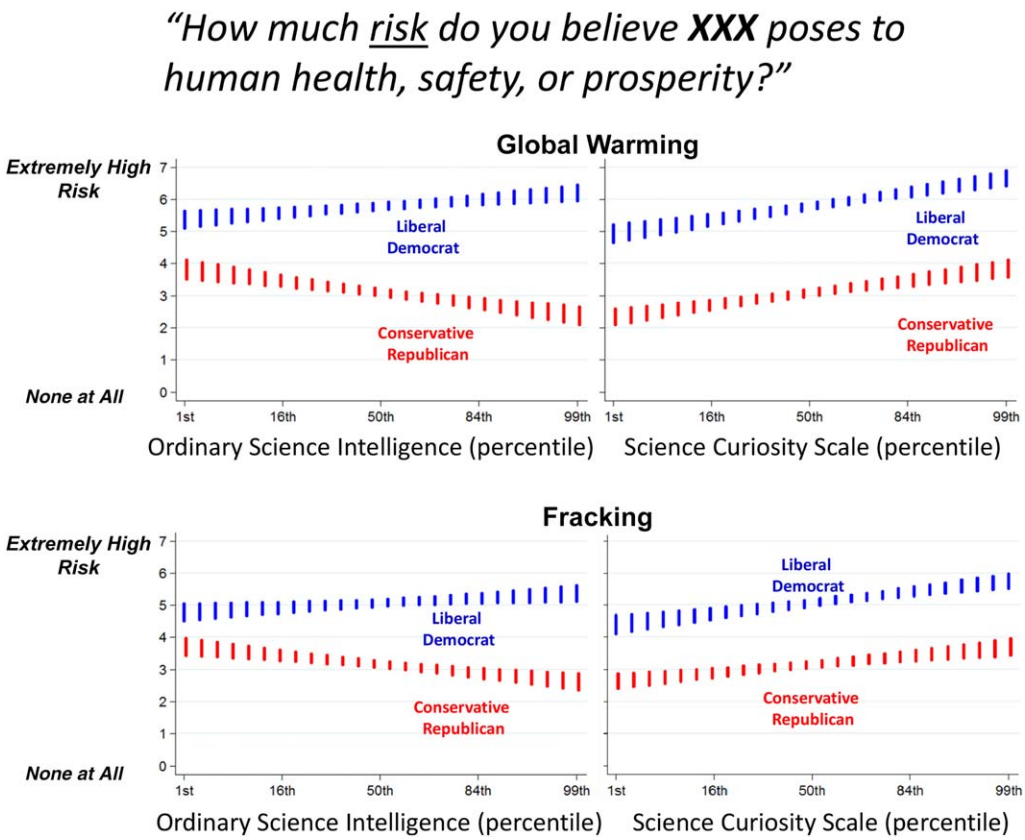

Figure 8. Respective impacts of science comprehension and of science curiosity on ISRPM polarization. Derived from linear regression reported in Table S3. Bars denote 0.95 CIs. [Color figure can be viewed at wileyonlinelibrary.com]

associated with increasing levels of polarization on risks such as those posed by global warming and fracking. But as SCS scores increased, the degree to which OSI aggravated polarization became progressively *smaller* (Figure 10). In short, the perverse effects MS2R abated as science curiosity increased.

Experimental Data

The discrepancy between SCS and OSI on subjects' climate-change risk perceptions begs an explanation. A plausible one is that individuals who are higher in science curiosity, in order to satisfy their appetite to experience wonder and surprise, expose themselves more readily to information that is contrary to their political predispositions, a form of engagement with information generally contrary to PMR. That is the conjecture that informs our experimental data, which was included in our second science-of-science filmmaking study.

In the experiment, subjects were assigned to one of two conditions. The conditions consisted of a pair of news article headlines that reported (genuine) scientific findings that evinced either a "climate-nonskeptical" or "climate-skeptical" orientation—that is, one either appearing to bolster the reality of human-caused global warming or one appearing to qualify the reality of it, respectively.

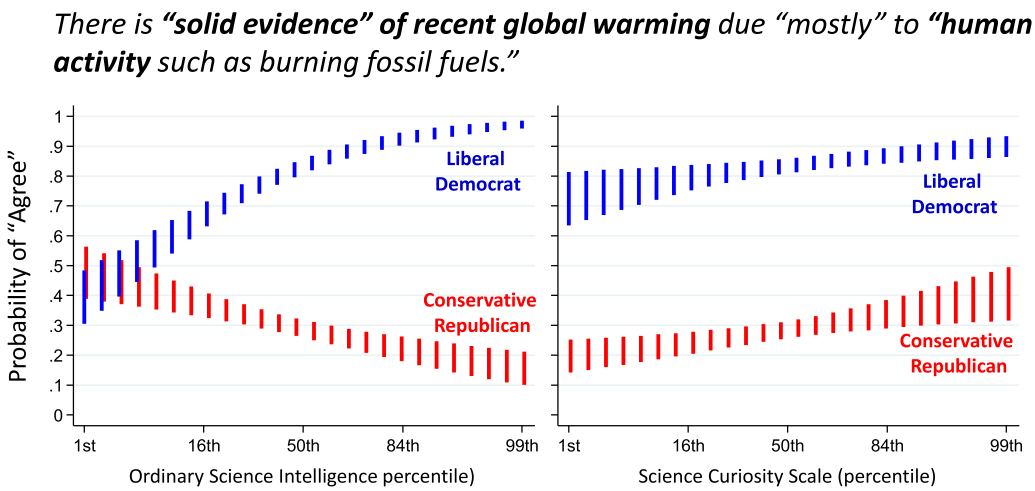

Figure 9. Respective impacts of science comprehension and of science curiosity on acceptance of human-caused global warming. Derived via logistic regression (Table S3, Model 2). Predictors for "Liberal Democrat" and "Conservative Republican" set at corresponding values of political orientation scale comprising liberal-conservative ideology and party identification. Where the impact of science comprehension is measured, the predictor for science curiosity is set to its mean—and vice versa. Bars denote 0.95 CIs. [Color figure can be viewed at wileyonlinelibrary.com]

The difference in the conditions consisted in how the headlines characterized the relevant evidence: either as surprising (novel) or unsurprising (consistent with or corroborative of preexisting evidence), a feature that was crossed with the "nonskeptical" or "skeptical" member of each pair (Table 1). Thus, in the "Nonskeptical unsurprising, Skeptical surprising" condition, the respective newspaper headlines were "Scientists Find Still More Evidence that Global Warming Actually *Slowed* in Last Decade" and "Scientists Report Surprising evidence: Arctic Ice Melting Even Faster Than Expected." In the "Nonskeptical surprising, Skeptical unsurprising" condition, in contrast, the respective headlines read, "Scientists Report Surprising Evidence: Ice *Increasing* in Antarctic, *Not* Currently Contributing to Sea Level Rise" and "Scientists Find Still More Evidence Linking Global Warming to Extreme Weather." Subjects were instructed to "pick the story most interesting to you."[5]

It is a generally recognized feature of PMR that individuals tend to prefer engaging with information that is (or is expected to be) outlook-affirming or -congruent over information that is (or expected to be) outlook-threatening or –noncongruent. This is particularly the case on issues in which they have strong views and in relation to which they display identity-protective reasoning (Hart et al., 2009; Jost et al., 2013). In this design, then, one might have expected right-leaning subjects to select the "skeptical" story in both conditions and left-leaning ones the "nonskeptical" story in both, regardless of the relative novelty of those stories.

Science curiosity, however, consists in a disposition to seek out and consume science information in order to experience the intrinsic pleasure of awe and surprise. For that reason, subjects higher in science curiosity might be expected to show a preference for the *surprising* story—the one conveying unexpected evidence—*regardless of its relationship to their predispositions*. Such a pattern would defy or offset the one associated with PMR (Figure 1).

The experimental study results were in accord with this hypothesis. As one might expect of partisans generally, subjects of low to modest science curiosity displayed a marked preference for unsurprising information consistent with their political predispositions on climate change. But this was not

[5] The experimental stimulus is reproduced in Appendix A in the online supporting information.

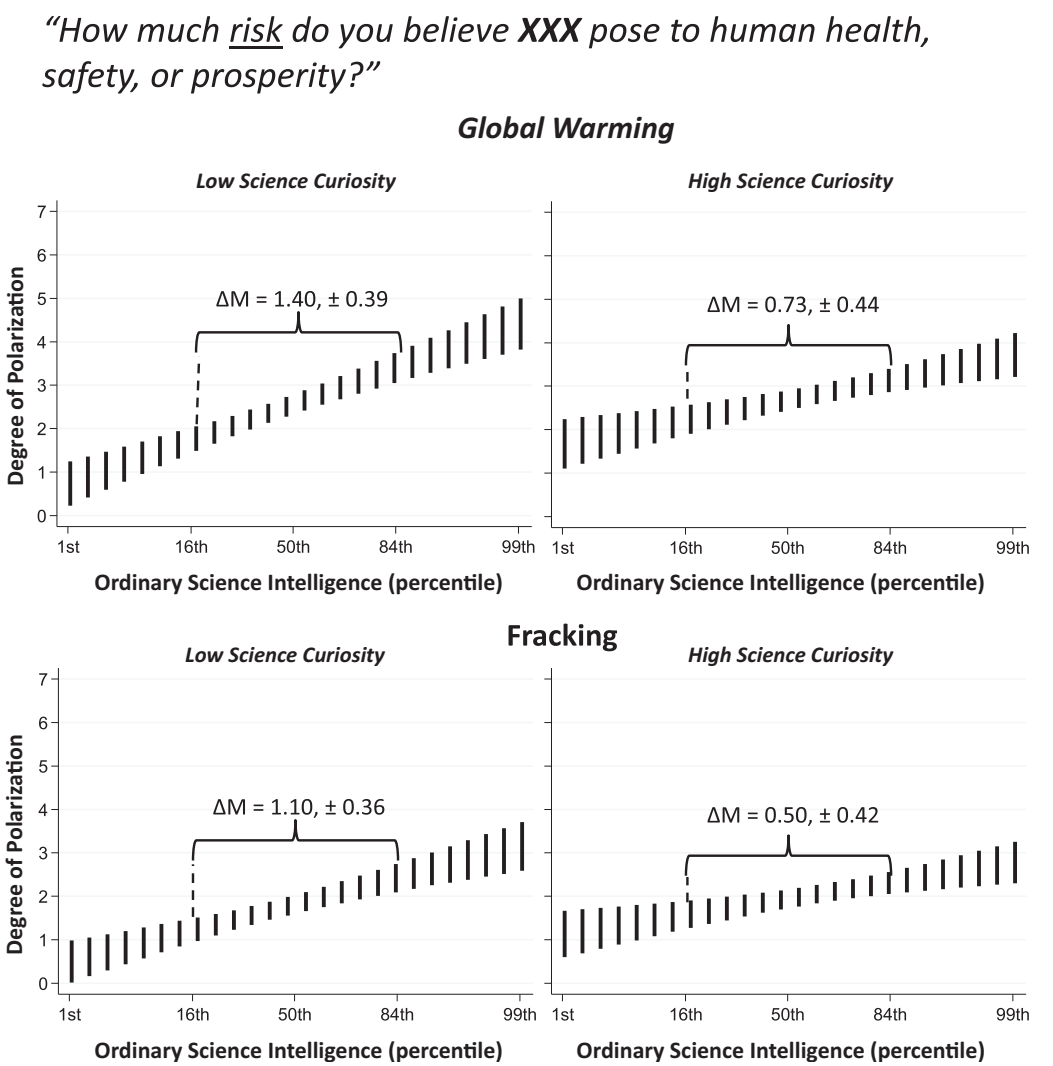

Figure 10. Diminished MS2R associated with increasing science curiosity. Derived from linear regression reported in Table S3, Models 1 and 3. "Low" and "high science curiosity" reflect predictor values of −1 and +1 *SD* on SCS, respectively. Y-axis reflects estimated difference in ISRPM responses of a "Liberal Democrat" and a "Conservative Republican" (as determined by scores on Left_right scale) in relation to OSI assessment score. For both ISRPM items, the slope is significantly less steep for subjects who score higher on SCS. Bars denote 0.95 CIs.

so for relatively science-curious subjects: They displayed a marked preference for novel information, even when it was contrary to their political predispositions (Figure 11).

As the raw data suggest, these effects were by no means trivial in magnitude. There was a 62% (± 13%)[6] probability that a Conservative Republican would choose to read a surprising "nonskeptical" news story over an unsurprising skeptical one if her score was one standard deviation above the average on SCS; this was 20 percentage points higher ± 19%) than that of a conservative Republican whose SCS score was one standard deviation below the mean. There was an even more substantial gap—44

[6] All "±" reflect 0.95 level of confidence.

Table 1. Experimental Conditions

	Nonskeptic	Skeptical
Condition 1	**unsurprising**	**surprising**
Condition 2	**surprising**	**unsurprising**

percentage points (± 30%)—in the probability that a moderately science-curious liberal Democrat would choose to read a surprising "skeptical" story (68%, ± 20%) than that a moderately science-uncurious liberal Democrat (24%, ± 18%) would (Figure 12). Differences in science comprehension failed to exert any such impact, although higher science comprehension did not in fact aggravate biased information search (Figure 13).

If reflective of how individuals behave outside the lab, moreover, this result would suggest that individuals higher in science curiosity more readily engage rather than spurn evidence contrary to their predispositions. Such behavior could furnish an explanation for what our observational data revealed: Higher science curiosity, unlike higher levels of other reasoning dispositions integral to science comprehension, has a uniform rather than a polarizing effect on subjects' perceptions of risk and like facts—indeed, an effect that at least partially negates the polarizing impact of those other dispositions.

Now What?

We believe the data we've presented paints a surprising picture. The successful construction of a psychometrically sound science-curiosity measure—even one with the constrained focus of the scale described in this article—might already have seemed improbable. Much more so, however, would have been the prospect that such a disposition, in marked contrast to others integral to science comprehension, would offset rather than amplify politically biased information processing. Our provisional explanation (the one that guided the experimental component of the study) is that the intrinsic pleasure that science-curious individuals uniquely take in contemplating surprising insights derived by empirical study counteracts the motivation most partisans experience to shun evidence that would defeat their preconceptions. For that reason science-curious individuals form a more balanced, and across the political spectrum a more uniform, understanding of the significance of such information on contested societal risks.

We stress, however, the *provisionality* of these conclusions. It ought to go without saying that all empirical findings are provisional—that valid empirical evidence never conclusively "settles" an issue but instead merely furnishes information to be weighed in relation to everything else one already knows and might yet discover in future investigations. In this case in particular, the novelty of the findings and the formative nature of the research from which they were derived would make it reasonable for any critical reader to demand a regime of "stress testing" before she treats the results as a basis for substantially reorganizing her understanding of the dynamics of political information processing.

Obviously, the same measures and designs we have featured can and should be applied to additional issues. But potentially even more edifying, we believe, would be the development of additional experimental designs that would furnish more reason to credit or to discount the interpretation of the data we've presented here. We describe the basic outlines of some potential studies of that sort.

More Footage of Curiosity in Action

The inferential strategy we've employed consists, essentially, in the examination of the beginning and ending frames in a moving film of information processing. We started with a still shot of what we

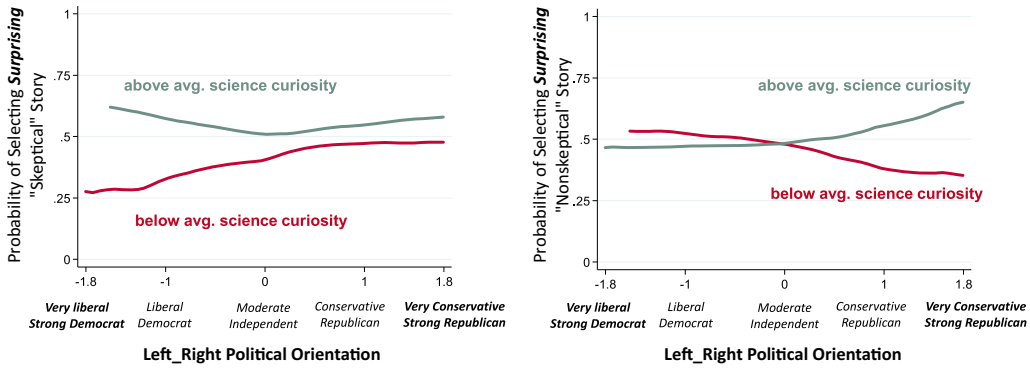

Figure 11. Experiment results: raw data. $N = 733$. Locally weighted regression. "Above avg." and "below avg. science curiosity" reflect classification of subjects in relation to mean scores on SCS. "Left_right" is political outlook scale formed by aggregation of 5-point liberal-conservative ideology and 7-point partisan identification items ($\alpha = 0.80$). [Color figure can be viewed at wileyonlinelibrary.com]

interpreted as the *result* of the impact of science curiosity in negating politically motivated information processing. Subject perceptions of risks and like facts implied that those high in science curiosity, unlike ones high in other elements of science comprehension, give the same rather than opposing effect to information that bears on contested societal risks (Figure 9 and Figure 10). Indeed, as science comprehension increases, the polarizing effect of other elements of science comprehension is reduced (Figure 10).

Proceeding backwards, we then simulated the *beginning* of such a process. Using experimental methods, we created a glimpse of the *first frame* in our moving picture of the impact of science curiosity on information processing. The demonstrated preference of science-curious individuals, when confronted with a choice, to opt for surprising, predisposition-challenging over unsurprising, predisposition-affirming information (Figure 11 and Figure 12) matched our surmise about why they ended up where they did—with a tendency to move in unison rather than in opposing directions as this element of science reasoning increases. We used inductive inference to effectively impute all the many "frames" in between.

A corroborative research program would try to fill these missing frames in with ones based on additional empirical observations. Experiments can be devised that would determine how in fact curious individuals *revise* their views when they expose themselves to politically uncongenial information in this fashion.

Obviously, the inferences we've drawn in this article posit that such exposure negates what would otherwise be a tendency toward polarization. But we could imagine a contrary possibility antagonistic to the inferences we have drawn: Perhaps curious subjects are motivated to examine surprising evidence *in order to enjoy the experience of arguing against it*. "Counterarguing" is another feature of PMR (Arceneaux & Johnson, 2013; Jost et al., 2013). Indeed, studies find that even when subjects are exposed only to contrary information, it will often *harden* their original convictions (Nyhan & Reifler, 2010; Nyhan, Reifler, & Ubel, 2013). If strong counterarguing was observed in science-curious subjects who selected surprising, politically uncongenial information, it would be a strong reason to *discount* the inferences we have drawn from our data about the PMR-neutralizing effects of science curiosity.

Our data supply reason to doubt this account. If subjects were selecting counterattitudinal information to argue against it, one might expect the subjects highest in OSI—the ones we know are most motivated to form identity-congruent beliefs—would likewise have selected counterattitudinal evidence. They didn't (Figure 13).

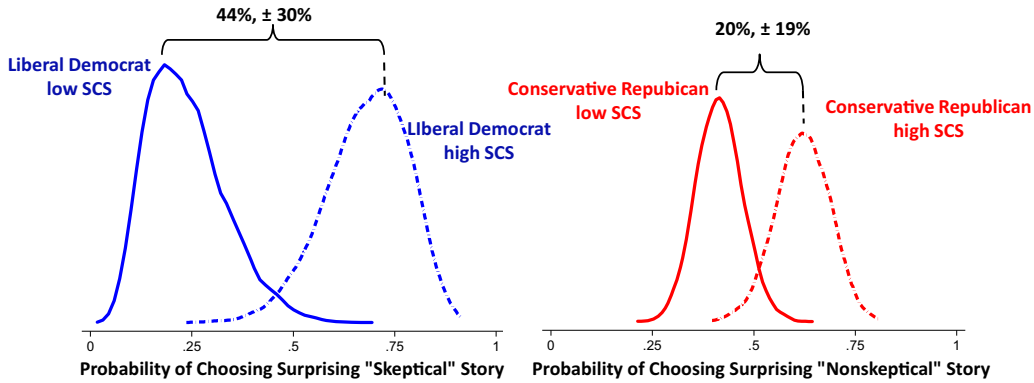

Figure 12. Predicted probabilities of choosing "surprising" ideologically uncongenial news story, rather than "unsurprising" congenial news story, conditional on level of science curiosity. $N = 733$. Monte Carlo simulation derived from logistic regression (Table S4, Model 2). Predictors for "Liberal Democrat" and "Conservative Republican" reflect corresponding values on Left_right scale. Predictors for "low" and "high" SCS reflect values of $+1$ and -1 *SD* SCS scale. Predicted probabilities control for OSI by setting OSI predictor to its mean. [Color figure can be viewed at wileyonlinelibrary.com]

In addition, the prediction that "missing frames" would reveal a counterargument response seems to envision that science-curious subjects are inordinately partisan and thus relish the opportunity to engage counterattitudinal information for the sake of demolishing it. In fact, science-curious individuals are not distinctively partisan. They are no more prone to *extreme* political outlooks than members of the general population at large; in our data, there was no correlation between subjects' SCS scores and the intensity of their left-right political outlooks.[7]

Nevertheless, we are convinced that the marginal benefits of interrogating our own data will be small relative to the benefits of obtaining more data with new studies specifically geared toward addressing the opposing "counterargument" conjecture. We plan to do such studies. We hope others will as well.

Mechanisms

Assuming that our basic finding—that science curiosity negates politically biased engagement with information—holds up, the question then becomes what explains such an effect. What cognitive mechanisms or dynamics are at work?

Let's consider two possibilities (no doubt there are additional ones). We can call the first of these the Bayesian Convergence Conjecture (BCC). BCC posits that, if furnished with comparable information, individuals, regardless of political outlook, can be expected to converge in their views on politically relevant facts. On this account, then, science curiosity should help to counteract PMR because it tends to offset (our experiment suggests) the biased-information search that is one element of it.

We suspect this explanation isn't right. Unlike some other Bayesian accounts of political information process (e.g., Gerber & Green, 1999), BCC does not deny the phenomenon of PMR. Nevertheless, it puts too much weight, we think, on its biased-search element. BCC imagines that the source of political polarization on basic facts is asymmetry in information search and exposure. Yet there is already PMR-related evidence that even when partisans are exposed to balanced information or unbalanced contrary information, they tend to discount it (Jost et al., 2013)—and sometimes even harden their views in the face of it (e.g., Nyhan & Reifler, 2010; Nyhan, Reifler, & Ubel, 2013).

[7] This assessment was made by treating the absolute score on the standardized Left-right measure used to assess political outlooks as a partisanship measure and then assessing the correlation between that measure and subjects' SCS scores.

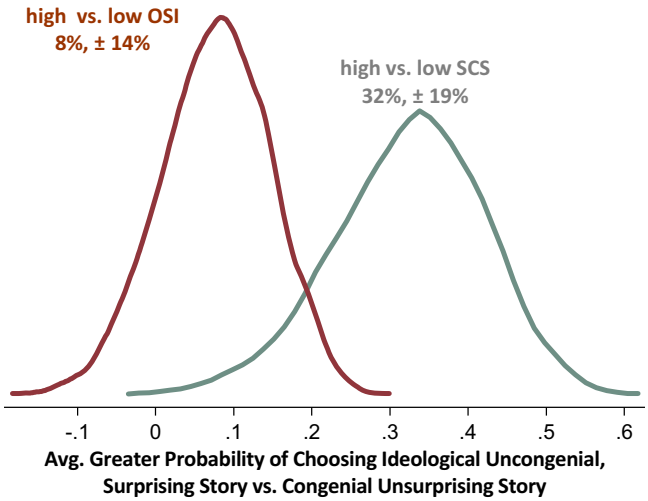

Figure 13. Predicted probabilities of choosing "surprising," ideologically uncongenial story conditional on level of science comprehension and science curiosity, respectively. $N = 733$. Monte Carlo simulation derived from logistic regression (Table S4, Model 2). Predicted probabilities control for OSI by setting OSI predictor to mean. Where the impact of science comprehension is measured, the predictor for science curiosity is set to its mean—and vice versa

Science-curious subjects, it seems, aren't reacting that way. They are dispositionally different. That's what the second potential mechanism focuses on.

Cognitive dualism refers to the tendency of individuals to adapt information processing to multiple ends (Kahan, 2015a). Often—maybe normally—they will conform such information to the stake they have in forming beliefs consistent with their political identities. But because *being* a particular kind of person, indicated by certain types of political commitments, is not the *only* thing people use their reason for, they will at least sometimes engage such information differently, too. Farmers, for example, have been observed to use information on climate change to form identity-congruent beliefs when they are behaving as citizens but to form truth-convergent ones when they are engaging in the task of farming, where they have an end—succeeding as farmers—that can be satisfied only with that form of information processing (Kowitt, 2016). Similar dynamics have been observed in relation to evolution: some individuals "disbelieve" in it when participating in activities that feature their identity as members of religious groups that subscribe to creationist strictures but "believe" in it when discharging their duties as science-trained professionals (Everhart & Hameed, 2013). Investing opinion surveys with the trapping of a standardized science test can toggle the switch from identity-protective to knowledge-evincing information processing, too (Kahan, 2015a; cf. Hall Jamieson & Hardy, 2014), presumably because individuals are habituated to use the latter when taking tests.

One might conjecture that something like this happens with science-curious individuals. They have a reason to engage information for truth seeking that those who are low in science curiosity don't have: to experience the pleasure of contemplating surprising insights into how the world works (Kahan et al., 2015). Even if they are no less committed to experiencing the goods associated with holding a particular political identity, the cumulative effect of exercising their reason for this nonpolitical end in contexts in which satisfying it poses no conflict with their identity might create a spillover effect that moderates their beliefs about highly contested matters of policy-relevant fact.

This is only a surmise, obviously. Whatever one's prior assessment of its probability is relative to the alternative BCP conjecture, the cognitive-dualism account merits—demands—additional evidence. It demands it, too, so that its strength in relation to plausible alternatives to both the BCP and cognitive dualism positions can be assessed.

Again, we plan to examine these issues. We welcome others to join us.

Science Communication

Also worthy of further study is the significance of science curiosity for effective science communication. We have presented evidence that science curiosity negates the defensive information processing characteristic of PMR. If this is correct, we can think of at least two implications worthy of further study.

The most obvious concerns the possibility of promoting greater science curiosity in the general population. If in fact science curiosity does negate the polarizing effects of PMR, then it should be regarded as a disposition essential to good civic character and cultivated self-consciously among the citizens of the Liberal Republic of Science so that they may enjoy the benefit of the knowledge their way of life makes possible (Kahan, 2015b).

This is easier said than done, however. Indeed, much, much easier. As difficult as the project to measure science curiosity has historically proven itself to be, the project to identify effective teaching techniques for inculcating it and other dispositions integral to science comprehension has proven many times as complicated. There's no reason not to try, of course, but there is good reason to doubt the utility of the admonition that educators and others to "promote" science curiosity as a remedy for countering the myriad deleterious consequences that PMR poses to the practice of enlightened self-government. If people knew how to do this, they'd have done it already.

Better, we suspect, would be to furnish science communicators with concrete guidance on how to get the benefit of that quantum of science curiosity that already exists in the general population (Hall Jamieson & Hardy, 2014). This objective is likely to prove especially important if the cognitive-dualism account of how science curiosity counters PMR proves correct. This account, as we have emphasized, stresses that individuals can use their reason for two ends—to form beliefs that evince who they are and to form beliefs that are consistent with the best available scientific evidence. They are more likely to do the latter, though, when there isn't a conflict between that two; indeed, *many* of the difficulties in effective science communication, we believe, are a consequence of forms of communication that needlessly put people in the position of having to choose between using their reason to be who they are and using it to know what is known by science—a dilemma that individuals understandably tend to resolve in favor of the former goal (Kahan, 2015a). To avoid squandering the value that open-minded, science-curious citizens can contribute to political discourse and to the broader science excommunication environment, science communicators should scrupulously avoid putting them in that position.

Indeed, helping science filmmakers to learn how to inadvertently put science-curious individuals to that choice *is* one of the aims of the research project that generated the findings reported in this article. If we are right about science curiosity and PMR, then this is an objective that science communicators in the political realm must tackle too.

Conclusion

Past research involving science curiosity has been hampered by the absence of a psychometrically valid measure of this disposition. Our ongoing research project on science-filmmaking suggests that it is possible to construct a valid science-curiosity instrument, however, if one is sufficiently concrete about its focus, avoids social desirability effects, and does not rely exclusively on self-report measures.

Surprisingly, a disposition measured by such an instrument seems to counteract biases in political information processing. The data presented in this article suggest that science curiosity, unlike other

dispositions integral to science comprehension, seems to counteract rather than aggravate the signature characteristics of politically motivated reasoning.

The supporting data were two-fold. First, we presented observational data demonstrating that as science curiosity increases, subjects do not polarize in their assessments of climate change risks but rather uniformly adjust their assessments of them. This is a dramatic departure from "motivated System 2 reasoning," which involves the magnification of polarization conditional on higher scientific reasoning proficiency, a widely observed dynamic. Not only did science curiosity itself avoid this tendency; it actually counteracted it: Among subjects who scored highest on our science-curiosity measure, the polarizing effect of science comprehension diminished in strength.

Second, we presented experimental data showing that subjects high in science curiosity display a marked preference for *surprising information*—that is, information contrary to their expectations about the current state of the best available evidence—even when that evidence *disappoints* rather than *gratifies* their political predispositions. This is in marked contrast, too, to the usual style of information-search associated with PMR, in which partisans avoid predisposition-threatening in favor of predisposition-affirming evidence.

Together these two forms of evidence paint a picture—a flattering one indeed—of individuals of high science curiosity. In this view, individuals who have an appetite to be *surprised* by scientific information—who find it pleasurable to discover that the world does not work as they expected—do not turn this feature of their personality *off* when they engage political information but rather indulge it in that setting as well, exposing themselves more readily to information that defies their expectations about facts on contested issues. The result is that these citizens, unlike their less curious counterparts, react more open mindedly and respond more uniformly across the political spectrum to the best available evidence.

But as we have taken pains to emphasize, this research remains at a formative stage. As always, there are unresolved questions. The goal of this article was to report the pleasure we took in observing these surprising results in the hope that doing so would motivate other curious researchers to join us in trying to answer them.

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Supporting Information

Additional supporting information may be found in the online version of this article at the publisher's website:

Appendix S1. Study Instruments

Appendix S2. Multivariate Analyses

Table S1. Engagement with study 1 video. OLS coefficients except for "Show Requested" models, which reflect logit coefficients. The R^2's for "Show Requested" are pseudo R^2's calculated by squaring Pearson correlation of predicted and observed values. **Bolded** denotes indicated predictor is significant at $p < 0.05$.

Table S2. Engagement with study 2 videos. OLS coefficients except for "Show Requested" models, which reflect logit coefficients. "Mass. Extinct." and "Darwin's Danger" are dummy variables coded 0-1 to reflect nonassignment or assignment to the conditions that were assigned to view those videos, respectively; the excluded reference category is assignment to the condition assigned to view the Hollywood Rundown video. The R^2's for "Show Requested" are pseudo R^2's calculated by squaring Pearson correlation of predicted and observed values. **Bolded** denotes indicated predictor is significant at $p < 0.05$.

Table S3. Impact of science comprehension and science curiosity on risk perceptions and belief in climate change. OLS coefficients except for "Belief in AGW" model, which reflects logit coefficients. The R^2' for "Belief in AGW" is pseudo R^2's calculated by squaring Pearson correlation of predicted and observed values. **Bolded** denotes indicated predictor is significant at $p < 0.05$.

Table S4. Experimental results. Outcome variable is choice of "surprising" story. Logit coefficients (z-statistic in parentheses). "Nonskeptical" is dummy variable coded "0" for assignment to "unsurprising nonskeptical, surprising skeptical" condition and "1" for assignment to "surprising nonskeptical, unsurprising skeptical" condition. Bolded denotes that indicated predictor, model Log-odds ratio $\chi 2$ value, or difference in model Log-odds ratio $\chi 2$ value is significant at $p < 0.05$.