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What is the "science of science communication"?

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Abstract

This essay seeks to explain what the "science of science communication" is by *doing* it. Surveying studies of cultural cognition and related dynamics, it demonstrates how the form of disciplined observation, measurement, and inference distinctive of scientific inquiry can be used to test rival hypotheses on the nature of persistent public conflict over societal risks; indeed, it argues that satisfactory insight into this phenomenon can be achieved *only* by these means, as opposed to the ad hoc story-telling dominant in popular and even some forms of scholarly discourse. Synthesizing the evidence, the essay proposes that conflict over what is known by science arises from the very conditions of individual freedom and cultural pluralism that make liberal democratic societies distinctively congenial to science. This tension, however, is not an "inherent contradiction"; it is a problem to be solved — *by the science of science communication* understood as a "new political science" for perfecting enlightened self-government.

Keywords

Risk communication

Introduction

Public opinion on societal risks presents a disorienting spectacle. Is the earth warming up as a result of human activity? Can nuclear wastes be safely stored in deep underground rock formations? Can natural gas be safely *extracted* by hydraulic fracturing of bedrock? Will inoculating adolescent girls against the human papilloma virus — an extremely common sexually transmitted disease responsible for cervical cancer — lull them into engaging in unprotected sex, thereby increasing their risk of pregnancy or of other STDs? Does allowing citizens to carry concealed handguns in public increase crime — or *reduce* it by deterring violent predation?

Never have human societies *known so much* about mitigating the dangers they face but *agreed so little* about what they collectively know. Because this disjunction features the persistence of divisive conflict in the face of compelling scientific evidence, we can refer to it as the "science communication paradox" (Figure 2).

Resolving this paradox is the central aim of a new *science of science communication*. Its central findings suggest that intensifying popular conflict over collective knowledge is in fact a predictable byproduct of the very conditions that make free, democratic societies so hospitable to the advancement of science. But just as science has equipped society to repel myriad other threats, so the science of science communication can be used to fashion tools specifically suited to dispelling the science communication paradox.

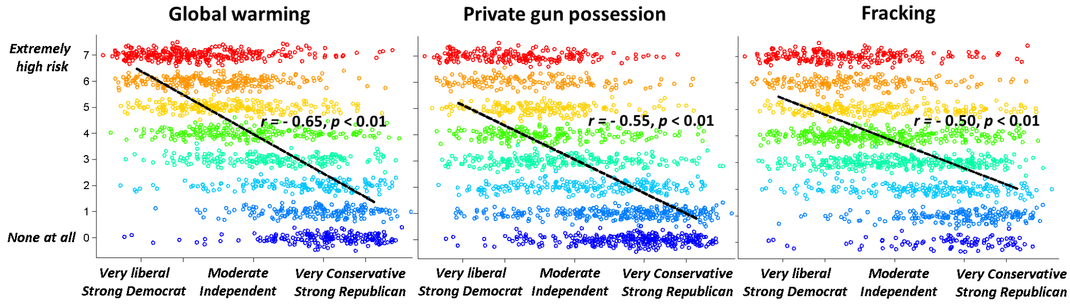

Figure 1. Polarization over risk. Scatterplots relate risk perceptions to political outlooks for members of nationally representative sample (N = 1800), April–May 2014 [Kahan, 2015].

The "public irrationality thesis"

What is the "science of science communication"? One could easily define it with reference to some set of signature methods and aims [Fischhoff and Scheufele, 2013]. But more compelling is simply to *do* the science of science communication — to *show* what it means to approach the science communication paradox *scientifically*.

The most popular explanation for the science communication paradox can be called the "public irrationality thesis" or "PIT." Members of the public, PIT stresses, are not very science literate. In addition, they do not think like scientists. Scientists assess risk in a conscious, deliberate fashion, employing the analytical reasoning necessary to make sense of empirical evidence. Members of the public, in contrast, appraise hazards intuitively, on the basis of fast-acting unconscious emotions. As a result, members of the public overestimate dramatic or sensational risks like terrorism and discount more remote but more consequential ones — like climate change [Weber, 2006; Marx et al., 2007; Sunstein, 2007; Sunstein, 2005].

PIT features genuine cognitive mechanisms known to be important in various settings [Kahneman, 2003; Frederick, 2005]. It therefore supplies a very plausible explanation of the science communication paradox.

But there will inevitably be a greater number of *plausible* accounts of any complex social phenomenon than can actually be *true* [Watts, 2011]. Cognitive psychology supplies a rich inventory of dynamics — "dissonance avoidance", "availability cascades", "tipping points", "emotional numbing", "fast vs. slow cognition", and the like. Treating these as a grab bag of argument templates, any imaginative op-ed writer can construct a seemingly "scientific" account of public conflict over risk.

Conjectures of this sort are *not* a bad thing. But those who offer them should acknowledge that they are only hypotheses, in need of empirical testing, and not hold them forth as genuine empirical "explanations." Otherwise, our understanding of the science communication paradox will drown in a sea of just-so stories.

So does PIT withstand empirical testing? If the reason members of the public fail to take climate change as seriously as scientists think they should is that the public lacks the knowledge and capacity necessary to understand empirical information, then we would expect the gap between public and expert perceptions to narrow as members of the public become more science literate and more proficient in critical reasoning.

But that does not happen (Figure 2). Members of the public who score highest in one or another measure of science comprehension, studies show, are no more concerned about global warming than those who score the lowest [Kahan, 2015; Kahan et al., 2012]. The same pattern, moreover, characterizes multiple other contested risks, such as the ones posed by nuclear power, fracking, and private possession of firearms [Kahan, 2015].

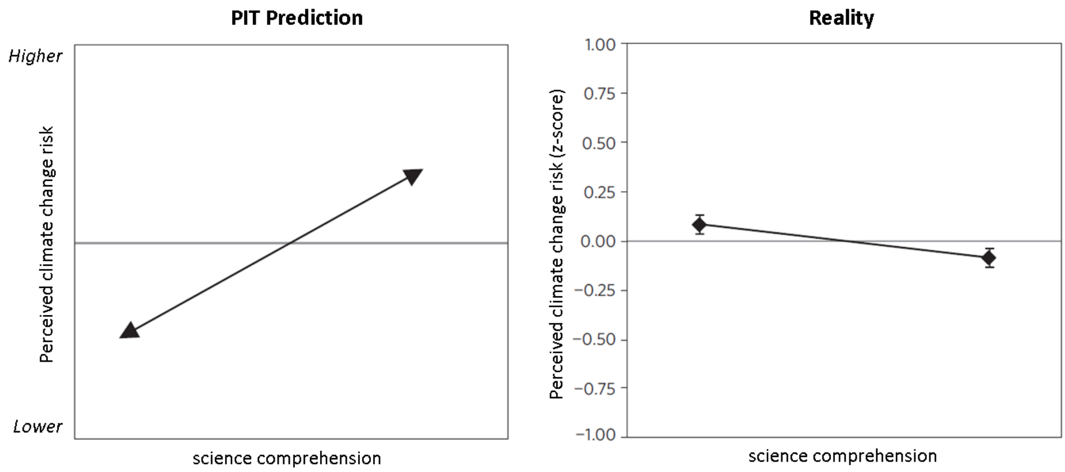

Figure 2. Impact of science comprehension on climate change polarization. Error bars are 0.95 confidence intervals (N = 1540) [Kahan et al., 2012].

The "cultural cognition thesis"

Another plausible conjecture — another *hypothesis* about the science communication paradox — is the "cultural cognition thesis" (CCT). CCT posits that certain types of group affinities are integral to the mental processes ordinary members of the public use to assess risk [Kahan et al., 2010].

"Motivated reasoning" refers to the tendency of people to conform their assessments of all sorts of evidence to some goal unrelated to accuracy [Sood, 2013; Kunda, 1990]. Students from rival colleges, for example, can be expected to form opposing perceptions when viewing a film of a disputed officiating call in a football game between their schools, consistent with their stake in experiencing emotional solidarity with their peers [Hastorf and Cantril, 1954].

CCT says this same thing occurs when members of the public access information about contested societal risks. When positions on *facts* become associated with opposing social groups — not universities but rather everyday networks of people linked by common moral values, political outlooks, and social norms — individuals selectively assess evidence in patterns that reflect their group identities [Kahan, 2011].

Numerous studies support CCT. In one, my colleagues and I examined the impact of cultural cognition on perceptions of scientific consensus [Kahan, Jenkins-Smith and Braman, 2013]. We asked our subjects — a large, nationally representative sample of U.S. adults — to indicate whether they regarded particular scientists as "experts" whose views an ordinary citizen ought to take into account on climate change, nuclear waste disposal, and gun control. We picked these issues precisely because they feature disputes over empirical, factual issues among opposing cultural groups.

The scientists were depicted as possessing eminent qualifications, including degrees from, and faculty appointments at, prestigious universities. However, half the study subjects saw a book excerpt in which the featured scientist took the "high risk" position (global warming *is* occurring; underground disposal of nuclear waste is *unsafe*; permitting carrying of concealed handguns *increases* crime) and half an excerpt in which the same scientist took the "low risk" position (there's *no* clear evidence human-caused global warming; underground disposal of nuclear wastes is *safe*; permitting concealed carry *reduces* crime).

The subjects' assessments of the scientists' expertise, we found, depended on the fit between the position attributed to the expert and the position held by most of the subjects' cultural peers. If the featured scientist was depicted as endorsing the dominant position in a subject's cultural group, the subject was highly likely to classify that scientist as an "expert" on that issue; if not, then not (Figure 3). Like sports fans motivated to *see* the officiating replay as supporting their team, the subjects selectively credited or discredited the evidence we showed them — the position of a highly qualified scientist — in a manner supportive of their group's position.

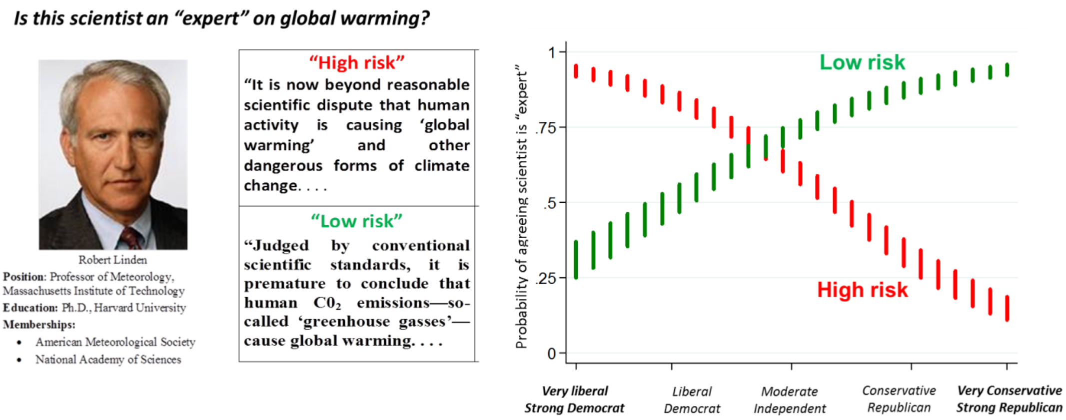

Figure 3. Biased perceptions of scientific expertise. Colored bars reflect 0.95 confidence intervals (N = 1336) [Kahan, Jenkins-Smith and Braman, 2013].

If this is how members of the public assess evidence of "expert consensus" outside the lab, we should expect members of diverse cultural groups to be polarized not just on particular risks but also on the weight of scientific opinion on those risks. In a survey component of the study, we found exactly that: subjects of diverse affiliations all strongly believed that the position that predominated in their group was consistent with "scientific consensus." In relation to National Academy of Sciences "expert consensus reports", all the groups were as likely to be right as wrong across the run of issues.

Science comprehension and polarization

PIT and CCT have also squared off face-to-face. Under PIT, one should expect individuals who are high in science comprehension to use their knowledge and reasoning proficiency to form risk perceptions supported by the best available scientific evidence. Individuals who lack such knowledge and reasoning proficiencies must "go with their gut", relying on intuitive heuristics like "what do people like me believe?" [Weber and Stern, 2011; Sunstein, 2006]. Accordingly, under PIT one would predict that as members of opposing cultural groups become more science literate and more adept at analytical reasoning — and thus less dependent on heuristic substitutes for science comprehension — they should converge in beliefs on climate change.

But the evidence refutes this prediction. In fact, the most science-comprehending members of opposing cultural groups, my colleagues and other researchers [Kahan et al., 2012; Hamilton, Cutler and Schaefer, 2012] have found, are the *most polarized* (Figure 4).

This is the outcome CCT predicts. *If* people can be expected to fit their assessments of evidence to the dominant position within their cultural groups, then those individuals most adept in reasoning about scientific data should be even "better" at forming culturally congenial beliefs than their less adept peers. This hypothesis is borne out by experiments showing that individuals who score highest on tests of one or another reasoning disposition opportunistically use that disposition to search out evidence supportive of their cultural predispositions and explain away the rest.

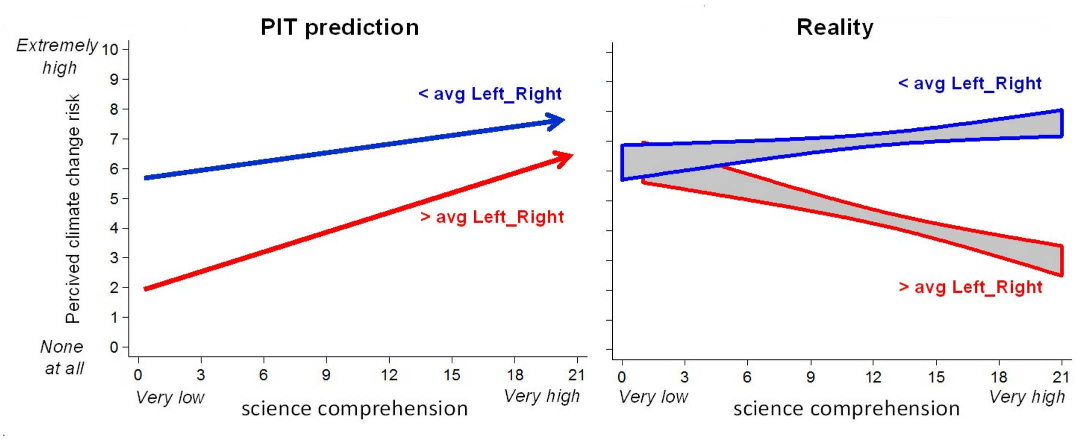

Figure 4. Polarizing impact of science comprehension on climate-change risk perceptions. Nationally representative sample (N = 1540). Shaded areas represent 0.95 confidence intervals [Kahan et al., 2012].

Pathological vs. normal cases

Scientific investigation of the science communication paradox, then, suggests that CCT furnishes a more satisfactory explanation than PIT. But it also reveals something else: such conflict — including the magnification of it by science comprehension — is *not* the norm. From the dangers of consuming artificially sweetened beverages to the safety of medical x-rays to the carcinogenic effect of exposure to power-line magnetic fields, the number of issues that do *not* culturally polarize the public is orders of magnitude larger than the number that do (Figure 5 and Figure 6).

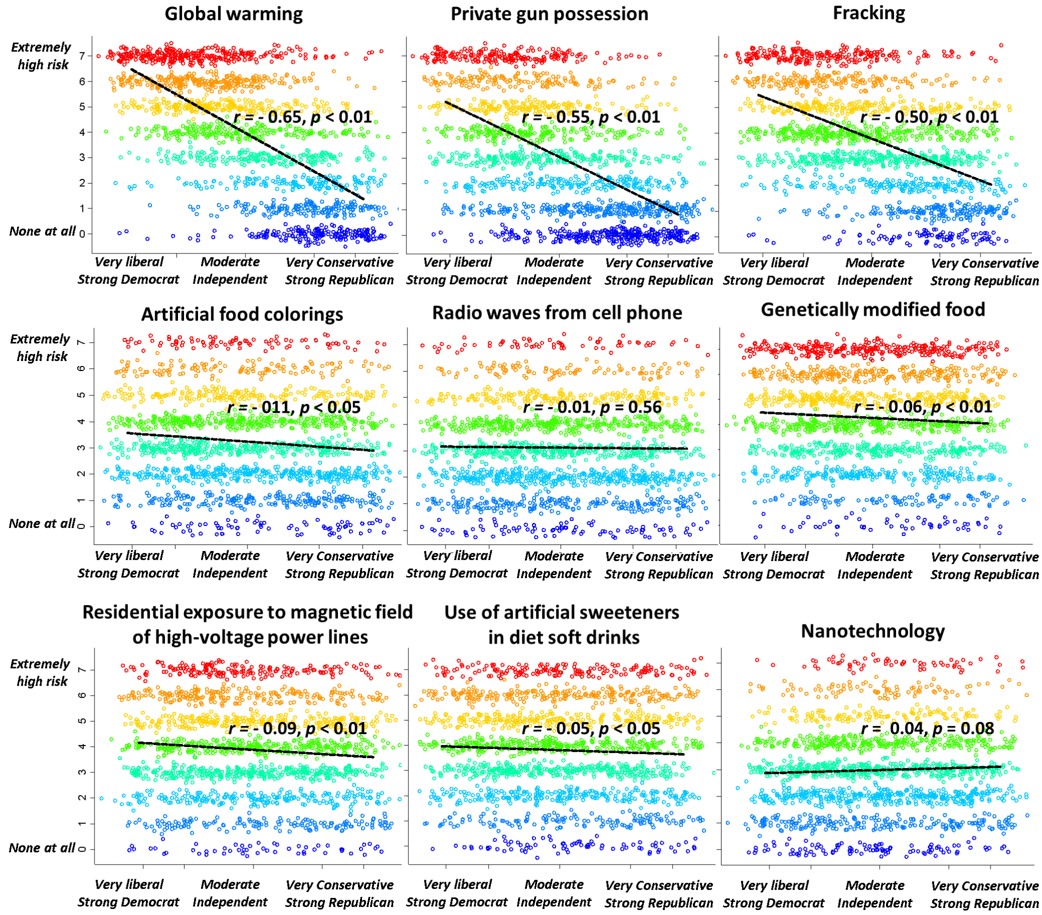

Figure 5. "Polarized" vs. "unpolarized" risk perceptions. Scatterplots relate risk perceptions to political outlooks for members of nationally representative sample (N = 1800), [Kahan, 2015].

Members of the public definitely do not have a better grasp of the science on the myriad issues that don't polarize them than they have of the few that do. In order simply to live — much less live well — individuals need to accept as known by science much more than they could comprehend or verify on their own. They do this by becoming experts at figuring out who knows what about what. It does not matter, for example, that half the U.S. population (science literacy tests show) believe "antibiotics kill viruses as well as bacteria" [National Science Foundation, 2014]: they know they should go to the *doctor* and take the medicine she prescribes when they are sick.

The place in which people are best at exercising this knowledge-recognition skill, moreover, is inside of identity-defining affinity groups. Individuals spend most of their time with people who share their basic outlooks, and thus get most of their information from them. They can also read people "like them" better — figuring out who genuinely knows what's known by science and who is merely pretending to [Watson, Kumar and Michaelsen, 1993].

This strategy is admittedly insular. But that is not usually a problem either: all the major cultural groups with which people identify are amply stocked with highly science-comprehending members and all enjoy operational mechanisms for

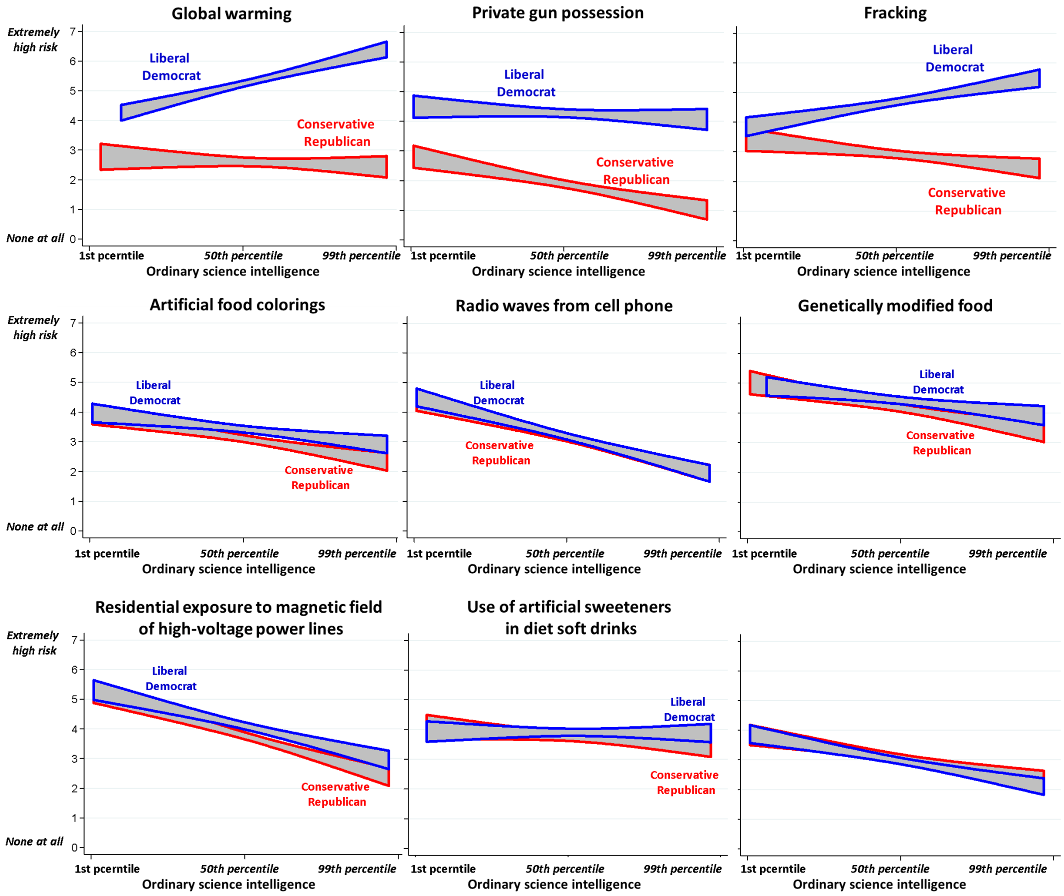

Figure 6. Science comprehension and polarization. Nationally representative sample (N = 1800), April-May 2014. Shaded areas represent 0.95 confidence intervals [Kahan, 2015].

transmitting scientific knowledge to their members. Any group that consistently misled its members on matters known to science and of consequence to their well-being would soon die out. Thus, ordinary members of diverse groups ordinarily converge on what is known by science.

Persistent nonconvergence — polarization — is in fact pathological. It occurs when factual issues become entangled in antagonistic cultural meanings that transform positions on them into badges of loyalty to opposing groups. In that circumstance, the same process that usually guides ordinary members of the public to what's known by science will systematically deceive them.

Popper's revenge. . .

It's no accident that the best philosophical exposition of science's distinctive way of knowing — *The Logic of Scientific Discovery* [Popper, 1959] — and one of if not *the* best philosophical expositions of liberal democracy — *The Open Society and its Enemies* [Popper, 1966] — were both written by Karl Popper. Only in a society that denies any institution the authority to stipulate what must be accepted as true, Popper recognized, can individuals be expected to develop the inquisitive and disputatious habits of mind that fuel the scientific engine of conjecture and refutation.

But as Popper understood, removing this barrier to knowledge does not dispense with the need for reliable mechanisms for certifying what science knows. What's distinctive of the Popperian "liberal republic of science" is not the absence of a social process for certifying valid knowledge but the multiplication of potential certifiers in the form of the pluralistic communities entered into by freely reasoning citizens.

Again, these communities typically will converge on what's known to science. But as the volume of knowledge and number of cultural certifiers both continue to grow, the occasions for disagreement among cultural groups necessarily increases. An expanding number of conflicts is thus guaranteed by sheer fortuity alone, although the occurrence of them can no doubt be instigated for strategic gain as well. Thus, the science communication paradox — the simultaneous increase in knowledge and conflict over what's known — is built into the constitution of the liberal republic of science. The science communication paradox is Popper's revenge.

The disentanglement principle

But as Popper also taught, there are no immutable forces at work in human history. The same tools used to fashion a scientific account of the source of the science communication paradox can be used to dispel it. The fundamental source of the paradox, empirical study suggests, is the entanglement of opposing factual beliefs with people's identities as members of one or another cultural group. It's logical to surmise, then, that the solution is to *disentangle* knowledge and identity when communicating scientific information [Kahan, 2015].

Lab experiments have been used to model this dynamic. In one, my research group tested U.S. and U.K. subjects' assessments of valid evidence on global warming [Kahan et al., 2015]. As expected, those we had first exposed to information on carbon-emission reductions were even more polarized on the validity of the global-warming evidence than were members of a control group. The images and language used to advocate carbon-emission limits triggered cultural cognition by accentuating the symbolic association between belief in climate change and conflict between groups defined by their opposing moral attitudes toward commerce, industry, and free markets.

Polarization dissipated, however, among subjects who had first been exposed to information on plans to study geoengineering. This technology resonates with the values of cultural groups whose members prize the use of human ingenuity to overcome environmental limits. By affirming rather than denigrating their cultural identities, the information on geoengineering dissolved the conflict those individuals experienced between crediting human-caused global warming and forming stances that express their defining commitments.

This lab-study insight comports with studies of "disentanglement" strategies in real-world settings. For example, research shows that standardized test questions that assess "belief" in evolution don't genuinely measure knowledge of either evolutionary science or science generally. Instead, they measure commitment to a form of cultural identity that features religiosity (Figure 7) [Kahan, 2015; Roos, 2012; Bishop and Anderson, 1990].

Figure 7. Disentangling identity from knowledge. Colored bars are 0.95 levels of confidence. Standardized test items on evolution generate biased results when administered to highly religious persons, but the effect can be erased by "disentangling" identity and knowledge in the item wording [Kahan, 2015].

Consistent with this finding, education researchers have devised instructional protocols that avoid conflating students' knowledge of evolutionary science with their professions of "*belief in*" it. By disentangling acquisition of knowledge from the obligation to make an affirmation that denigrates religious students' identities, these instructional methods enable students who say they "don't disbelieve in" evolution to learn the elements of the modern synthesis — natural selection, random mutation, and genetic variance — just as readily as nonreligious students who say they "do believe in" it [Lawson and Worsnop, 1992; Lawson, 1999].

Real-world communicators have also successfully used disentanglement to promote public engagement with climate science. Members of the Southeast Florida Regional Climate Compact — a coalition of local governments in Broward, Miami-Dade, Monroe, and Palm Beach Counties — have adopted a "Regional Climate Action Plan" containing over 100 distinct mitigation and adaption measures.

As it happens, the residents of Southeast Florida are as polarized on whether human activity is causing global warming as are those in the rest of the U.S. But the deliberative process that generated the Regional Climate Action Plan didn't put *that* question; instead, officials, guided by evidence-based methods, focused, relentlessly, on how communities could *use* scientific knowledge to address the region's practical, everyday needs.

The highly participatory process that led to adoption of the Regional Climate Action Plan enveloped residents with vivid, genuine examples of diverse local stakeholders — including businesses and local homeowner associations — evincing confidence in climate science through their words and actions. That *process* disentangled "what should we do with what we know", a question that unifies Southeast Floridians, from "whose side are you on", the divisive question that shapes the national climate science debate [Kahan, 2015].

These examples teach a common lesson — the science communication *disentanglement principle*. To negotiate the dynamics that form Popper's Revenge, science communication professionals must protect citizens from having to choose between *knowing what's known by science* and *being who they are* as members of diverse cultural communities.

A "new political science..."

But like other forms of scientific insight geared to protecting human societies from danger, the disentanglement principle cannot be expected to implement itself. Government regulatory procedures will need to be revised, programs of education reorganized, and professional norms updated to refine and exploit the knowledge generated by the science of science communication.

Identifying the precise nature of these reforms and the means for implementing them, moreover, will likewise require *empirical* study and not mere imaginative story-telling. These were the central themes of a pair of historic colloquia on the science of science communication recently sponsored by the National Academy of Sciences in 2012 and 2013.

As aristocratic forms of government yielded to modern democratic ones in the early 19th century, Tocqueville famously called for a "new political science for a world itself quite new" [Tocqueville, Reeve and Spencer, 1838]. Today, mature liberal democracies require a "new political science", too, one suited to the distinctive challenge of enabling citizens to reliably recognize the enormous stock of knowledge that their freedom and diversity make possible.

The science of science communication *is* that new political science.

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