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# Culturally Antagonistic Memes and the Zika Virus: An Experimental Test

## **Abstract**

This paper examines a remedy for a defect in existing accounts of public risk perceptions. The accounts in question feature two dynamics: the affect heuristic, which emphasizes the impact of visceral feelings on information processing; and the cultural cognition thesis, which describes the tendency of individuals to form beliefs that reflect and reinforce their group commitments. The defect is the failure of these two dynamics, when combined, to explain the peculiar selectivity of public risk controversies: despite their intensity and disruptiveness, such controversies occur less frequently than the affect heuristic and the cultural cognition thesis seem to predict. To account for this aspect of public risk perceptions, the paper describes a model that adds the phenomenon of culturally antagonistic memes – argumentative tropes that fuse positions on risk with contested visions of the best life. Arising adventitiously, antagonistic memes transform affect and cultural cognition from consensus-generating, truth-convergent influences on information processing into conflictual, identity-protective ones. The paper supports this model with experimental results involving perceptions of the risk of the Zika virus: a general sample of US subjects, whose cultural orientations were measured with the Cultural Cognition Worldview Scales, formed polarized affective reactions when exposed to information that was pervaded with antagonistic memes linking Zika to global warming; when exposed to comparable information linking Zika to unlawful immigration, the opposing affective stances of the subjects flipped in direction. Normative and prescriptive implications of these results are discussed.

## **Keywords**

risk perception, affect heuristic, cultural cognition, Zika virus

## **Disciplines**

Communication | Critical and Cultural Studies | Health Communication | Social and Behavioral Sciences

## Culturally antagonistic memes and the Zika virus: an experimental test

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This paper examines a remedy for a defect in existing accounts of public risk perceptions. The accounts in question feature two dynamics: the affect heuristic, which emphasizes the impact of visceral feelings on information processing; and the cultural cognition thesis, which describes the tendency of individuals to form beliefs that reflect and reinforce their group commitments. The defect is the failure of these two dynamics, when combined, to explain the peculiar selectivity of public risk controversies: despite their intensity and disruptiveness, such controversies occur less frequently than the affect heuristic and the cultural cognition thesis seem to predict. To account for this aspect of public risk perceptions, the paper describes a model that adds the phenomenon of *culturally antagonistic memes* – argumentative tropes that fuse positions on risk with contested visions of the best life. Arising adventitiously, antagonistic memes transform affect and cultural cognition from consensus-generating, truth-convergent influences on information processing into conflictual, identity-protective ones. The paper supports this model with experimental results involving perceptions of the risk of the Zika virus: a general sample of US subjects, whose cultural orientations were measured with the Cultural Cognition Worldview Scales, formed polarized affective reactions when exposed to information that was pervaded with antagonistic memes linking Zika to global warming; when exposed to comparable information linking Zika to unlawful immigration, the opposing affective stances of the subjects flipped in direction. Normative and prescriptive implications of these results are discussed.

**Keywords:** risk perception; affect heuristic; cultural cognition; Zika virus

### 1. The strange world of public risk controversy

The landscape of public risk perceptions is dominated by two opposing features: pockets of cultural polarization on a very small number of putative hazards; and the absence of conflict over a vast expanse of the same. Variance in cultural conflict across and within societies highlights the dissonance of the juxtaposition. For example, at the very time the US general public was rebelling against universal administration of a vaccine to protect adolescent school girls from the human papilloma

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virus, a sexually transmitted disease that causes cancer, they were placidly assenting to mandatory vaccination of the same girls to protect them from hepatitis-B, another cancer-causing sexually transmitted disease (Kahan 2013a). GM food risks bitterly divide people in France and numerous other European nations (Sato 2007); Americans, in contrast, don't even realize that 75% of the food stuffs on their supermarket shelves contain them (Hallman, Cuite, and Morin 2013) and prefer regulatory decisions be left to experts (McFadden and Lusk 2016). Public fears crippled the nuclear industry in the US in the 1980s; French pride in this technology has made nuclear energy that society's primary source of power (Slovic et al. 2000). What accounts for these patterns?

No doubt many things (Renn and Rohrman 2000). But in this paper we examine a particular dynamic that can help explain the advent of adventitious forms of political conflict over risk: culturally antagonistic memes.

This explanation doesn't supplant but rather supplements and integrates two others understood to be central to public conflict over risk. The affect heuristic refers to the gravitational force individuals' visceral feelings exert on their appraisals of risk information (Finucane et al. 2000). Cultural cognition refers to the tendency of individuals to form risk perceptions that reflect and reinforce their group commitments (Bolsen, Druckman, and Cook 2015). Culturally antagonistic memes – highly suggestive, highly inflammatory argumentative tropes that fuse risks to contested understandings of the best way to live – knit the two together in a fashion that predictably generates a crazy-quilt patchwork of risk controversies (cf. Toplak and Stanovich 2003; Stanovich and West 2007).

We furnish support for this theory with evidence from an original experiment involving a novel and as-yet non-polarizing risk source: the Zika virus. The experiment found that exposing a large sample of ordinary members of the US general public to materials redolent with antagonistic memes excited opposing affective states among members of diverse cultural groups, whose members thereafter displayed biased formation of beliefs about the virus's dangers.

After a short background discussion, we describe the design and results of the study. Because knowledge of such dynamics can and should inform practice (Jamieson and Hardy 2014), we conclude with a discussion of the implications of this study and practice of risk communication.

## **2. Two dynamics and a missing link**

### **2.1. *In general***

The motivation for the study reported in this paper was to improve upon a model of public risk perceptions that is powerful but manifestly incomplete. That model consists of two dynamics: the *affect heuristic*, and the *cultural cognition thesis*.

One might assume that how people feel about a potential source of danger – a gun, for example, or a nuclear power plant – reflects their weighing of its perceived costs and benefits. The affect heuristic, however, stands this view on its head. In the main, emotional appraisals aren't a consequence of the significance people give to information about societal risks; rather they are the source of it, shaping the effect they assign to information on the risk source's potential consequences (Slovic et al. 2004).

Indeed, the impact of affect on risk perceptions is not confined to cost-benefit evidence. It extends to all manner of information, including the weight of expert opinion, trust of regulators, and the efficacy of policy interventions (Slovic et al.

2004; Poortinga and Pidgeon 2005; Kahan, Jenkins-Smith, and Braman 2011). Psychometrically, *all* such judgments are best understood as separate indicators or measures of a latent (that is, unobserved) pro- or con-attitude (Romer and Hennessy 2007).

The cultural cognition thesis posits that *values are cognitively prior to fact* on contested societal risks (Kahan et al. 2006). It is dissonant to believe that what one views as noble is in fact dangerous, and what is base benign. It is also hazardous, socially, to form risk perceptions at odds with those of people with whom one shares close social ties: precisely because *their* perceptions of what's virtuous and vicious are likely to be highly correlated with their perceptions of what's beneficial and harmful, a person who forms deviant risk perceptions is likely to be viewed as *morally deviant* (Douglas 1966), and thus denied the benefits, psychic and material, that flow from close social ties (Sherman and Cohen 2002).

The affect heuristic and cultural cognition thesis complement one another. The former says we should expect individuals' perceptions of facts to cohere with their feelings about a risk source but does not tell us whether we should expect those feelings to be positive or negative. Similarly, in attributing risk perceptions to individuals' feelings, the affect heuristic does not furnish an explanation for why those feelings, and the resulting perceptions of risk, vary systematically across groups.

The cultural cognition thesis fills in these gaps. Group values invest objects (for example, guns), actions (the termination of a pregnancy), or states of affairs (industrialization) with social meanings the valence of which determines whether group members' affective appraisals are positive or negative. When groups attach *opposing* meanings to one and the same risk source, they will form opposingly valenced affective orientations, and thus opposingly valenced information-processing biases, toward it (Peters and Slovic 1996; Slovic and Peters 1998; Peters, Burraston, and Mertz 2004).

The affect heuristic also makes a vital contribution to the cultural cognition of risk. In effect, the former supplies the latter with a set of individual-level cognitive mechanisms that plausibly link cultural affiliations and related sensibilities to information processing. Without these, there would be nothing to connect cultural identity to risk perceptions but the black box functionalism that mars numerous other theories of group influence on individual belief and preferences (Elster 1989; Balkin 1998; Kahan 2012).

We will call this conception of how the affect heuristic and cultural cognition fit together the *AH-CCT Model*. This model supplies a powerful explanatory framework; empirical studies have linked the processes it describes to numerous risk conflicts, from ones over the reality of climate change to the consequences of gun control to the safety of nuclear power (Kahan 2010, 2012).

Nevertheless, the model is also manifestly incomplete. Among the things it doesn't account for is why in fact there are so few of the types of conflicts that it appears to explain.

In any modern, pluralistic liberal democracy, the number of cases in which individuals of diverse identities polarize are swamped by the number in which they do not. There is no meaningful level of public conflict in the US, for example, over exposure to the magnetic fields of high-power transmission lines, the safety of medical X-rays, or the ill-health effects of smoking, just to name a few. No cultural group in the US of any meaningful size is up in arms over use of nanotechnology in consumer products, GM food stuffs, or mad cow disease (Kahan 2015a, forthcoming-a).

But one could easily imagine these risks exciting intense and intensely opposed affective resonances across diverse cultural groups. Indeed, with respect to many of them cultural conflict either once did exist in the US or now does elsewhere (Gusfield 1993; Gaskell, Bauer et al. 1999; Nathanson 1999; Slovic et al. 2000; Ferrari 2009).

If the affect heuristic and cultural cognition are so pervasive, why are public conflicts over risk so few and far between? Obviously, there cannot plausibly be conflicts over each and every societal risk, but there could, in any given society at any given time, be substantially more than there are.

Actually, AH-CCT can easily be used to construct an explanation for the relative tranquility of public attitudes toward risk, too. On this account, the affect heuristic and cultural cognition are understood to be founts of public *consensus*, not *dissensus*.

Individuals need to accept more science than they can understand. To get the benefits of what science knows requires them to become experts not in all the various domains of science that touch on their welfare – something that it is impossible for them to do – but instead to become experts at *recognizing* valid science (Keil 2003, 2010, 2012). They do this through pattern recognition – a preconscious faculty of perception that assimilates particular instances of a putative object (Margolis 1987, 1996) – here, scientific expertise, or the work of scientific experts – to an inventory of prototypes acquired through experience.

In order for pattern recognition to perform this or any other task, however, it must be appropriately calibrated. That is, it must, through preconscious mechanisms, make its presence felt when the occasion arises, and appropriately orient individuals with respect to the object being classified (Stanovich 2009, 2011).

Cultural cognition and the affect heuristic can be seen as working in tandem to guide this process. Cultural cognition supplies individuals with the psychic incentive necessary to immerse themselves in a rich source of expertise prototypes – the ones latent in the interactions of their cultural groups. The affect heuristic, on this account, is what *makes* the sort of tacit knowledge acquired in this way capable of suppling orienting guidance: by summoning it when the occasion is apt, and by motivating action consistent with it (Peters, Lipkus and Diefenbach 2006; Evans et al. 2015). Admittedly, this form of affective orientation originates in discrete, relatively insular sets of social interactions among members of like-minded groups. But no group of any size would long survive (that is, persist as a meaningful source of orientating guidance) were it structured in a manner that tended consistently to mislead its members on forms of decision-relevant science essential to their welfare. Accordingly, there is good reason to believe that a system of parallel cultural certification of knowledge will endow diverse citizens with largely convergent affective intuitions on which forms of scientific evidence are valid and which not (Kahan 2015b).

This model of how the affect heuristic and cultural cognition relate to risk perception is also plausible. But the incompleteness of this conception of AH-CCT reciprocates the incompleteness of the first: what now needs to be explained is why diverse groups don't *always* converge. Something is missing – without which the AH-CCT model is in danger of explaining everything and hence nothing. The missing piece that helps the AH-CCT model avoid this flaw, we submit, consists of *culturally antagonistic memes*.

The surmise that memes are a 'missing link' that alters the import of critical reasoning dispositions has been suggested by Stanovich and colleagues (Toplak and

Stanovich 2003, 2007, 2008; Macpherson and Stanovich 2007). Dispositions such as actively open-minded thinking and cognitive reflection consist precisely in the tendency to self-consciously interrogate strongly held beliefs, including those associated with membership in groups. But researchers have found that these dispositions exert such an effect only unevenly, and in fact can sometimes be associated with the aggravation of ‘myside bias’ – the tendency to selectively credit information in a manner that presupposes the truth of one’s own views on contested matters. Stanovich and West (2007, 241) have suggested that ‘an explanation. ... might be found by combining some concepts from the emerging science of memetics – the science of the epidemiology of idea-sized units called memes. ... –with dual process theor[ies]’ of cognition. On this account, ‘it is not people who are characterized by more or less myside bias but *beliefs* that differ in the degree of belief bias they engender’ (Stanovich and West 2008, 159).

Our account builds on this conjecture. ‘Memes’ refer to ideas and practices that enjoy wide circulation and arouse self-reinforcing forms of attention as well as spontaneous adaptation and elaboration (Balkin 1998; Blackmore 2000). A small subset of these sorts self-replicating ideas and practices, the ones we call ‘culturally antagonistic memes’ refer to highly evocative, highly inflammatory argumentative tropes used by members of one group to stigmatize another.

When they figure in debates over risk, these contempt-pervaded tropes invest positions on them with affective resonances symbolic of opposing groups’ values or identities. In the resulting discourse climate, individuals will come to perceive risk regulation as ‘express[ing] the public worth of one subculture’s norms relative to those of others, demonstrating which cultures have legitimacy and public domination’ and thereby ‘enhanc[ing] the social status of groups carrying the affirmed culture and degrad[ing] groups carrying that which is condemned as deviant’ (Gusfield 1968, 59). Conducted in the idiom of instrumental consequences, the stances diverse citizens adopt on which activities genuinely threaten society and which policies truly mitigate the attendant dangers become rhetorical subterfuges in an ‘ongoing debate about the ideal society’ (Douglas and Wildavsky 1982, 36).

This process is effected through a decisive switch in the sort of information processing that is characteristic of the AH-CCT model. From a reliable and consensus-generating guide to valid decision-relevant science, the affective heuristic and cultural cognition at this point combine to generate a divisive, non-truth-convergent source of *identity-protective motivated cognition* (Hastorf and Cantril 1954; Lord, Ross, and Lepper 1979; Sherman and Cohen 2006; Kahan 2010; Greene 2013; Jost, Hennes, and Lavine 2013).<sup>1</sup>

By fusing contending positions on a risk or like facts to opposing group identities, antagonistic memes effectively transform positions on them into badges of membership in, and loyalty to, competing groups. Because this state of affairs pits opposing groups’ knowledge-certification systems against one another, the forms of information-processing associated with cultural cognition and the affect heuristic will under these conditions necessarily lose their power to generate truth-convergent forms of consensus across them.

This switch will not cause such information processing to abate, however. There is rarely any personal action that an individual can take that will affect the level of danger that a societal risk poses to him or anyone he cares about; his decisions as a consumer, voter, or participant in public debate won’t matter enough, for example, to affect the course of climate change, or the regulation of fracking, or the siting of



nuclear waste facility. In contrast, such an individual's personal behavior, including the attitudes he evinces on issues infused with social meanings, will typically have tremendous significance for the impressions that others form of his character (Lessig 1995; Sherman and Cohen 2002). As a result, it will be individually rational, if collectively disastrous, for individuals to form habits of mind that reliably produce identity-affirming rather than accurate ones when societal risks become infused with meanings that divide their groups from others (Kahan 2015b).

Indeed, these habits of mind will become seamlessly interwoven into the capacities essential for assessing scientific information. 'Motivated system 2 reasoning' refers to the tendency of individuals to *use* their proficiency in numeracy, cognitive reflection, and science comprehension to ferret out and credit identity-congruent evidence and explain away the rest (Kahan, forthcoming-b). Much as a virus does to the genetic material of an otherwise healthy cell, identity-protective cognition effectively insinuates itself into reasoning dispositions essential to recognizing the best available evidence (Kahan 2013b; Kahan et al., forthcoming). Their cognitive faculties having been redirected in this fashion, the individuals most adept in these forms of reasoning will end up the most polarized on culturally contentious risks (Hamilton 2011; Hamilton, Cutler, and Schaefer 2012; Kahan et al. 2012).

On this account, identity-protective cognition is thus not a natural outgrowth of but rather a pathological *deformation* of the processes associated with the AH-CCT model. The trigger of this pathology, moreover, is the advent of culturally antagonistic memes (Figure 1).

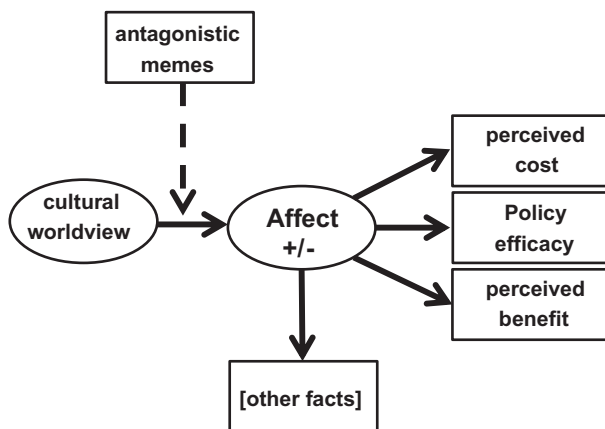


Figure 1. AH-CCT model and antagonistic memes.

Notes: Due to the affect heuristic, all facts relating to risk perception – including expected benefits and costs, and the efficacy of risk regulation – are posited to be caused by a generic affective orientation. Psychometrically, they are indicators of a latent affective disposition or orientation toward the putative risk source. According to the *cultural cognition thesis*, cultural commitments determine the valence – positive or negative – of affect in relation to the risk source. These dynamics can but need not generate identity-protective cognition; whether they will depends on whether, as a result of antagonistic memes, positions on the putative risk source become entangled in opposing cultural social meanings that make adherence to competing beliefs status enhancing for members of opposing groups.



## 2.2. A concrete illustration

Many persistently contested science issues fit this pattern. But we will focus on one that we believe is particularly well suited for illustration: the US experience with the HPV vaccine.

The HPV vaccine confers (near-perfect) immunity to the human papilloma virus, an extremely common sexually transmitted disease that causes cervical cancer. The vaccine also has the distinction of being the *only* childhood immunization recommended for universal administration by the US Centers for Disease Control that is not now on the schedule of mandatory school-enrollment immunizations in the United States. Legislative proposals to add it were defeated in dozens of states in the years from 2007 to 2008 as a result of intense political controversy over the safety and effectiveness of the vaccine (Kahan 2013a).

Although the proposal to add the HPV vaccine to the list of mandatory vaccinations divided the public along predictable lines, the conflict over it was in fact not inevitable. Only a few years before nearly every state had endorsed the CDC's proposal for universal administration of the HBV vaccine, which likewise confers immunity for a sexually transmitted disease, hepatitis-B, that causes cancer. The HBV vaccine is now given in infancy, but at that time it was an adolescent shot, just like the HPV vaccine. During the years in which legislative battles were raging over the latter vaccine, nationwide vaccination rates for the former were well over 90% (Kahan 2013a).

Like every other childhood vaccine that preceded it, the HBV vaccine was considered and approved for inclusion in state universal-immunization schedules by non-political public health agencies delegated this expert task by state legislatures. The vast majority of parents thus learned of the vaccine for the first time when consent to administer it was sought from their pediatricians, trusted experts who advised them the vaccine was a safe addition to the array of prophylactic treatments for keeping their children healthy. Just as important, regardless of who these parents were – Republican or Democrat, devout evangelical or atheist – they were all afforded ample evidence that parents just like them were getting their kids vaccinated for HBV. This is a science communication environment in which the AH-CCT model can be expected to generate largely *convergent* affective reactions across all groups – exactly the outcome that was observed.

The HPV's vaccine path to public awareness, in contrast, was much more treacherous. Seeking to establish a dominant position in the market before the approval of a competing shot, the manufacturer of the HPV vaccine orchestrated a nationwide campaign to establish immunization mandates by *statutes* enacted by *state legislatures*. What was normally a routine, nonpolitical decision – the administrative updating of states' mandatory-vaccination immunization schedules – thus became a high-profile, highly partisan dispute. People became acquainted with the vaccine not during visits to their pediatricians' office but while viewing political news outlets. There they were bombarded with reports on the 'slut shot' (Taormino 2006) and 'virgin vaccine' (Page 2006) for school girls, a framing enabled by the manufacturer's decision to seek fast-track FDA approval of a women's-only shot as part of company's plan to vault over the conventional, less speedy, depoliticized administrative-approval process (Gollust et al. 2015).

These media stories and resulting social media reaction were replete with what we are referring to as 'culturally antagonistic memes' (Figure 2). 'Trust us: Vioxx,



Figure 2. Culturally antagonistic memes: the HPV vaccine.

Now Gardasil,' declared a viral internet feature that mocked the manufacturer's own advertising campaign. 'HPV vaccine: Republicans prove themselves morons once again,' sneered liberal commentators (2011). 'They value your virginity more than your life,' another righteously intoned; 'there was a time when only the loony left believed that the loony right favored death over sex; not any more' (Goodman 2015). Individualist-oriented commentators retorted: 'Let's use teenage girls as lab rats for a monopoly' (Erickson 2011).

These are exactly the conditions one would expect to fuse a risk issue to antagonistic social meanings, thereby triggering identity-protective cognition on the vaccine's risks and benefits (Bolsen, Druckman, and Cook 2013; Fowler and Gollust 2015). Studies confirmed that exactly that happened (Gollust et al. 2010; Kahan, Braman, Cohen, et al. 2010).

### 3. Study: Zika and culturally antagonistic memes

#### 3.1. Why Zika

The aim of this study was to experimentally model the impact that scholars have speculated memes have in redirecting critical reasoning dispositions and that we surmise explains the patchwork quality of public conflicts over risks HPV and HBV vaccines. The focus of the study was the impact of culturally antagonistic-meme generating communications on the perceived risks of the *Zika virus*.

We selected the Zika virus for two reasons. The first is that we are confident there *isn't* currently meaningful cultural dissensus on Zika at the current time. For over five months, the Annenberg Public Policy Center (2016a) has been tracking US public opinion on the disease. Attention early on spiked and then leveled off, and is now rising again; knowledge about the health effects of the virus and about effective means of self-protection have proven uneven; certain misunderstandings about the link between the virus and microcephaly have persisted, albeit at modest levels (Annenberg Public Policy Center 2016b).

But nothing in this mix varies meaningfully with ideology, religion, or like forms of cultural identity. There is reason to be apprehensive about the speed with which members of the public are progressing in their understanding of key facts about the virus. But the evidence suggests that culturally diverse members of the public are progressing in unison, much in the manner one would expect under the 'normal,' nonpathological process contemplated by the AH-CCT Model (Figure 1).

At the same time, there has been a steady accumulation of communications tying the Zika health threat to already culturally charged issues (Figure 3). The voice of public health officials furnishing the public with precautionary advice is only one in a chorus, whose other members include a collection of advocacy groups all seeking to leverage public anxiety over Zika into greater attention to their special cause (see Figure 3).

Among these are anti-immigrant groups. These actors suggest that the spread of Zika is likely to be accelerated by undocumented aliens as well as lawful immigrants from Zika-affected regions. ‘Latin America’s Zika virus is the latest undocumented immigrant to hit our shores,’ one commentator caustically notes (Malkin 2016). It’s obvious from the ‘available evidence’ that ‘open borders contribute to the vulnerability of the United States to the virus’ (Corsi 2016). ‘People from Central and South America, ground zero for Zika and other infectious diseases including tuberculosis, dengue, Chagas, Chikungunya and schistosomiasis, make up nearly 15 percent of the illegal-immigrant population in the U.S.’ (Malkin 2016). ‘[A] drain on our economy, a peril to our national security, and a drag on our souls,’ illegal immigrants are now ‘hazardous to our health, thanks to sloppy US immigration laws acting as incubators for diseases once foreign to North America – like the untreatable Zika virus’ (Abruzzo 2016).

Climate change advocates have also latched onto Zika. ‘Zika is the kind of thing we’ve been ranting about for 20 years,’ one observes. ‘We should’ve anticipated it. Whenever the planet has faced a major climate change event, man-made or not, species have moved around and their pathogens have come into contact with species with no resistance’ (Milman 2016). Now ‘thanks to climate change’ Zika could ‘soon enjoy a greater reach’ (Mercer 2016), ‘spread[ing] deeper’ into currently secure areas of the U.S. (Gillis 2016). Of all the ‘tragedies stemming from global warming,’ including the ‘floods and droughts and storms, the failed harvests and forced migrations, . . . no single item on the list seems any more horrible than the emerging news from South America about the newly prominent Zika disease’ (McKibben 2016). ‘We need to face up to the fact that pushing the limits of the planet’s ecology has become dangerous in novel ways.’ ‘The Republicans are in denial about climate change, but in the real world, we can feel it. . . . It’s also an invitation



Figure 3. Culturally antagonistic memes: Zika.

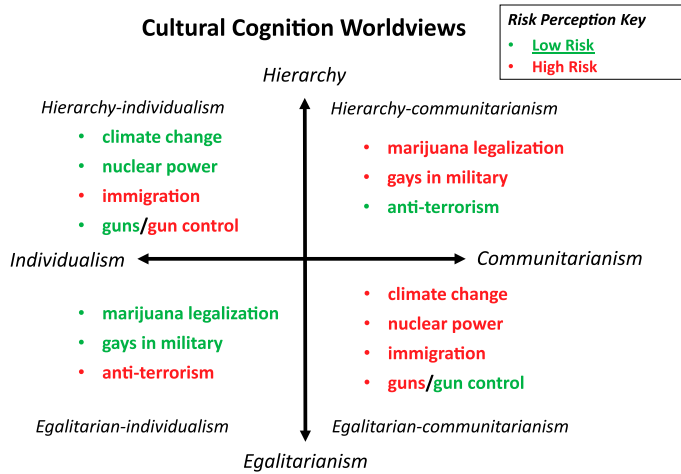


Figure 4. Cultural cognition of thesis.

Notes: Drawing on a typology proposed by Douglas (1970), the cultural cognition thesis (Slovic 2010) posits that conflicts over risk perceptions reflect cultural predispositions toward the legitimacy of socially stratified forms of authority ('Hierarchy vs. Egalitarianism') and the relative prerogatives of individuals and collectivities ('Individualism vs. Communitarianism'). Observational and experimental research based on the Cultural Cognition Worldview scales have established relationships between the cultural 'ways of life' associated with the scheme and environmental other societal risks (Xue et al. 2014).

for breeding mosquitoes and putting Americans at risk all across the United States' (Johnson 2016).

The situation presented, then, furnishes an ideal one to extend previous research. The tropes that inform advocacy material linking Zika to other culturally contested issues are replete with the accusatory and resentment-focusing tropes featured in highly polarized risk disputes. Yet in no previous study has there been an opportunity to test the impact of such tropes in relation to an issue not already the subject of at least modest contestation.

It is quite possible, of course, that the explanation for the patchwork of contestation and tranquility that forms the fabric of public risk perception is some as-yet undetected factor intrinsic to particular risk sources. It is perfectly plausible to believe, too, that deeper, historical influences render a particular risk source either impervious or distinctly amenable to controversy of a particular form, in particular societies.

But through an appropriately constructed study, one can test the alternative hypothesis that it is the contingent advent of exposure to culturally antagonistic memes that triggers such conflict, and accounts for its complexion and intensity. The study we conducted was aimed at furnishing evidence relevant to assessing the relative plausibility of these alternative conjectures.

### 3.2. *Methods*

#### 3.2.1. *Sample*

The study was administered to a large ( $N = 2400$ ) sample of US adults. Subjects were recruited by YouGov, a public research firms which conducts online surveys

and experiments on behalf of academic and governmental researchers and commercial customers (including political campaigns).<sup>2</sup> Fifty-seven percent of the sample members were female; 73% were white, 10% were African-American, and 9% were Hispanic. The average age was 48 (SD = 17). The median educational attainment was ‘some college,’ and the median income was \$40,000 to \$49,000. Thirty-five percent of the sample identified as ‘Democrats,’ 26% as Republicans, and 43% as ‘Independents.’ The study was administered from 22 April to 11 May 2016.

### 3.2.2. *Experimental*<sup>3</sup>

Subjects were assigned to one of three conditions: ‘Public Health,’ ‘Immigrant’ and ‘Global Warming.’ Subjects in all three read a news story on Zika public health risks. Patterned on a Centers for Disease Control advisory (2016), the stories presented identical, true information on Zika. The stories explained that ‘an epidemic of Zika infections in Brazil has been linked to a spike in microcephaly, a birth defect that results in stunted brain and head sizes in newborns.’ The stories also summarized research findings indicating that ‘Zika might cause microcephaly in the babies of women infected during pregnancy.’ Finally, they all reported CDC-issued ‘guidelines aimed at protecting pregnant women from exposure to the virus’:

- Men with confirmed cases of the virus or who have had symptoms of the virus are now advised to wait at least six months after their symptoms begin before having unprotected sex. ...
- Women and men without symptoms who have traveled to or had sex with someone who has traveled to a Zika-infected area are now advised to wait at least eight weeks after possible exposure to the virus before the woman tries to become pregnant, according to the guidelines.
- Men who have traveled to a Zika-infected area who have not had symptoms of the virus are now advised to abstain from sex or use a condom for at least eight weeks after returning from the area.

The public health risk content was underscored by the headline in the Public Health condition story (‘Public Impact of Zika Grows’) and by the common subheadline in each condition (‘CDC updates Zika advice for sex and pregnancy’).

The headlines, leads and introductory material in the Global Warming and Immigrant condition versions were patterned on real communications linking the spread of Zika to climate change and illegal immigration. Thus, in Global Warming (headline: ‘Global Warming Could Spread Zika, Group Warns’), the lead stated,

We can now add still another danger to the litany of risks – coastal flooding, droughts, destructive hurricanes, reduced agricultural production – attributable to global warming: the accelerated spread of Zika, the mosquito-borne virus suspected of causing infants to be born with abnormally small heads in Brazil and other Latin American countries.

The story attributed this conclusion to

a report issued today by Save our Planet (SOP), a Washington, D.C., based group dedicated to promoting policies aimed at counteracting the impact of human activity on climate change.

... '[W]ith climate change, plants and animals that thrive in warmer habitats are going to move to previously cooler areas, including those in the continental United States,' Carlsmith explained at a Washington, D.C. news conference. 'Mosquitos carrying the Zika virus can be expected to do the same.'

The story in *Immigrant* (headline: 'Influx of Immigrants Could Spread Zika, Group Warns') used a parallel structure. 'We can now add still another danger to the litany of harms – increased unemployment, higher crime rates, crushing tax burdens to cover the exploding demand for welfare benefits – attributable to the flood of illegal immigrants: the accelerated spread of Zika, the mosquito-borne virus suspected of causing infants to be born with abnormally small heads in Brazil and other Latin American countries.' The story then went on to describe a 'a report issued today by Protect America's Borders (PAB), a Washington, D.C., based group dedicated to promoting policies aimed at reducing eligibility for legal immigration to the United States and increasing governmental efforts to combat illegal entry into the country.' The spokesman for the group was quoted as stating that 'as infected Mexicans, Columbians, Brazilians, and others come to the U.S., Americans will inevitably join the ranks of people who get this disease and whose babies are then born with this horrific deformity.'

### 3.2.3. *Cultural worldviews*

Subjects' cultural outlooks were measured with the Cultural Cognition Worldview scales (Decision Making Individual Differences Inventory 2011). Patterned on Mary Douglas's group–grid typology (Douglas 1970; Rayner 1992), the scales use a two-dimensional framework to characterize preferences about how society and other groups should be organized (Figure 4). One dimension, 'hierarchy-egalitarianism,' assesses attitudes toward social stratification in status and roles (e.g. 'We need to dramatically reduce inequalities between the rich and the poor, whites and people of color, and men and women'; 'society as a whole has become too soft and feminine'). The other, 'individualism–communitarianism,' assesses attitudes toward the relative prerogatives and obligations of individuals, on the one hand, and those of collectivities, on the other (e.g. 'The government interferes far too much in our everyday lives'; 'the government should do more to advance society's goals, even if that means limiting the freedom and choices of individuals').

The Cultural Cognition Worldview scales were developed to implement Douglas's proposal (1999) to link the Cultural Theory of Risk (Douglas and Wildavsky 1982) the Psychometric Paradigm (Slovic 2000). Their psychometric properties and explanatory power have been shown to make them superior to a wide variety of alternatives used to examine the impact of cultural predispositions on perceptions on risk perceptions (Xue et al. 2014).

We used the 12-item short form (Kahan 2012) (Appendix A). Two, six-item orthogonal factors – the loadings for which appropriately reflected the 'hierarchy-egalitarianism' and 'individualism–communitarianism' worldview dimensions – were extracted from the 12-item battery. Factor scores – 'Hfac' for hierarchy-egalitarianism ( $\alpha = 0.88$ ), and 'Ifac' for individualism–communitarianism ( $\alpha = 0.81$ ) – were used to measure the posited latent dispositions. Although the measures are continuous and treated as such in multivariate analyses, one can for expositional purposes refer to individuals as 'Hierarch individualists,' 'Hierarch communitarians,' 'Egalitarian indi-



vidualists,’ and ‘Egalitarian communitarians,’ respectively, based on their scores in relation to the means of the two cross-cutting scales.

#### 3.2.4. Zika beliefs and attitudes

We also measured subjects’ beliefs about and attitudes toward Zika with several batteries of items. The two most important items related to the subjects’ Zika risk perceptions:

**ZIKA\_ISRPM.** How much risk do you believe the Zika virus poses to human health in the United States? [0 ‘no risk at all’; 1 ‘Very low risk’; 2 ‘Low risk’; 3 ‘Between low and moderate risk’; 4 ‘Moderate risk’; 5 ‘Between moderate and high risk’; 6 ‘High risk’; 7 ‘Very high risk’]

**ZIKAWORRY.** How concerned are you that the Zika virus will spread to where you live? [0 ‘not at all concerned’; 1 ‘slightly concerned’; 2 ‘between slightly and moderately concerned’ 3 ‘moderately concerned’ 4 ‘Between moderately and very concerned’ 5 ‘very concerned’]

These two items were intended to measure a latent *affective* disposition toward Zika. The simple Likert measure of relative risk reflected in ZIKA\_ISRPM (for ‘Industrial Strength Risk Perception Measure’) has been validated across a variety of contexts as a powerful one-item predictor of more particular attitudes and even behaviors, a quality that vouches for its status as an indicator of the type of generic orientation associated with the affect heuristic (Weber, Blais, and Betz 2002; Ganzach et al. 2008; Dohmen 2011). It is especially suited for assessing sources of variance in risk-related affect (Kahan 2015a).

A standard item in the ongoing Annenberg Public Policy Center’s ‘Science Knowledge Survey’ (2016a), ZIKAWORRY directly solicits an affective appraisal. Its high degree of covariance with ZIKA\_ISRPM ( $r = 0.71$ ), furnishes grounds for confidence that both are valid Zika affect indicators. The two were combined to form a scale, which was labeled ‘ZAFFECT’ ( $\alpha = 0.80$ ).

Another battery of items required subjects to assess propositions, some true and some false, relating to the health risks of Zika. Many of these items were ones the subjects should have been able to answer correctly based on information contained in the news stories (e.g. disagree or agree, ‘a person can catch Zika from being bitten by a mosquito that is carrying the Zika virus’; ‘public health experts would say’ that ‘a man who has travelled to a location that is currently experiencing a high rate of Zika infections but who is NOT experiencing symptoms after returning’ cannot ‘infect another person through sexual intercourse’). Other tested general knowledge of facts not specifically or explicitly asserted in the stories; (e.g. disagree or agree, ‘A person can catch Zika from sitting next to someone who has been infected by the Zika virus’; ‘a person can catch Zika from drinking water sprayed with a chemical used to stop the spread of mosquitoes’). Still others included currently unsupported propositions related to the experimental stimuli news stories (e.g. ‘Immigrants entering the United States illegally have caused the spread of the Zika virus to the United States’; ‘global warming has caused the Zika virus to spread to the United States’). The 16 items in this battery were combined into a scale, scored with Item Response Theory, which was designated ZLIT ( $\alpha = 0.80$ ).

By way of external validation, ZLIT was assessed in relation to subjects’ scores on the Ordinary Science Intelligence assessment (Kahan 2016). Designed for use in



the study of risk perception and science communication, OSI measures both the capacity and the motivation to comprehend scientific information. ZLIT correlated positively with OSI ( $r = 0.45$ ,  $p < 0.01$ ),<sup>4</sup> supporting the inference that ZLIT measures dispositions related to science-information processing.

Finally, a ‘Zika Policy’ battery was administered. Items in this set used a six-point oppose–support Likert scale to assess subjects’ endorsement of a variety of measures to combat infection by the virus and the spread of it generally (e.g. ‘the release of genetically engineered mosquitos designed to interfere with breeding and reproducing of Zika-carrying mosquitos’; ‘increased funding for the U.S. Center for Disease Control to take steps to prevent the spread of Zika in the U.S.’; ‘development of a vaccine against infection by the Zika virus’).

The resulting scale, ZPOLICY ( $\alpha = 0.71$ ) was heavily left skewed. Depending on how one looks at it, this is fortunate and unfortunate. It is fortunate insofar as it implies that coming into the study subjects had already formed a strong commitment to public interventions to combat Zika. It is unfortunate insofar as the low level of variance in the scale constrained the possibility of explaining individual differences, within and between conditions.

### 3.3. *Hypotheses*

#### 3.3.1. *Zika affect*

As explained, the motivation for the study was to test the power of culturally antagonistic memes to excite identity-protective cognition through its impact on affect and cultural cognition. The study design was structured to create conditions in which such an effect would likely reveal itself *if* in fact this account of how antagonistic memes operate within the AH-CCT model is correct.

Climate change and immigration are culturally charged issues. Both have been shown to generate correspondingly polarized perceptions of risk (e.g. Kahan et al. 2016). Advocacy materials of the sort discussed in Section 3.1 and reflected in the stimulus materials for the Global Warming and Immigrant conditions could thus be expected to excite identity-protective cognition by establishing an affective link between Zika and these issues.

Accordingly, evidence that the experimental assignment induces cultural polarization in ZAFFECT, an affect measure extracted from risk perception indicators, would make it more plausible to believe that Zika risk perceptions can be a conduit of antagonistic memes. By the same token, a finding of the lack of such an effect would reduce the plausibility of this concern; such a result would be compatible with the conjecture that the selectivity of risk conflicts is rooted in features intrinsic to the risk source in question, or in deeper historical and cultural influences not readily triggered or modified by adventitious exposure to particular and particularly inflammatory forms of communication. We will refer to these two predicted results – polarization conditional on treatment and no such polarization – as the *AM-vulnerability* and *AM-immunity* hypotheses, respectively.

The specific *direction* of any effect also bears on the weight of the evidence. Climate change tends to generate greater concern among individuals as their worldviews become more egalitarian and communitarian, while immigration tends to generate greater concern as their worldviews become more hierarchical and individualistic (Kahan et al. 2016). So a finding of opposing patterns of polarization

along these lines between these two conditions would be supportive of the inference of a vulnerability of Zika risk perceptions to antagonistic-meme effects.<sup>5</sup>

This formulation of the inferential strategy assumes that individuals with these identities will not be polarized in the Public Health Condition, or at least not so strongly polarized in that condition as in the Global Warming and Immigrant ones. This surmise seems plausible. So, too, however, does the conjecture that there will be polarization in the Public Health Condition among individuals who are relatively individualistic and ones who are relatively communitarian: persons with these outlooks tend to diverge on the value of public provisioning for collective needs (or at least on the perception of the necessity and efficacy of such provisioning) (Rayner 1992). They thus might be affectively disposed to form opposing responses to the information in the Public Health version of the article, in which the expectation of public interventions is more salient in the lead and not diluted by the inclusion of other issues with strong cultural resonances.

The inferential value of the evidence, however, does not depend strongly on the absence of cultural polarization in the Public Health condition. In the event of such polarization, the AM-vulnerability hypothesis would still predict polarization in Zika affect conditional on assignment to the Immigrant and Global Warming conditions, which, for the reasons discussed, should vary in their directional effects.

### 3.3.2. ZLIT

Identity-protective cognition involves conforming assessments of information to culturally congruent affective appraisals of a putative risk source. If the AM-vulnerability hypothesis is correct, then we should observe the signature of this form of biased information processing in the ZLIT scale. If not, then not.

What effect would *count* as supportive of the AM-vulnerability hypothesis with respect to this measure, however, merits attention. ZLIT consists of propositions that variously assert or deny connections between behaviors and Zika risks. If the subjects are unaffected by identity-protective cognition, ZLIT should register their levels of knowledge about Zika risks uniformly between conditions. But if the experimental assignment does trigger identity-protective cognition, we should expect subjects' knowledge to be distorted by their unconscious motivation to endorse propositions that affirm their cultural identities and to deny ones that threaten or denigrate their identities. Accordingly, corroboration of the AM-vulnerability hypothesis would take the form of a main effect: viz., degradation of ZLIT scores in Global Warming and Immigrant relative to scores in Public Health.

Such degradation, moreover, should be attributable primarily to between-condition differences that reflect the motivation of subjects to affirm or deny propositions consistent with their experimentally manipulated affective orientation toward ZIKA. One would expect, for example, Egalitarian Communitarians to affirm that 'Global warming has caused the Zika virus to spread to the United States' (GWSPREAD) and Hierarch Individualists that 'immigrants entering the United States illegally have caused the spread of the Zika virus to the United States' (IMMSPREAD) more readily in the Global Warming and Immigrant conditions, respectively. Moreover, many (not all) of the ZLIT battery items also reflect incorrect propositions (or ones incorrect at the time of the study administration; e.g. 'the number of cases of babies being born in the United States with abnormally small heads and brains has increased in recent months'; 'there is currently an outbreak of

Zika infections in Europe’; ‘a person can catch Zika from sitting next to someone who has been infected by the Zika virus’) that one might expect individuals more readily to affirm when assigned to a condition in which evincing fear was identity-affirming and to deny when assigned to a condition in which such fear would be identity-threatening or identity-denigrating.

Borrowing a term from Sunstein (2006), we will refer to this pattern of responses as ‘misfearing.’ As we use the term, ‘misfearing’ does not involve the affective appraisal of risk per se; indeed, we are skeptical not only of the assertion that affect is inimical to accurate risk perception generally but of the claim that risk perception uninformed by affect could ever be appropriately or reliably discerning of true danger, even among individuals of the highest proficiency in conscious, effortful information processing (Peters, Lipkus, and Diefenbach 2006; Evans et al. 2015; generally Damasio 2010).

We mean by misfearing the condition in which affect becomes unmoored from the cues that might be expected to encapsulate personal and collective understandings of the physical harm associated with a putative risk source, and instead becomes responsive to the *status threat* an individual will endure within an affinity group if he or she manifests endorsement of a risk claim (Slovic 2000, 2010). A token of identity-protective cognition, affect-driven information processing will under these circumstances necessarily generate polarization rather than convergence on the best available evidence among culturally diverse citizens. However big the contribution that appropriately calibrated affect makes to activating the processes that help individuals to discern risk, affect infused in this way with identity-protective cognition is highly likely to be inimical to their collective well-being (Kahan and Slovic 2006).

To test this hypothesis, a subset of ZLIT items having this quality – of being incorrect but likely to attract endorsement disproportionately when fear of Zika is identity-affirming – were combined into a separate ‘MISFEARING’ scale ( $\alpha = 0.76$ ).<sup>6</sup> Accordingly, if the AM-vulnerability hypothesis is correct, we should expect to see evidence of a *misfearing effect*: that is, a tendency to score higher on this scale (by answering more items *incorrectly*) in the experiment condition in which a higher level of fear is identity-congruent than when it is not. The AM-immunity hypothesis, in contrast, predicts the absence of such an effect.

The AM-vulnerability hypothesis sees antagonistic memes as triggering a cognitive switch whereby critical reasoning dispositions become identity-convergent rather than truth-convergent in their operation. Accordingly, the AM-vulnerability hypothesis posits that the misfearing effect should, perversely, be most intense in subjects highest in science comprehension.

Again, this inferential strategy assumes that there will be no or minimal polarization in Public Health. If there is polarization in that condition, however, the competing hypotheses remain amenable to investigation by comparing whether subjects of opposing cultural identities vary their responses to items conditional on their assignment to Global Warming and Immigrant, experimental treatments expected to generate opposing effects among subjects with Egalitarian Communitarian and Hierarchical Individualistic identities.

### 3.3.3. *ZIKA\_POLICY*

For the same reason that one might expect bundling of information on Zika with contentious cultural issues to crate culturally opposed affective responses to Zika

risks, so one might expect such a bundling to generate comparable divisions in comprehension or support for policy-making interventions to reduce the Zika public health threat. Accordingly, any AM-vulnerability effects in relation to ZIKA\_POLICY should track those observed in connection with ZAFFECT. The AM-immunity hypothesis, in contrast, predicts that positions on ZIKA\_POLICY will be unaffected by the experimental assignment.

### 3.4. Results

#### 3.4.1. ZAFFECT

The experimental assignment had a small main effect on ZAFFECT (Table B1, Model 1).<sup>7</sup> Relative to subjects assigned to Public Health ( $M = 0.02$ ,  $SE = 0.03$ ) and Immigrant ( $M = 0.07$ ,  $SE = 0.4$ ), subjects assigned to Global Warming were slightly less concerned about Zika risks ( $M = -0.10$ ,  $SE = 0.04$ ).

The impact conditional on cultural outlooks was more substantial (Figure 5). In Public Health, Egalitarian Communitarians had the highest ZAFFECT score ( $M = 0.25$ ,  $SE = 0.06$ ), and Hierarchical Individualists the lowest ( $M = -0.20$ ,  $SE = 0.06$ ). Hierarch Communitarians ( $M = 0.13$ ,  $SE = 0.06$ ) and Egalitarian Individualists ( $M = -0.07$ ,  $SE = 0.06$ ) were in between, with scores close to the sample mean (Figure 6).

Assignment to the Global Warming condition generated a substantial shift in concern (Figures 5 and 6). The ZAFFECT scores of Hierarch Communitarians ( $\Delta M = -0.21$ ,  $\pm 0.18$ ), Hierarchical Individualists ( $\Delta M = -0.29$ ,  $\pm 0.17$ ), and

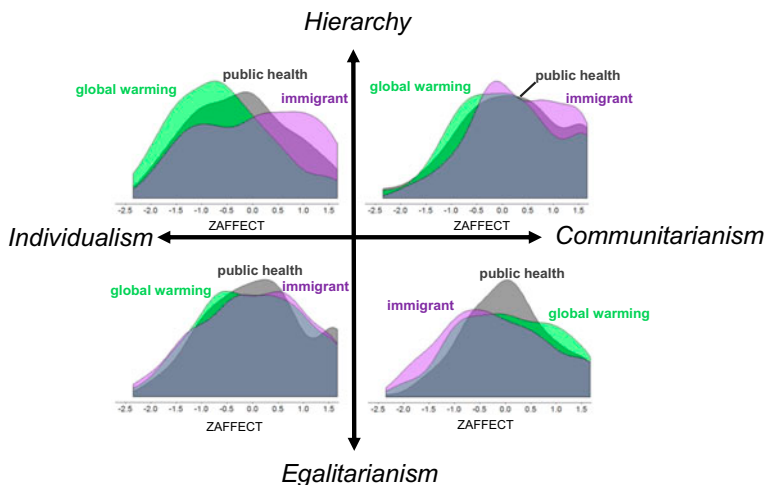


Figure 5. Experimental results for ZAFFECT: raw data.

Notes: The impact of the experimental assignment conditional on cultural worldviews can be gauged by observing within any quadrant the relative density of the observations for each color-coded condition. For example, the left-leaning skew of the green density plot in the upper left and the right-leaning skew of the same-colored density plot in the lower right denote the opposing reactions of Hierarchical Individualists and Egalitarian Communitarians, respectively, as do the opposing skews of the purple-colored immigrant density distributions. The experimental impact was less pronounced on Hierarchical Communitarians and Egalitarian Individualists.

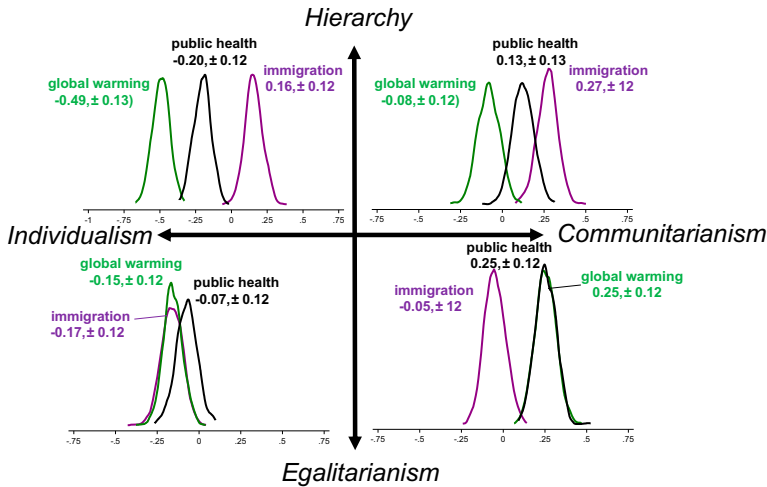


Figure 6. Experimental impact for ZAFFECT (z-scores): Multivariate regression analysis. Notes: Derived from Monte Carlo simulations based on multivariate regression (Table B1, Model 3). ‘±’ refers to the 2.5 and 97.5% boundaries of estimated mean probability density distributions (King, Tom, and Wittenberg 2000).

Egalitarian Individualists ( $\Delta M = -0.08, \pm 0.16$ ) all *declined* relative to the scores of their Public Health counterparts.<sup>8</sup> The scores of Egalitarian Communitarians ( $\Delta M = 0.00, \pm 0.16$ ) did not change. However, the gap between the typical Egalitarian Communitarian and the typical Hierarchical Individualist – members of groups that are highly polarized on climate change risks (Kahan et al. 2012) – widened substantially ( $\Delta M = 0.75, \pm 0.21$ ) relative to the already sizable gulf between them in the Public Health condition ( $\Delta M = 0.45, \pm 0.20$ ).

Assignment to Immigrant produced an even more dramatic effect (Figure 6). Indeed, Hierarch Individualists and Egalitarian Communitarians flipped in their relative positions, as the latter’s ZAFFECT score increased by 0.65 ( $\pm 0.17$ ) and latter’s dropped by 0.31 ( $\pm 0.18$ ), nearly a one-standard deviation change relative to their scores in Global Warming. Hierarch Communitarians’ scores increased by 0.35 ( $\pm 0.17$ ), creating a 0.44 ( $\pm 0.20$ ) gap between them and Egalitarian Individualists, whose scores in Immigrant did not change materially relative to their scores in Global Warming ( $\Delta M = -0.01, \pm 0.17$ ).

### 3.4.2. ZLIT and misfearing

As explained, ZLIT can be used to measure whether the experimental assignment affected information processing and belief formation. ZLIT scores were on average 0.12 SD’s ( $\pm 0.08$ ) lower for subjects assigned to either the Global Warming or the Immigrant conditions than were the scores of those assigned to Public Health (Table B2, Model 1).<sup>9</sup>

Relatively egalitarian and individualistic subjects scored higher than relatively hierarchical and communitarian ones in all conditions. But cultural worldview scores did not otherwise vary depending on the experimental assignment (Table B2, Models 2 & 3).

The experimental impact also affected scores on the MISFEARING scale. Indeed, misfearing effects – the tendency to more readily credit incorrect statements evincing Zika fear when doing so was hypothesized to be identity-affirming – grew in tandem with subjects scores on the Ordinary Science Intelligence assessment (Table B3, Model 4 & Figure 7). For example, the predicted probability that a subject modestly above average in science comprehension would incorrectly indicate ‘there is currently an outbreak of Zika infections in Europe’ grew 27 percentage points ( $\pm 7\%$ ) when he or she was assigned to the condition in which Zika fear was identity-affirming rather than identity-threatening. Equivalent to the effect that identity-protective cognition has in appropriating faculties of science comprehension generally (Kahan 2013a; Kahan et al., forthcoming), this pattern reflects the

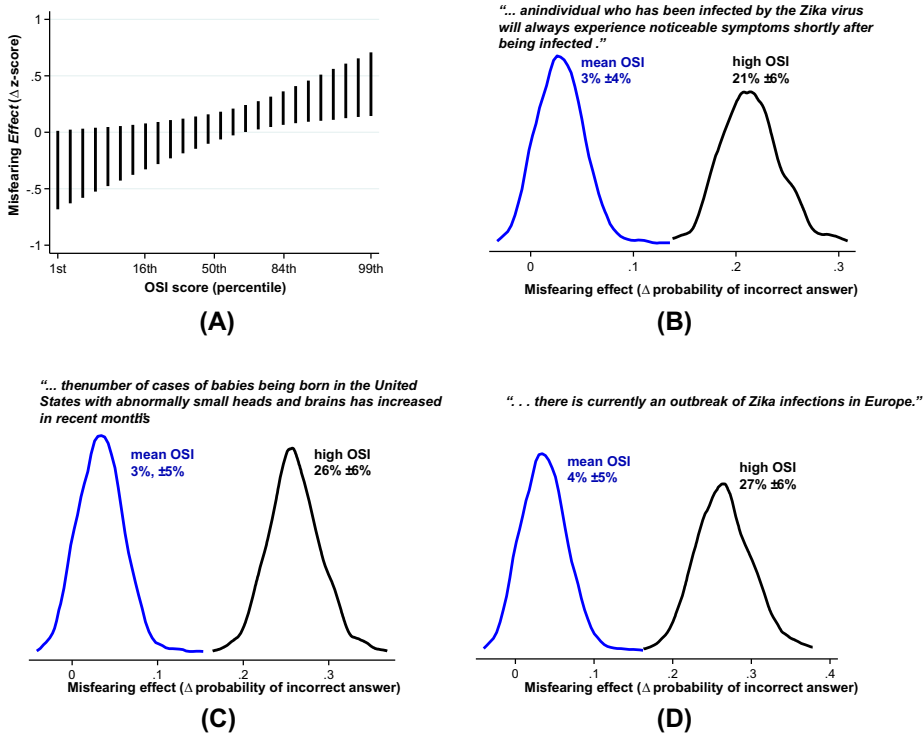


Figure 7. Misfearing effect.

Notes: Derived by multivariate regression (Table B3, Model 4), Panel A estimates the impact of the misfearing effect in relation to Egalitarian Communitarian and Hierarchical Individualist subjects’ scores on the Ordinary Science Comprehension assessment. Black bars denote 0.95 confidence intervals. Based on Monte Carlo Simulations of the effect of the experimental manipulation on the MISFEARING scale, Panels B–D illustrate the magnitude of the effect: the probability density distribution indicated the increased likelihood that a Hierarchical Individualist or Egalitarian Communitarian subject who scores either at the mean or one standard-deviation above the mean on the Ordinary Science Intelligence assessment will supply the incorrect response to the specified item conditional on being assigned to an experimental condition in which Zika fear is posited to be identity-affirming rather than identity-threatening. No such effect was observed in Hierarchical communitarian or Egalitarian Individualist subjects. ‘ $\pm$ ’ refers to the 2.5 and 97.5% boundaries of estimated-mean probability density distributions (King, Tom, and Wittenberg 2000).

signature reasoning deformation associated with System 2 motivated reasoning (Kahan, *forthcoming-b*).

In the case of a subject modestly above average in science comprehension, the predicted misfearing effect was 21 percentage points ( $\pm 6\%$ ) for the proposition that ‘an individual who has been infected by the Zika virus will always experience noticeable symptoms shortly after being infected.’ This result, in particular, illustrates the potentially perverse effects of identity-protective cognition on information processing. Intuitively, this proposition seems to connote a high level of risk. But in fact, it understates the danger posed by Zika exposure, for it implies that an individual who is asymptomatic is incapable of transmitting the virus by sexual intercourse, an error that could result in infection of a woman who is or will become pregnant, thereby enhancing her risk of giving birth to a microcephalic infant. The impact of Global Warming in arousing an affective state of risk *concern* in Egalitarian Communitarians and risk *skepticism* in Hierarch Individualists, then, paradoxically was associated with the former *crediting* and the latter *denying* a proposition that, if accepted, would lull individuals into seriously risky personal behavior.

These effects, obviously, are not attributable to the *health-related* information subjects in different conditions received. Rather, what they reflect is the impact of the experimental assignment on the predispositions of diverse subjects to selectively credit or reject information in patterns congruent with the identity-affirming or identity-denigrating *affective* resonance induced by the experimental assignment.

#### 3.4.3. ZPOLICY

The affect heuristic posits that support for policies to abate a societal risk, like perceptions of risk-related facts, are indicators of a generic affective orientation toward the risk source. Accordingly, the AM-vulnerability hypothesis predicts that an experimental manipulation that influences an affective orientation of that sort should have a parallel impact on support for relevant risk-regulation policies.

No such effect was observed in this study (Table B4). Unlike scores on ZAFFECT and ZLIT, sample-wide scores on ZPOLICY showed no evidence of being affected by the experimental manipulation overall. Hierarchical Individualist subjects were less supportive of public policy interventions than were Egalitarian Communitarian subjects generally (Table B4, Model 2). But there was no effect on scores conditional on subjects’ cultural outlooks (Table B4, Model 3), a result in line with the AM-immunity hypothesis.

## 4. Implications

The aim of the reported study was to use Zika risk perceptions to model how culturally antagonistic memes can transform a consensus-generating process of information processing into a culturally divisive one. The study design pitted two opposing hypotheses against each other: the AM-vulnerability hypothesis, which predicted that exposure to communications redolent with culturally antagonistic memes would generate the indicia of identity-protect cognition; and the AM-immunity hypothesis, which predicted there would be no such effect. We now take stock of the results, dividing the discussion into positive, normative, and prescriptive implications.



## 4.1. Positive

### 4.1.1. AM-vulnerability vs. AM-immunity: weighing the evidence

Only modestly divided in the Public Health condition, Hierarchic Individualists and Egalitarian Communitarians formed highly divergent affective reactions in Global Warming and Immigrant conditions. In the former condition, Hierarchical Individualists adopted a stance of skepticism toward Zika risks that mirrored their skepticism toward human-climate change, creating a sizable gulf of concern between them and their Egalitarian Communitarian rivals. In Immigrant, in contrast, it was the Egalitarian Communitarians who reacted dismissively and the Hierarchical Individuals who evinced alarm.

The health-risk information that subjects of diverse outlooks received within each conditions was equivalent. The only thing that varied was the *valence* of the argumentative tropes used to tie those risks to others that already excite opposing affective reactions in individuals of diverse cultural worldviews. The transfer of these antagonistic affective stances to Zika risks was exactly what the AM-vulnerability hypothesis predicted.

The AM-vulnerability hypothesis also predicted that the experimental treatment would affect the quality of information processing. It did.

There was a main effect – one independent of cultural worldviews – consisting in the degradation of ZLIT scores conditional on assignment to the Global Warming or Immigrant conditions. This is the result one would expect if subjects were unconsciously motivated to assess propositions based *not* on the strength of the evidence they were exposed to in the study or had previously encountered *but rather* on the congruence of such assertions with the affective orientation that had been induced by the experimental assignment.

This inference was bolstered by evidence of the tendency of subjects to ‘misfear’ Zika – that is, to more readily credit *false* propositions relating to Zika risks when doing so was identity-affirming rather than identity-threatening. Not only did experimentally treated subjects display a greater willingness to endorse false accounts of the source of the current Zika public health emergency when assigned to the condition in which Zika fear was identity-congruent. They also evinced a disturbing inability even to recognize when affirming a false proposition – that Zika infection always results in symptoms within a short period of time, for example – actually *underestimated* the true risk posed by the virus and the utility of personal precautions to avoid infection.

The probability that subjects would ‘misfear’ Zika in this fashion did not abate but instead *intensified* as their science comprehension capacity increased. This form of ‘motivated system 2 reasoning’ (Kahan, [forthcoming-b](#)) is the telltale sign that individuals are using their reason to form identity-convergent rather than truth-convergent beliefs. The power of the experimental manipulation to excite this form of information processing constitutes the study’s most compelling proof of the conjecture (cf. Toplak and Stanovich 2003; Stanovich and West 2007) that culturally antagonistic memes explain the seemingly chaotic pattern of evidence-resistant public conflicts over risk across place and time.

The experiment had *no* meaningful impact, however, on subjects’ perceptions of the appropriateness of policy interventions to contain Zika risks. This result was more consistent with the prediction made by the AM-immunity hypothesis.

How much, then, should this result discount the weight of the evidence overall in support of the AM-vulnerability hypothesis? That is for readers to decide, of course. But we would suggest the answer is ‘not much.’

The public’s exposure to information on Zika has been uneven. There is a high likelihood that that they will have heard of the virus and its causal nexus with microcephalic infants (Annenberg Public Policy Center 2016a). Formed on the basis of communications much like those featured in the Public Health condition news story, the affective response is likely to be one that inclines them to support for public health interventions. This conclusion is consistent with the highly skewed character of the responses we observed to our Zika policy items.

The sorts of communications featured in the Global Warming and Immigrant conditions, in contrast, are relatively new and, while steadily growing in frequency, definitely not yet a central feature of communications on the virus in the media or elsewhere. Accordingly, there is little reason to expect such argumentative tropes to have been widely or repeatedly observed by the subjects. Indeed, if they had been, one would expect the experimental treatment to have little or no impact on the subjects affective responses to Zika (Druckman, Fein, and Leeper 2012; Druckman 2012).

The affect heuristic implies that information exposure that succeeds in changing affect should be expected to change individuals’ acceptance of information about a societal risk, and hence their policy preferences relating to it. Nevertheless, it seems reasonable to believe that this shift will occur over time and over successive affect-shaping and affect-reinforcing information exposures.

By administering a single dose of such information, the experimental manipulation in this study had a demonstrable effect on Zika affect and related forms of information processing. To be sure, it *didn’t* generate a comparable shift in policy preferences. But if affective orientations on Zika are as unformed and labile as the subjects’ responsiveness to our study’s experimental manipulation suggests, then one might expect persistent exposures to such communications outside the lab to polarize members of the public on policy interventions over time as well.

Indeed, such an effect might well be predicted by another important dynamic: the *social amplification of risk* (Kasperson et al. 1988). Fortifying accounts that focus only on individual cognition, the social amplification of risk systematizes the contribution that various forms of social influence make to transmission of risk perceptions and resulting public risk controversies. In particular, this theory features how feedback effects inherent in the media and other forms of communication compound processes like the ones contemplated by the affect heuristic and the cultural cognition thesis. Unrepresented by anything in this particular study design, social amplification might be expected to magnify the real-world counterparts of effects observed in the lab, making their ultimate impact on policy interventions even more probable.

For sure, this interpretation *ought* to be engaged critically! But critically engaging it means considering it in relation not to an inferentially barren ‘null hypothesis’ but in relation to the practically significant alternative conjecture that informed our study design: the AM-immunity hypothesis, which posits that risk conflict is inherent in the properties of risk sources, combined perhaps with more deep-seated social influences, and thus not amenable to being readily manipulated by exposure to culturally antagonistic memes. *That* hypothesis predicted not only that the subjects’ policy preferences would be unaffected but also that their affective orientations and

information processing wouldn't be either. The experimental results strongly refuted any such expectation.

#### 4.1.2. *Miserly processing: an alternative explanation?*

Of course, the greater consistency of the results with the AM-vulnerability than with the AM-immunity hypotheses leaves open the possibility that a third theory – one that is unconnected to the AH-CCT model but that makes the same predictions for our experiment – might still be true. We can think of at least one such rival that deserves mention here. Highly influential in political science, this position treats individual citizens as ‘miserly information processors’ who resort to one or another set of heuristic substitutes to compensate for their incapacity to work out which policy positions best fit their values and interests (e.g. Zaller 1992).

Arguably the most important heuristic cue for such citizens is the partisan identity of information sources (Mondak 1993; Lau and Redlawski 2001). In our study, arguments were advanced by parties conspicuously identified with issues of clear partisan import – namely, global warming and immigration. On the ‘miserly processor’ account, then, one might view the results of our study as evincing the disposition of citizens to give decisive weight to the views of partisan-aligned advocates, making it unnecessary to invoke identity-protective cognition, the affect heuristic, or the role we have attributed to antagonistic cultural memes in determining the object and valence of affective appraisals of risk.

Certain features of our study cast doubt on this view. For one thing, subjects of opposing political orientations did not respond to the experimental stimulus in the manner just described: as we discuss in Appendix C, the results we have reported cannot be reproduced by substituting left–right political outlooks for cultural world-views.

But more importantly still, the experimental effects were not attributable to miserly information processing. The ‘miserly processor’ position sees reliance on cues such as source credibility and group influences as ‘heuristic substitutes’ for conscious, effortful information processing, and thus predicts attenuation of partisan-source effects in cognitively sophisticated actors (Kam 2005). The culturally biased information processing effects observed in our study, however, were strongest among the cognitively most proficient subjects. This result is more in accord with the view that sees memes as a *switch* that substitutes identity-protection for truth-seeking as the object of rational information processing (Toplak and Stanovich 2003; Stanovich and West 2008; Macpherson and Stanovich 2007).

But we do not in fact see these arguments as furnishing deceive ‘proof’ against the ‘miserly processor’ position. It is in the nature of the inductive logic undergirding empirical inquiry that results will always be underdetermined with reference to the universe of mechanisms that could account for them. Accordingly, at any given time the pragmatic empiricist can never do more than adjudicate the relative plausibility of subsets of serious contenders. This study was aimed at assessing the relative plausibility of alternative accounts of how affect and identity-protective cognition are activated, not the plausibility of accounts that assume those processes, on the hand, and the ‘miserly processing’ position, on the other. Rather than mine this study for additional grounds for deciding between the AH-CCT model and the ‘miserly processor’ theory, then, it would make more sense to construct additional

studies self-consciously constructed to test the relative plausibility of these opposing accounts.

#### **4.2. Normative**

In our view, the normative significance of the experimental results reported in this paper is straightforward: the advent of advocacy that opportunistically bundles Zika with positions on culturally fraught issues should itself be treated as a serious threat to public health. From climate change to the HPV vaccine, from gun control to nuclear power, identity-protective cognition – the signature reasoning pathology associated with the AH-CCT Model – has demonstrated itself to be a poisonous influence on public engagement with valid decision-relevant science. Because identity-protective cognition feeds on the bundling of science information with culturally recriminatory rhetoric (Gollust et al. 2010; Bolsen and Druckman 2015; Bolsen, Druckman, and Cook 2014), anyone who observes the advent of such rhetoric in connection with a novel risk source, such as the Zika virus, should be alarmed.

The dangers that such advocacy posed to the HPV vaccine in the US were anticipated and even empirically modeled before they actually ripened into reason-eviscerating conditions of cultural conflict (Kahan 2013a). No one acted, and to this day the stigma that that vaccine bears continues to discourage proper public engagement with this critical form of decision-relevant science. Similar passivity in the face of all we know – including the accumulated insight of the study of science communication, the outcome of episodes like the HPV vaccine fiasco in the US, *and* the anticipatory empirical modeling presented in this study – would, in our view, constitute a form of recklessness on the part of those charged with protecting the public health.

#### **4.3. Prescriptive**

The prescriptive implications of our study, we believe, are both patently obvious and painfully obscure. What's obvious, then, is that actors in a position to do so should combat the emergence of antagonistic memes. What's far from obvious, however, is who is in a position to do what and how to effectuate that end. Without any pretense to completeness, we offer some reflections on the latter issue.

Government agencies and other risk communicators are not in a position to *prohibit* behavior generative of antagonistic memes, certainly. But they are in a position to boost the immunity of the body politic to the impact of them.

As we have emphasized, the AH-CCT Model does not naturally lead to polarization. On the contrary, under the Model diverse citizens ordinarily converge on the best available evidence as a result of their immersion in group interactions that feature the opinions and behavior of group members situated to recognize valid scientific information. The AH-CCT Model predicts cultural division only if antagonistic memes take root, fusing positions on risk to opposing group identities.

It follows that the most effective way to protect the science communication environment from culturally antagonistic memes is for government and other professional risk communicators to intervene *early on* in the career of the public's affective assessment of a putative risk source. The affect heuristic counsels that individuals will conform information to their affective appraisals. Thus, where culturally uniform affective appraisals are already deep and settled, one can expect the public to be relatively unaffected by communications that contain the sorts of argumentative

tropes that can evolve into antagonistic memes. Such appraisals, the AH-CCT Model implies, are formed in the context of relatively insular interactions among individuals who share basic cultural outlooks. Accordingly, professional risk communicators stand a reasonable chance in beating antagonistic-meme-generating communications to the punch – or in turning such punches into at best glancing blows – if they *seed* these affect-shaping affinity groups with the sorts of information likely to align their members' sensibilities with the best available scientific evidence.

This is a recommendation that is admittedly general. But it can still furnish guidance, in the form of an injunction to act decisively and quickly in a case like that of the Zika virus, where evidence shows that the public's sensibilities remain largely unformed. It can also furnish the basis for a research program that focuses on formulating and testing hypotheses that can help validate such a prescription and sharpen it into progressively more determinate directives.

## 5. Conclusion: antagonistic memes in the 'Liberal Republic of Science'

In the course of exploring a more general theory, we presented evidence that the public's comprehension of the best available evidence on a particular public health threat – the spread of the Zika virus – is at risk of being compromised by a distinctive science communication pathology. The infectious agent of this pathology consists in culturally antagonistic memes fabricated and propagated by advocates seeking to cash in on the public fear of Zika by bundling it with rhetoric calculated to excite contempt for those who oppose them on culturally charged issues like illegal immigration and climate change. When exposed to communications incorporating such rhetoric, culturally diverse study subjects formed polarizing affective reactions that in turn degraded their capacity to make sense of valid public health information.

Obviously, we don't *know* whether what we observed in the lab will occur outside of it. But we believe that the best way to reduce the *risk* of this outcome is to recognize that the proliferation of the sorts of rhetorical opportunism featured in this study is a *public health threat* in its own right. Public health agencies and individual public health professionals; professional health communicators and science journalists; responsible advocacy groups and ordinary citizens who support the causes being irresponsibly advanced by these means – all should oppose such forms of discourse. Had individuals and groups situated to do something recognized the consequences of the entanglement of decision-relevant science in antagonistic cultural meanings and taken coordinated action to avert this state, at least some of the current controversies featuring identity-protective cognition we are convinced, could have been avoided (Kahan 2013a).

Indeed, the failure of democratic societies to equip themselves to contain the threat posed by antagonistic memes exposes their citizens to recurring public health threats the magnitude of which rivals and in many cases exceeds those associated with the first Zika public health emergency. The toll this incapacity has exacted already includes the stifling of informed public engagement with science relevant to a variety of consequential hazards. The perpetuation of this deficit is certain to cost democratic societies the benefit of innumerable additional scientific insights, too, whether or not the threat that antagonistic memes pose to the communication of the best evidence on Zika materializes. In this sense, the public health crisis posed by Zika also furnishes an opportunity to begin to learn the critical lessons necessary for

liberal democracies to annihilate this welfare-crippling science communication pathology.

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### Notes

1. Cultural cognition is typically understood as a species of motivated reasoning (Hastorf and Cantril 1954; Kunda 1990) that manifests itself in the tendency to selectively credit evidence in a manner consistent with predispositions protective of group identity (Kahan 2011; Bolsen, Druckman, and Cook 2015). Paralleling work on how cultural outlooks shape societal risk perceptions, there is a rich political science literature on ‘ideologically motivated reasoning,’ in which individuals’ right–left political outlooks orient information processing (e.g. Lodge and Taber 2013). In our view, cultural worldviews and left–right political outlooks are not alternative accounts of what guides motivated reasoning in relation to social risks and related policy-relevant facts. Rather they are merely alternative frameworks for *measuring* the latent, group-related disposition that is posited to be driving unconscious, identity-protective information processing. Which framework – cultural worldviews or left–right political outlooks – should be used turns, in our opinion, on pragmatic criteria relating to the relative contribution one or the other makes to explanation, prediction, and prescription for the subject matter at hand (Kahan, forthcoming-b). Elaboration of this position, along with alternative data analyses that substitute left–right political outlooks for cultural worldviews in relation to the experimental results reported in this paper, are presented in Appendix C.
2. For information on YouGov’s sampling and stratification methods, see Ansolabehere and Rivers (2013).
3. The stimulus is reproduced in Appendix A.
4. The correlation was measured in the responses of subjects assigned to the Public Health condition to minimize any potential confounding identity-protective cognition effects associated with exposure to the charged themes featured in the news stories in the Global Warming and Immigrant conditions.
5. Although the hypotheses in this study, then, focus predominantly on divisions between Hierarchical Individualists and Egalitarian Communitarians, the Cultural Cognition Thesis does not imply that only individuals with these outlooks will ever polarize over risks. For studies in which Hierarchical Communitarians and Egalitarian Individualists divide, see Kahan et al. (2012, 2016); and Kahan, Braman, Monahan, et al. (2010).
6. See Appendix A. GWSPREAD and IMSPREAD were omitted from the MISFEARING scale to assure that any observed effect in the Global Warming and Immigrant conditions was not being driven by responses solely to these two items.
7. All experimental-effect estimates referred to in the text and illustrated graphically reflect univariate and multivariate regression models, which for expositional convenience are reproduced in Appendix B and are labeled ‘Table Bx.’
8. All ‘±’ margins of error reflect a 0.95 level of confidence.
9. Not surprisingly, the experimental manipulation polarized Hierarchical Individualist and Egalitarian Communitarian subjects in the expected directions on GWSPREAD (‘Global warming has caused the Zika virus to spread to the United States’) and IMSPREAD (‘Immigrants entering the United States illegally have caused the spread of the Zika virus to the United States’). As noticeable as these effects were, they did not alone account for the degradation in ZLIT scores. When those items were removed from the



scale, scores remained on average 0.10 SDs ( $\pm 0.08$ ) higher for subjects assigned to Public Health than did scores for subjects assigned to either to Global Warming or Immigrant.

10. Items underscored type were included in the Misfearing Scale.

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## Appendix A. Study instrument

### A1. Experimental stimulus

#### A1.1. Public Health news story

## Public health impact of Zika concern grows CDC updates Zika advice for sex and pregnancy

By Jeff Brooks, Associated Press

We can now add still another concern to the litany of risk factors—the outbreak of flu at a co-worker's daycare center; the unanticipated side effects of new medical treatment; diet, exercise, and other behaviors—that determine our vulnerability to serious diseases: the accelerated spread of Zika, the mosquito-borne virus determined to be causing infants to be born with abnormally small heads in Brazil and other Latin American countries.

This is the conclusion of a report issued today by a group of the Public Health Consortium, a group of public health researchers from leading universities who study the emergence of new illnesses and other threats to Americans' health.

"The reason Zika infections are now concentrated south of the border," said PHC spokesman David Carlsmith, "is that the virus is carried by a mosquito that thrives in the warmer, wetter conditions typical of those regions."

"But once a person is bitten by such a mosquito, that individual can himself transmit Zika to another person," Carlsmith explained at a Washington, D.C. news conference. "Accordingly, as individuals Americans will inevitably join the ranks of people who get this disease and whose babies are then born with this horrific deformity."

"The spread of Zika is the kind of thing we've been ranting about for 20 years," added Lisa McFarlane, a University of Arizona epidemiologist who was one of the PHC report authors. "We should've anticipated it. Viruses travel everywhere humans do in today's global economy."

Transmitted by the *Aedes aegypti* mosquito, Zika has spread to at least 34 countries and territories. The World Health Organization estimates 3 to 4 million people across the Americas will be infected in the next year.

Public health officials suspected Zika might be the cause of a microcephaly, a birth defect that results in stunted brain and head sizes in newborns, when they observed a jump in the number of cases in infants born to women infected by the disease in Brazil, the site of a current Zika epidemic.

That suspicion has now been verified by scientists.

Exactly how likely an infant born to a woman infected by Zika is to develop microcephaly, however, remains under study, as does the risk of other possible health dangers associated with Zika infection.

The CDC has already warned pregnant women against travel to Brazil and other areas now experiencing Zika outbreaks.

On Wednesday, the agency issued additional guidelines aimed at protecting pregnant women from exposure to the virus.

**Men with confirmed cases of the virus or who have had symptoms of the virus are now advised to wait at least six months after their symptoms begin before having unprotected sex.**

These timelines update previous guidelines, based on new information learned about how long the virus stays in semen, Dr. Denise Jamieson of the CDC told reporters.

"We considered the longest-known risk period for these categories. We then allowed for three times the known period of time," Jamieson said. The CDC issued other guidelines:

- **Women and men without symptoms who have traveled to or had sex with someone who has traveled to a Zika-infected area are now advised to wait at least eight weeks** after possible exposure to the virus before the woman tries to become pregnant, according to the guidelines.
- **Men who have traveled to a Zika-infected area who have not had symptoms of the virus are now advised to abstain from sex or use a condom for at least eight weeks** after returning from the area.

"We still don't know the exact extent of the risk," Jamieson acknowledged, "but as scientists continue to investigate, we think these are the sensible precautions for members of the public to take."

The guidelines apply to sexual intercourse, as well as oral and anal sex.

## A1.2. Global Warming news story

## Global warming could spread Zika, group warns

### CDC updates Zika advice for sex and pregnancy

By Jeff Brooks, Associated Press

We can now add still another danger to the litany of risks—coastal flooding, droughts, destructive hurricanes, reduced agricultural production—attributable to global warming: the accelerated spread of Zika, the mosquito-borne virus determined to be causing infants to be born with abnormally small heads in Brazil and other Latin American countries.

This is the conclusion of a report issued today by Save our Planet (SOP), a Washington, D.C., based group dedicated to promoting policies aimed at counteracting the impact of human activity on climate change.

"Zika is carried by a particular kind of mosquito suited for the warmer, wetter conditions typical of tropical areas," said SOP spokesman David Carlsmith. "But with climate change, plants and animals that thrive in warmer habitats are going to move to previously cooler areas, including those in the continental United States," Carlsmith explained at a Washington, D.C. news conference. "Mosquitos carrying the Zika virus can be expected to do the same."

"The spread of Zika is the kind of thing we've been ranting about for 20 years," added Lisa McFarlane, a University of Massachusetts climate scientist who was one of the SOP report authors. "We should've anticipated it. Whenever the planet has faced a major climate change event, species have moved around, carrying infectious pathogens with them."

Transmitted by the *Aedes aegypti* mosquito, Zika has spread to at least 34 countries and territories. The World Health Organization estimates 3 to 4 million people across the Americas will be infected in the next year.

Public health officials suspected Zika might be the cause of a microcephaly, a birth defect that results in stunted brain and head sizes in newborns, when they observed a jump in the number of cases in infants born to women infected by the disease in Brazil, the site of a current Zika epidemic.

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"We considered the longest-known risk period for these categories. We then allowed for three times the known period of time," Jamieson said.

The CDC issued other guidelines:

- **Women and men without symptoms who have traveled to or had sex with someone who has traveled to a Zika-infected area are now advised to wait at least eight weeks** after possible exposure to the virus before the woman tries to become pregnant, according to the guidelines.
- **Men who have traveled to a Zika-infected area who have not had symptoms of the virus are now advised to abstain from sex or use a condom for at least eight weeks** after returning from the area.

"We still don't know the exact extent of the risk," Jamieson acknowledged, "but as scientists continue to investigate, we think these are the sensible precautions for members of the public to take."

The guidelines apply to sexual intercourse, as well as oral and anal sex.



*A1.3. Immigrant news story***Influx of immigrants could spread Zika, group warns**

CDC updates Zika advice for sex and pregnancy

By Jeff Brooks, Associated Press

We can now add still another danger to the litany of harms-increased unemployment, higher crime rates, crushing tax burdens to cover the exploding demand for welfare benefits-attributable to the flood of illegal immigrants: the accelerated spread of Zika, the mosquito-borne virus determined to be causing infants to be born with abnormally small heads in Brazil and other Latin American countries.

This is the conclusion of a report issued today by Protect America's Borders (PAB), a Washington, D.C., based group dedicated to promoting policies aimed at reducing eligibility for legal immigration to the United States and increasing governmental efforts to combat illegal entry into the country.

"The reason Zika infections are now concentrated south of the border," said PAB spokesman David Carlsmith, "is that the virus is carried by a mosquito that thrives in the warmer, wetter conditions typical of those regions."

"But once a person is bitten by such a mosquito, that individual can himself transmit Zika to another person," Carlsmith explained at a Washington, D.C. news conference. "Accordingly, as infected Mexicans, Columbians, Brazilians, and others come to the U.S., Americans will inevitably join the ranks of people who get this disease and whose babies are then born with this horrific deformity."

"The spread of Zika is the kind of thing we've been ranting about for 20 years," added Lisa McFarlane, a University of Arizona epidemiologist who was one of the PAB report authors. "We should've anticipated it. People from Central and South America-ground zero for all kinds of infectious diseases, including tuberculosis, dengue, Chagas, Chikungunya and schistosomiasis-make up nearly 15 percent of the illegal-immigrant population in the U.S."

Transmitted by the *Aedes aegypti* mosquito, Zika has spread to at least 34 countries and territories. The World Health Organization estimates 3 to 4 million people across the Americas will be infected in the next year.

Public health officials suspected Zika might be the cause of a microcephaly, a birth defect that results in stunted brain and head sizes in newborns, when they observed a jump in the number of cases in infants born to women infected by the disease in Brazil, the site of a current Zika epidemic.

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"We considered the longest-known risk period for these categories. We then allowed for three times the known period of time," Jamieson said.

The CDC issued other guidelines:

- **Women and men without symptoms who have traveled to or had sex with someone who has traveled to a Zika-infected area are now advised to wait at least eight weeks** after possible exposure to the virus before the woman tries to become pregnant, according to the guidelines.
- **Men who have traveled to a Zika-infected area who have not had symptoms of the virus are now advised to abstain from sex or use a condom for at least eight weeks** after returning from the area.

"We still don't know the exact extent of the risk," Jamieson acknowledged, "but as scientists continue to investigate, we think these are the sensible precautions for members of the public to take."

The guidelines apply to sexual intercourse, as well as oral and anal sex.

Please check this box when you have read the article and are ready to advance. (you will not be able to go back once you advance)

**A2. Outcome measures***A2.1. ZAFFECT*

Now we'd like to ask you your opinions on this issue.

We'd like to get your views on the risks posed by the Zika virus.

- (1) **ZIKA\_ISRPM.** How much risk do you believe *the Zika virus* poses to human health in the United States? [0 'no risk at all'; 1 'Very low risk'; 2 'Low risk'; 3 'Between low and moderate risk'; 4 'Moderate risk'; 5 'Between moderate and high risk'; 6 'High risk'; 7 'Very high risk'].
- (2) **ZIKAWORRY.** How concerned are you that the Zika virus will spread to where you live?[ 0 'not at all concerned'; 1 'slightly concerned'; 2 'between slightly and moderately concerned' 3 'moderately concerned' 4 'Between moderately and very concerned' 5 'very concerned'].



A2.2. ZLIT<sup>10</sup>

Now we'd like to get your views on the conclusions supported by the scientific evidence currently available on Zika. Please indicate how strongly you disagree or agree with each of these statements.

*Randomize order*

- (1) *CASUAL*. A person can catch Zika from sitting next to someone who has been infected by the Zika virus.
- (2) *SEXUAL*. A woman can catch Zika from having sex with a man who has been infected by the Zika virus.
- (3) *BITE*. A person can catch Zika from being bitten by a mosquito that is carrying the Zika virus.
- (4) *SPRAY*. A person can catch Zika from drinking water sprayed with a chemical used to stop the spread of mosquitoes.
- (5) *MICRO*. A pregnant woman who is infected with the Zika virus is more likely to have a baby with an unusually small head and brain.
- (6) *GMSPREAD*. The Zika virus was introduced by a genetically modified form of mosquito.
- (7) *SYMPTOMS*. An individual who has been infected by the Zika virus will always experience noticeable symptoms shortly after being infected.
- (8) *USOUTBREAK*. There have been more reported cases of Zika in the United States than in any other country.
- (9) *USMICRO*. The number of cases of babies being born in the United States with abnormally small heads and brains has increased in recent months.
- (10) *GWSPREAD*. Global warming has caused the Zika virus to spread to the United States.
- (11) *IMMSPREAD*. Immigrants entering the United States illegally have caused the spread of the Zika virus to the United States.
- (12) *LATINOUTBREAK*. Right now Zika infections are concentrated in Brazil and other central and south American countries.
- (13) *EUROUTBREAK*. There is currently an outbreak of Zika infections in Europe.

Now we'd like to get your views on the Zika-related advice that public health authorities are giving to people in various situations. Please indicate how strongly you disagree or agree with each of these statements. [strongly Disagree, moderately disagree, slightly disagree, slightly agree, moderately agree, strongly agree]

- (14) *DIAGNOSED*. Consider the case of a man has been diagnosed with a Zika infection.
 

In his case, public health authorities would recommend he SHOULD wait at least six months before having sex without a condom.
- (15) Consider the case of a man who has travelled to a location that is currently experiencing a high rate of Zika infections but is NOT experiencing symptoms after returning. In his case, what would public health experts say:
 

*NOSYMPTOM1*. There is NO RISK that he can infect another person through sexual intercourse.

*NOSYMPTOM 2*. There is NO RISK that he can infect a pregnant woman by engaging in unprotected sexual intercourse with her.

*NOSYMPTOM3*. He SHOULD *either* abstain from sex *or* use a condom for at least eight weeks after returning from the area.
- (16) Consider the case of a couple who is considering having children and who have travelled to a location that is currently experiencing a high rate of Zika infections .
 

*PREGDELY*. In their case, they SHOULD wait at least eight weeks after returning before the woman tries to become pregnant.

## A2.3. ZPOLICY

Now we'd like to get your views on what sorts of public policies would help to prevent the spread of Zika in the United States. P Please indicate how strongly you oppose or support the following policies ['strongly oppose,' 'moderately oppose,' 'slightly oppose,' 'slightly support,' 'moderately support,' 'strongly support']

*Randomize order*

- (1) *GW\_POLICY*. Policies to prevent global warming.
- (2) *IM\_POLICY*. Policies limiting immigration to the United States.
- (3) *GMM\_POLICY*. The release of genetically engineered mosquitos designed to interfere with breeding and reproducing of Zika-carrying mosquitos.
- (4) *VACP\_POLICY*. Development of a vaccine against infection by the Zika virus.
- (5) *QUAR\_POLICY*. Quarantining individuals who enter United States after traveling to parts of world now experiencing Zika outbreaks.
- (6) *LATE\_ABORTION*. Allowing abortions in the third trimester of pregnancy(during or after the 27th week)if medical tests indicate that the fetus has a malformed head and brain as a result of infection by the Zika virus.
- (7) *CONDUM\_COVER*. Mandating that employer-provided health insurance plans cover the cost of condoms in regions in which Zika outbreaks are determined to be occurring.

**A3. Cultural worldview scales**

Now we'd like to ask you your opinion on some social and moral issues.

[RANDOMIZE blocks and items within each block. each item separate page]

*individualist-communitarianism scale* ('I' items valenced toward individualism, 'C' towards communitarianism)

People in our society often disagree about how far to let individuals go in making decisions for themselves. How strongly you agree or disagree with each of these statements? [strongly disagree, moderately disagree, slightly disagree, slightly agree, moderately agree, strongly agree]

- (1) *IINTRSTS*. The government interferes far too much in our everyday lives.
- (2) *CHARM*. Sometimes government needs to make laws that keep people from hurting themselves.
- (3) *IPROTECT*. It's not the government's business to try to protect people from themselves.
- (4) *IPRIVACY*. The government should stop telling people how to live their lives.
- (5) *CPROTECT*. The government should do more to advance society's goals, even if that means limiting the freedom and choices of individuals.
- (6) *CLIMCHOI*. Government should put limits on the choices individuals can make so they don't get in the way of what's good for society.

*Hierarchy-egalitarianism scale* ('H' items valenced toward hierarchy, 'E' toward egalitarianism)

People in our society often disagree about issues of equality and discrimination. How strongly you agree or disagree with each of these statements? [strongly disagree, moderately disagree, slightly disagree, slightly agree, moderately agree, strongly agree]

- (1) *HEQUAL*. We have gone too far in pushing equal rights in this country.
- (2) *EWEALTH*. Our society would be better off if the distribution of wealth was more equal.
- (3) *ERADEQ*. We need to dramatically reduce inequalities between the rich and the poor, whites and people of color, and men and women.
- (4) *EDISCRIM*. Discrimination against minorities is still a very serious problem in our society.
- (5) *HREVDIS2*. It seems like blacks, women, homosexuals, and other groups don't want equal rights, they want special rights just for them.
- (6) *HFEMININ*. Society as a whole has become too soft and feminine.

**Appendix B. Multivariate regression models**

Table B1. Experimental results for ZAFFECT: regression models.

	Model 1	Model 2	Model 3
Global warming	<b>-0.12</b> (-2.40)	<b>-0.14</b> (-2.75)	<b>-0.14</b> (-2.87)
Immigrant	0.05 (1.04)	0.03 (0.56)	0.03 (0.50)
Hfac		-0.03 (-1.23)	-0.06 (-1.75)
Ifac		<b>-0.14</b> (-6.65)	<b>-0.16</b> (-4.59)
Hfac_x_GW			<b>-0.10</b> (-2.04)
Ifac_x_GW			-0.04 (-0.83)
Hfac_x_Imm			<b>0.23</b> (4.39)
Ifac_x_Imm			<b>0.11</b> (2.16)
Constant	0.02 (0.64)	0.03 (0.72)	0.03 (0.74)
<i>N</i>	2399	2275	2275
<i>R</i> <sup>2</sup>	<b>0.00</b>	<b>0.02</b>	<b>0.05</b>
<i>F</i> -test ( $\Delta R^2$ )		<b>23.2 (2, 2270)</b>	<b>13.7 (4, 2266)</b>

Notes: Dependent variable is ZAFFECT. Unstandardized OLS regression coefficients with *t*-statistics denoted parenthetically. Bolded denotes that indicated predictor coefficient, *R*<sup>2</sup> or *F*-test statistic is significant at  $p < 0.05$ .

Table B2. Experimental results for ZLIT: regression models.

	Model 1	Model 2	Model 3
Global warming	<b>-0.14</b> (-2.68)	<b>-0.14</b> (-2.89)	<b>-0.14</b> (-2.86)
Immigrant	-0.10 (-1.91)	-0.08 (-1.63)	-0.08 (-1.64)
Hfac		<b>-0.15</b> (-7.66)	<b>-0.20</b> (-5.55)
Ifac		<b>0.20</b> (9.87)	<b>0.22</b> (6.19)
Hfac_x_GW			0.07 (1.32)
Ifac_x_GW			-0.04 (-0.85)
Hfac_x_Imm			0.07 (1.39)
Ifac_x_Imm			-0.01 (-0.13)
Constant	<b>0.10</b> (2.65)	<b>0.09</b> (2.63)	<b>0.09</b> (2.63)
<i>N</i>	2275	2275	2275
<i>R</i> <sup>2</sup>	<b>0.00</b>	<b>0.06</b>	<b>0.07</b>
<i>F</i> -statistic ( $\Delta R^2$ )		<b>78.0 (2, 2270)</b>	0.81 (4, 2266)

Notes: Dependent variable is ZAFFECT. Unstandardized OLS regression coefficients with *t*-statistics denoted parenthetically. Listwise deletion for missing data. Bolded denotes that indicated predictor coefficient, *R*<sup>2</sup> or *F*-test statistic is significant at  $p < 0.05$ .

Table B3. Experimental results for MISFEARING.

	Model 1	Model 2	Model 3	Model 4
Public health	0.09 (1.74)	0.08 (1.74)	0.09 (2.17)	-0.04 (-0.84)
Global warming	0.12 (1.87)	0.09 (1.87)	<b>0.12</b> (2.75)	<b>-0.11</b> (-2.60)
Hfac		<b>0.08</b> (2.44)	0.01 (0.41)	<b>0.11</b> (3.39)
Ifac		<b>-0.28</b> (-7.99)	<b>-0.18</b> (-5.73)	<b>-0.20</b> (-6.67)
Hf_x_ph		<b>0.10</b> (1.96)	0.08 (1.91)	-0.01 (-0.27)
If_x_ph		-0.02 (-0.35)	-0.02 (-0.57)	0.01 (0.24)
Hf_x_gw		<b>0.11</b> (2.25)	<b>0.11</b> (2.61)	-0.08 (-1.76)
If_x_gw		0.02 (0.44)	-0.01 (-0.19)	0.03 (0.67)
OSI			<b>-0.46</b> (-14.45)	<b>-0.45</b> (-13.96)
OSI_x_ph			0.04 (0.87)	-0.01 (-0.26)
OSI_x_gw			0.00 (0.02)	0.02 (0.44)
Hf_x_osi			<b>-0.06</b> (-2.92)	0.01 (0.22)
If_x_osi			<b>0.17</b> (9.08)	<b>0.19</b> (6.00)
Hf_x_osi_x_ph				<b>-0.11</b> (-2.33)
If_x_osi_x_ph				0.01 (0.18)
hf_x_osi_x_gw				-0.09 (-1.94)
If_x_osi_x_gw				-0.07 (-1.61)
_cons	<b>-0.09</b> (2.44)	<b>-0.08</b> (-2.23)	<b>-0.11</b> (-3.49)	0.01 (0.47)
<i>N</i>	2272	2272	2272	2272
<i>R</i> <sup>2</sup>	0.00	0.10	0.31	0.32
<i>F</i> -statistic ( $\Delta R^2$ )		<b>42.6(6, 2263)</b>	<b>142.8(5, 2258)</b>	<b>2.46 (4, 2254)</b>

Notes: Dependent variable is ZAFFECT. Unstandardized OLS regression coefficients with *t*-statistics denoted parenthetically. Listwise deletion for missing data. Bolded denotes that indicated predictor coefficient, *R*<sup>2</sup> or *F*-test statistic is significant at *p* < 0.05.

Table B4. Experimental results for ZPOLICY: regression models.

	Model 1	Model 2	Model 3
Global Warming	-0.01 (0.87)	-0.02 (-0.40)	-0.02 (-0.45)
Immigrant	-0.01 (0.81)	-0.02 (-0.40)	-0.02 (-0.42)
Hfac		<b>-0.26</b> (-15.86)	<b>-0.24</b> (-8.06)
Ifac		<b>-0.21</b> (-12.66)	<b>-0.24</b> (-8.40)
Hfac_x_GW			-0.03 (-0.84)
Ifac_x_GW			0.04 (1.07)
Hfac_x_Imm			-0.02 (-0.56)
Ifac_x_Imm			0.05 (1.28)
Constant	0.01 (0.78)	0.01 (0.46)	0.01 (0.50)
<i>N</i>	2183	2183	2183
<i>R</i> <sup>2</sup>	0.00	0.16	0.16
<i>F</i> -statistic ( $\Delta R^2$ )		<b>207.6 (2, 2178)</b>	0.7 (4, 2174)

Notes: Dependent variable is ZPOLICY. Unstandardized OLS regression coefficients with *t*-statistics denoted parenthetically. Listwise deletion for missing data. Bolded denotes that indicated predictor coefficient or *F*-statistic is significant at *p* < 0.05.

### Appendix C. Left–right political outlooks

In this appendix, we examine how substituting left–right political outlooks for cultural worldviews affects analysis of the experimental results. We do so to aid in evaluation of the relative utility of left–right political outlooks and cultural worldviews as measures of the orientating disposition that unconsciously guides the motivated-reasoning effects observed in the study.

Motivated reasoning refers to the tendency of individuals to conform information to some goal collateral to factual accuracy (Kunda 1990). Among these goals are the formation of perceptions of risk and related policy-relevant facts that protect one’s standing within some identity-defining affinity group (Sherman and Cohen 2006; Greene 2013; Westfall, Van Boven, Chambers, and Judd 2015). A latent variable, the disposition to form group-identity-convergent perceptions is variously measured by left–right political outlooks (e.g. Cohen 2003; Kahan 2013b; Lodge and Taber 2013; Bolsen, Druckman, and Cook 2014) and by cultural worldviews (e.g. Kahan, Braman, Cohen, et al. 2010; Bolsen et al. 2015). In our view, when used to test hypotheses about politically motivated reasoning, left–right political outlooks and cultural worldviews are not alternative ‘theories’ but simply alternative measurement frameworks for operationalizing a single theory about the sources of conflict over societal risk and related facts (Kahan, *forthcoming-b*), the choice between which would be made on the basis of explanatory, predictive, and prescriptive power.

In the study reported in the paper, subjects’ left–right outlooks are measured with a standardized scale (‘Left\_right,’  $\alpha = 0.77$ ) that aggregates their responses to two items:

- (1) **CONSERVATIVE.** ‘How would you describe your political views? [1 = ‘very liberal’; 2 = ‘liberal’; 3 = ‘moderate’; 4 = ‘conservative’; 5 = ‘very conservative’].
- (2) **PARTY IDENTIFICATION.** Generally speaking, do you usually think of yourself as a Republican, a Democrat, or an Independent?’; ‘[if Independent:] As an independent, do you consider yourself to lean Democrat, lean Republican, or not lean either way?’; ‘Would you call yourself a very strong Democrat/Republican or a not very strong Democrat/Republican’ [1 = ‘Very strong Democrat’; 2 = ‘Democrat’; 3 = ‘Lean Democrat’; 4 = ‘Intendent’; 5 = ‘Lean Republican’; 6 = ‘Republican’; 7 = ‘Very strong Republican’].

The two regression models reported in Table C1 examine the experimental impact on the key outcome variable ZAFFECT conditional on subjects’ left–right political outlooks and subjects’ cultural worldviews, respectively.

Table C1. Multivariate regression analysis of experimental effects associated with cultural worldview and left–right political outlook predictors.

	Model 1	Model 2
Global warming	<b>-0.15</b> (-2.96)	<b>-0.15</b> (-2.90)
Immigrant	0.02 (0.46)	0.04 (0.71)
Hfac	-0.06 (-1.69)	
Ifac	<b>-0.16</b> (-4.41)	
Hfac_x_GW	<b>-0.11</b> (-2.08)	
Ifac_x_GW	-0.05 (-1.04)	
Hfac_x_Imm	<b>0.22</b> (4.33)	
Ifac_x_Imm	<b>0.10</b> (2.02)	
Left_right		-0.08(-1.89)
LR_x_GW		-0.06 (-1.06)
LR_x_IMM		<b>0.23</b> (4.01)
Constant	0.02 (0.60)	0.02 (0.49)
R <sup>2</sup>	0.05	0.02
BIC	6259.8	6305.7
ΔBIC		+54.1

Notes:  $N = 2219$ . Outcome variable is ZAFFECT. Unstandardized OLS coefficients,  $t$ -statistic denoted parenthetically. Listwise deletion for missing data. Bolded denotes that indicated predictor is significant at  $p < 0.05$ .

Model 2, which uses left–right political outlooks, fails to register the full range of the effects observed in Model 1, which uses the Cultural Cognition Worldview Scales. In particular, the ‘ideologically motivated reasoning’ model fails to detect any evidence that assignment to Global Warming (LR\_x\_GW:  $b = -0.06$ ,  $t = -1.06$ ) generated polarization in the subjects’ affective responses relative to those in Public Health, where there was also no meaningful political polarization (Left\_right:  $b = -0.08$ ,  $t = -1.89$ ). In Model 1, it is apparent that the Hierarch Individualists and Egalitarian Communitarians were polarized in Public Health (sum of Hfac and Ifac:  $b = -0.22$ ,  $t = -4.40$ ,  $p < 0.01$ ) and that the degree of polarization among such subjects became significantly greater in Global Warming (sum of Hfac\_x\_GW + Ifac\_x\_GW:  $b = -0.16$ ,  $t = -2.21$ ,  $p < 0.05$ ). The failure of Left\_right to detect these effects is a substantial defect in the explanatory power of Model 1.

If one thought it was worthwhile to take a position on which disposition – left–right political outlooks or cultural worldviews – accounts for the experimental result, one could assess the weight of the evidence in favor of each possibility by comparing the models’ Bayes Information Criterion (BIC) values. Such an analysis measures the relative likelihood of the observing the data if the one or the other model is ‘true’ (Raftery 1995). The difference in the BICs of Model 2 and Model 1 is 54.1. This is a margin that signifies that the observed data are astronomically more consistent ( $e^{54/2}$  times more consistent, to be precise [Raftery 1995; Wagenmakers 2007]) with Model 1 than with Model 2, signifying that the hypothesis ‘cultural worldviews account for the experimental results’ is that many times more probable than the hypothesis that ‘political outlooks did.’