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Beyond Misinformation: Understanding and Coping with the "Post-Truth" Era

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The terms "post-truth" and "fake news" have become increasingly prevalent in public discourse over the last year. This article explores the growing abundance of misinformation, how it influences people, and how to counter it. We examine the ways in which misinformation can have an adverse impact on society. We summarize how people respond to corrections of misinformation, and what kinds of corrections are most effective. We argue that to be effective, scientific research into misinformation must be considered within a larger political, technological, and societal context. The post-truth world emerged as a result of societal mega-trends such as a decline in social capital, growing economic inequality, increased polarization, declining trust in science, and an increasingly fractionated media landscape. We suggest that responses to this malaise must involve technological solutions incorporating psychological principles, an interdisciplinary approach that we describe as "technocognition." We outline a number of recommendations to counter misinformation in a post-truth world.

General Audience Summary

Imagine a world that considers knowledge to be "elitist." Imagine a world in which it is not medical knowledge but a free-for-all opinion market on Twitter that determines whether a newly emergent strain of avian flu is really contagious to humans. This dystopian future is still just that—a possible future. However, there are signs that public discourse is evolving in this direction: terms such as "post-truth" and "fake news," largely unknown until 2016, have exploded into media and public discourse. This article explores the growing abundance of misinformation in the public sphere, how it influences people, and how to counter it. We show how misinformation can have an adverse impact on society, for example by predisposing parents to make disadvantageous medical decisions for their children. We argue that for countermeasures to be effective, they must be informed by the larger political, technological, and societal context. The post-truth world arguably emerged as a result of societal mega-trends, such as a decline in social capital, growing economic inequality, increased polarization, declining trust in science, and an increasingly fractionated media landscape. Considered against the background

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of those overarching trends, misinformation in the post-truth era can no longer be considered solely an isolated failure of individual cognition that can be corrected with appropriate communication tools. Rather, it should also consider the influence of alternative epistemologies that defy conventional standards of evidence. Responses to the post-truth era must therefore include technological solutions that incorporate psychological principles, an interdisciplinary approach that we describe as "technocognition." Technocognition uses findings from cognitive science to inform the design of information architectures that encourage the dissemination of high-quality information and that discourage the spread of misinformation.

Keywords: Misinformation, Fake news, Post-truth politics, Demagoguery

Imagine a world that has had enough of experts. That considers knowledge to be "elitist." Imagine a world in which it is not expert knowledge but an opinion market on Twitter that determines whether a newly emergent strain of avian flu is really contagious to humans, or whether greenhouse gas emissions do in fact cause global warming, as 97% of domain experts say they do (Anderegg, Prall, Harold, & Schneider, 2010; Cook et al., 2013, 2016; Oreskes, 2004). In this world, power lies with those most vocal and influential on social media: from celebrities and big corporations to botnet puppeteers who can mobilize millions of tweetbots or sock puppets—that is, fake online personas through which a small group of operatives can create an illusion of a widespread opinion (Bu, Xia, & Wang, 2013; Lewandowsky, 2011). In this world, experts are derided as untrustworthy or elitist whenever their reported facts threaten the rule of the well-financed or the prejudices of the uninformed.

How close are we to this dystopian future? We may not be there (yet), although there are reasons to be concerned about our trajectory. The terms "post-truth" and "post-fact," virtually unknown 5 years ago, have exploded onto the media scene with thousands of recent mentions. To illustrate, the media search engine *Factiva* returns 40 hits in the global media for "post-truth" in all of 2015, compared to 2535 in 2016 and around 2400 during the first 3 months of 2017 alone. The prevalence of misinformation in 2016 led the Oxford Dictionary to nominate "post-truth" as the word of the year (Flood, 2016). The rapidly growing recognition of the role of misinformation follows on the heels of earlier warnings, for example by the World Economic Forum—a not-for-profit institution "committed to improving the state of the world"—which ranked the spread of misinformation online as one of the 10 most significant issues facing the world in 2013 (WEF, 2013).

During the 2016 U.S. presidential campaign, independent fact checker *PolitiFact* judged 70% of all statements by Donald Trump to be false or mostly false. For his opponent, Hillary Clinton, this rate was much lower (although arguably still quite high) at 26%. Donald Trump won the presidency, suggesting that his comparatively impoverished record of accuracy, compared to that of his opponent, did not diminish his attractiveness with a large number of voters.[1] Impressions of President Trump's popularity were possibly boosted by the fact that a substantial portion of all pro-Trump traffic on Twitter was driven by tweetbots, with automated pro-Trump traffic being at least 4 times as prevalent as automated pro-Clinton traffic (Kollanyi, Howard, & Woolley, 2016).

The dissociation between accuracy and President Trump's attractiveness to voters is underscored by recent laboratory research investigating the effects of corrections on voters' beliefs and voting intentions: Swire, Berinsky, Lewandowsky, and Ecker (2017) presented statements that President Trump made on the primary campaign trail to a large sample of participants and elicited belief ratings. Half the statements were true (e.g., "the U.S. spent $2 trillion on the war in Iraq") and the other half consisted of false claims (e.g., "vaccines cause autism"). When participants received corrections of the false statements, and affirmations of the correct statements, their belief ratings changed accordingly: all participants, including Trump supporters, believed statements less after they were identified as false, and they believed them more after they were affirmed as being correct. However, for Trump supporters there was no association between the extent to which they shifted their belief when a statement was corrected and their feelings for President Trump or their intention to vote for him. Thus, it seems that President Trump's false claims did not matter to his supporters—at least they did not matter sufficiently to alter their feelings or voting intentions.

This article uses the context of those recent public events to pursue a number of questions: What explains the growing abundance of misinformation? Why do people believe in misinformation? If misinformation is corrected, do people reliably update their beliefs? To what extent are people concerned with whether or not information is accurate? This article places the findings from cognitive research on misinformation into a broader political and societal context. We point to a few societal mega-trends that might help us understand the current malaise in public discourse. We conclude by providing some tentative pointers to possible solutions.

The Fallout From Misinformation

It is a truism that a functioning democracy relies on a well-informed public (Kuklinski, Quirk, Jerit, Schwieder, & Rich, 2000). Conversely, if people are pervasively misinformed, chances are that societal decisions will be suboptimal. Likewise, if an individual is misinformed, that person's decisions may not be in their best interest and can have adverse consequences. For example, following the unsubstantiated—and now thoroughly debunked (DeStefano & Thompson, 2004; Godlee, Smith, & Marcovitch, 2011)—claims of a link between childhood

[1] When assessing this attractiveness, it must be borne in mind that Donald Trump lost the popular vote by nearly 3,000,000 votes (http://edition.cnn.com/2016/12/21/politics/donald-trump-hillary-clinton-popular-vote-final-count/).

vaccinations and autism, many parents (primarily in the U.K.) decided not to immunize their children. As a result of these misinformation-driven choices, there was a marked increase in vaccine-preventable disease, and substantial expenditure was required to overcome this public-health crisis (Larson, Cooper, Eskola, Katz, & Ratzan, 2011; Poland & Spier, 2010; Ratzan, 2010).[2]

Misinformation misinforms, with a potentially adverse impact on individuals and society. There are, however, several more insidious and arguably more dangerous elements of misinformation. There is evidence that the presence of misinformation causes people to stop believing in facts altogether. For example, van der Linden, Leiserowitz, Rosenthal, and Maibach (2017) found that participants who were presented with both a persuasive fact and a related piece of misinformation experienced no change in belief overall—the misinformation cancelled out the fact. Similarly, McCright, Charters, Dentzman, and Dietz (2016) found that when accurate information about climate change was accompanied by a contrarian counter frame (e.g., "many scientists and policy-makers urge us to take action to reduce our greenhouse gas emissions" followed by "some scientists testifying at Congressional hearings are quick to point out that the Earth hasn't actually warmed in the last decade") cancelled out valid climate information.

The insidious fallouts from misinformation are particularly pronounced when the misinformation is packaged as a conspiracy theory. The mere exposure to conspiratorial discourse, even if the conspiratorial claims are dismissed, makes people less likely to accept official information (Einstein & Glick, 2015; Jolley & Douglas, 2013; Raab, Auer, Ortlieb, & Carbon, 2013). For example, in one study, exposure to conspiracy theories decreased participants' intentions to engage in politics and to reduce their carbon footprint (Jolley & Douglas, 2013). In another study, exposure to a conspiracy claim was found to adversely affect trust in government services and institutions, including those *unconnected* to the conspiratorial allegations (Einstein & Glick, 2015). In light of those fallouts, it is concerning that conspiracy theories tend to be particularly prevalent in times of economic and political crises (van Prooijen & Douglas, 2017).

Misinformation is therefore not just about being misinformed. It is also about the overall intellectual well-being of a society. We will resume this thread after we briefly summarize existing research on misinformation and then propose an alternative framing for the situation societies are currently facing.

Research on Misinformation and its Correction

There has been growing research interest on how people respond to corrections of misinformation—that is, information that is initially presumed to be true but is then later corrected (for reviews see, e.g., Cook, Ecker, & Lewandowsky, 2015; Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012; Schwarz, Newman, & Leach, 2016). This body of research has converged on the conclusion that corrections are rarely fully effective: that is, despite being corrected, and despite acknowledging the correction, people by and large continue to rely at least partially on information they know to be false. This phenomenon is known as the continued-influence effect (Lewandowsky et al., 2012), and it has been observed across a broad range of materials and modes of testing, persisting even when participants are warned at the outset that they may be misinformed (Ecker, Lewandowsky, & Tang, 2010).

In some circumstances, when the correction challenges people's worldviews, belief in false information may ironically even increase. For example, when Republicans are informed that there were no Weapons of Mass Destruction (WMDs) in Iraq immediately before the invasion of 2003, their mistaken beliefs in the existence of WMDs may become even stronger (Nyhan & Reifler, 2010). Analogous findings have been reported with messages relating to climate change (Hart & Nisbet, 2012) and vaccinations (Nyhan, Reifler, Richey, & Freed, 2014). Even very subtle contextual cues can reduce the efficacy of a correction when those cues activate misinformation-congruent mental models. For example, a picture of an Imam in Middle-Eastern attire can reduce the efficacy of a message attributed to that person compared to when the same message is accompanied by a picture of the Imam dressed in Western attire (Garrett, Nisbet, & Lynch, 2013). It is unclear whether the effects of challenges to people's worldview are ideologically symmetrical. On the one hand, corrections have been shown to lose their effectiveness with Democrats if the information challenges their worldviews (Nyhan & Reifler, 2010). On the other hand, most backfire effects to date have been observed in response to stimuli that challenge Republican worldviews, and this asymmetry is confirmed by other research that we discuss later. Thus, corrections are effective only when at least two conditions are met: first, they must not directly challenge people's worldviews. This can be achieved by, for example, affirming the self-worth of recipients or by making the correction more persuasive by graphical means (Nyhan & Reifler, 2011). Second, corrections must explain why the misinformation was disseminated in the first place or they must provide an alternative explanation of the relevant event. For example, even though mock jurors demonstrably rely on tainted evidence that they are admonished to disregard when determining a verdict, this reliance on tainted evidence disappears when jurors are made suspicious of the motives underlying the dissemination of that tainted evidence (Fein, McCloskey, & Tomlinson, 1997). That is, if inflammatory pretrial publicity is seen to be the result of an over-eager prosecutor leaking information to the media, then it can be disregarded. If the source of the same inflammatory publicity is unspecified, then a routine admonishment to disregard the evidence will have no effect. (see also, Guillory & Geraci, 2013; Johnson & Seifert, 1994; Lewandowsky, Stritzke, Oberauer, & Morales, 2005; Seifert, 2002).

The findings from misinformation research are sufficiently consistent to permit a summary as concise guidelines, for

[2] There are other instances in which the misinformation, at least at first glance, does not seem to entail notable adverse consequences for society. For example, there exists an online community of people who believe that Nelson Mandela died in jail in the 1980s, notwithstanding the fact that he served as President of South Africa after his release from prison in 1990 (Spinney, 2017).

example in the "Debunking Handbook" authored by the first and third author (http://sks.to/debunk). Moreover, decades of work in communication research have provided valuable pointers about how controversial scientific issues—such as climate change—can be communicated successfully (Scheufele, 2013).

One might therefore be tempted to conclude that improved communication techniques and more effective corrections could suffice to put an end to people being pervasively misinformed. The central thesis of this article is that this conclusion would be too simplistic. We argue instead that resolution of the post-truth malaise requires a consideration of the larger political, technological, and social context in which misinformation unfolds.

Misinformation or Alternative Epistemologies?

What is a tax? Is it a "burden" that requires "relief"? Or is it a "civilization surcharge" that enables society to function? Do we deal with terrorism in a "war" or by "law enforcement"? There is much research to suggest that the framing of information is crucial to the way in which it is disseminated or discussed (Lakoff, 2010). When taxation is framed as a burden in public discussion, this is unlikely to favor policy options that include a tax increase, and if there is a war on terrorism then this is unlikely to be limited to peacetime policing techniques.

The framing of the current post-truth malaise as "misinformation" that can be corrected or debunked fails to capture the full scope of the problem. This framing at least tacitly implies that misinformation is a blemish on the information landscape—our mirror of reality—that can be cleared up with a suitable corrective disinfectant. This framing fails to capture the current state of public discourse: the post-truth problem is not a blemish on the mirror. The problem is that the mirror is a window into an alternative reality. To illustrate, one of the most popular climate stories on social media in 2016, which was shared more than half a million times, contained false information claiming that tens of thousands of scientists had declared global warming a hoax (Readfearn, 2016). This assertion is based on the so-called Oregon Petition, a collection of 31,000 signatories that reject human-caused global warming. However, the minimum qualification required to be a signatory of the Oregon Petition is a Bachelor's degree in science: thus, the 31,000 signatories comprise only around 0.3% of the 10.6 million U.S. science graduates since the 1970/71 school year. The list contains no affiliations, making verification of signatories problematic (e.g., Charles Darwin and the Spice Girls are among the signatories; van der Linden et al., 2017). Further, and perhaps most important, according to the breakdown of areas of expertise listed on the petition website, fewer than 1% of the signatories have any expertise in climate science. Thus, the Oregon Petition is an example of the so-called "fake-experts" strategy that was pioneered by the tobacco industry in the 1970s and 1980s (Cook, Lewandowsky, & Ecker, 2017; Oreskes & Conway, 2010). A recent analysis of Facebook shares established the breadth of this pattern. Qiu, Oliveira, Shirazi, Flammini, and Menczer (2017) compared the distribution of Facebook shares for two types of articles. One class of articles (low truth value) involved claims that had been debunked by fact-checkers or that undermined claims that had been verified by fact-checkers. The other class of articles (high truth value) supported verified claims or contributed to the debunking of hoaxes. The distribution of Facebook shares did not differ between the two types of articles. Qiu et al. (2017) presented a model that attributed the lack of differentiation to the information (over-) load and finite attention that people experience in real-life social-media settings.

Corroborating the disconnect between message quality and virality is an analysis of Twitter activity by Weng, Flammini, Vespignani, and Menczer (2012). They found that intrinsic message characteristics such as content quality or appeal are not required in order for a meme to go viral. Rather, all that was required to explain the virality of memes were the extrinsic factors of social network structure and competition for finite user attention. Thus, neither intrinsic meme appeal nor user influence nor external events were required to explain the virality of memes. The only source of heterogeneity in the model of Weng et al. is the audience size of users but not the quality of their messages. Other research has underscored the importance of arousal and emotion in the sharing of online information (e.g., Berger & Milkman, 2012; Heath, Bell, & Sternberg, 2001).

A notable aspect of those social-media trends is that many of the worrisome myths involved have been living on the fringes of the internet for quite some time—for example, the claim that many scientists disavow climate change originated in 1998, and "birther" claims about former president Obama surfaced as early as 2004. At the time of this writing, however, claims of this type have become mainstream. Climate science denial is no longer the purview of fringe conspiracy theorists but a view held by senior officials of the current administration, including the president. At one point, President Trump also promulgated doubts about former president Obama's place of birth (Krieg, 2016).

Quantitative support for our assertion that certain types of misinformation have moved from the fringes of the internet into the mainstream was recently provided by a textual analysis of the output of conservative U.S. think tanks that aims to deny the scientific consensus position on climate change (Boussalis & Coan, 2016). This analysis showed a marked increase in the production of denialist content after 2009, compared to the preceding decade, and it yielded evidence that the proportion of arguments casting doubt on mainstream climate science positions (relative to arguments against climate policy) is increasing among some key players (Boussalis & Coan, 2016). This is one indication that the amount of misinformation on climate change has increased in proportion to the strength of scientific evidence that human greenhouse gas emissions are altering the Earth's climate.

The efficacy of those contrarian talking points was established in a further network and content analysis by Farrell (2015b). Farrell's analysis showed a clear increase over time (1993–2003) of the semantic similarity between denialist material and what major news media and U.S. presidents were saying and writing. (No such increase in similarity was observed for the floor of the U.S. Congress.)

In light of these developments, we suggest that a better framing of the post-truth malaise is through the lens of political drivers that have created an alternative epistemology that does not conform to conventional standards of evidentiary support.

In this alternative reality, former president Obama was born in Kenya, climate change is a hoax created by the Chinese (or climate scientists; Lewandowsky, Gignac, & Oberauer, 2013), the U.N. is trying to install a World Government, the Democratic party is involved in a child sex trafficking ring run out of the basement of a pizzeria in Washington D.C. (Kafka, 2016), and NASA is operating a child slave colony on Mars (Mathis-Lilley, 2017). Opinion polls have affirmed that elements of this alternative epistemology are held by a sizable segment of the American public. For example, a 2011 poll showed that 51% of Republican primary voters thought that then-president Obama had been born abroad (Barr, 2015). Similarly, 20% of respondents in a representative U.S. sample have been found to endorse the proposition that climate change is a hoax perpetrated by corrupt scientists (Lewandowsky, Gignac, et al., 2013). The idea that the Democratic party was running a child sex ring was at one point believed or accepted as being possibly true by nearly one third of Americans and nearly one half of Trump voters (Kafka, 2016). This alternative epistemological community is not easily punctured by empirical evidence or corrections issued by "elitist" media or politicians.

It follows that understanding the origins of this post-truth world requires the analysis of political and social mega-trends on a decadal scale. It is only by understanding those trends that a solution can be attempted. To anticipate our conclusion, we believe that the solution requires a more integrated, multidisciplinary approach that combines an in-depth examination of cognition with possible technological solutions that are cognizant of current political constraints.

This raises a potential dilemma because the definition of "political" is itself contested and because some influential voices have argued against the involvement of science in political issues. For example, Daniel Kahneman has recommended that scientists should scrupulously avoid the political, and that if science involves a matter "that anybody in Congress is going to be offended by, then it's political" (cited in Basken, 2016). We reject this broad definition which would render several scientific fields, such as evolutionary biology and climate science, off limits. Indeed, given the number of congressional districts and the diversity among Representatives, Kahneman's criterion might disallow much of contemporary science. Fortunately, both surveys (Pew Research Center, 2009) and experimental studies (Kotcher, Myers, Vraga, Stenhouse, & Maibach, 2017) have shown that scientists can, in some circumstances, advocate policies without necessarily losing public credibility.

We therefore adopt a different stance and suggest that science sometimes cannot help but be political: for example, the potential political fallout must not deter medical researchers from determining—and then publicly articulating—that smoking causes lung cancer. Likewise, the fact that misinformation has political consequences and cannot be understood without political inferences will not deter us from exploring the important questions of how we ended up in a post-truth world, what the consequences might be, and how we might approach the problem. Quite on the contrary, *not* exploring those variables would be a highly political act because it would help maintain the status quo, thus contributing to the insidious consequences of the exposure to misinformation.

The Emergence of a Post-Truth World: Decadal Supporting Trends

We consider a few societal trends that may have contributed to the emergence of a post-truth world over the last few decades. Our choice of trends is informed by their likely link to the emergence of more radical and extremist political movements, which in turn are likely to be reliant more on ideology than evidence.

Decline in Social Capital and Shifting Values

There is evidence for a long-term decline in social capital and civic engagement since the 1960s or 1970s. Social capital refers to factors such as good will, empathy, trust among people, trust in public institutions, and civic engagement (for a thorough review of definitions, see Aldrich & Meyer, 2015). Using a cross-sectional sample of more than 9 million respondents, Twenge, Campbell, and Freeman (2012) found that young Americans' trust in others has declined considerably since the mid-1970s, as has their willingness to engage with government or to help the environment. This decline may not be without consequence: two European studies have found that increased social capital can improve poor households' ability to make ends meet (Guagnano, Santarelli, & Santini, 2016), and that increased social capital is associated with increased levels of happiness (Rodríguez-Pose & von Berlepsch, 2014).

At a personal level, the decline of social capital is revealed by a reduction in the average number of confidantes that Americans have, that is people with whom they can share a secret or private matter without fear of betrayal of that trust. Whereas people in 1985 on average considered three others to be their confidantes, in 2004 that number had shrunk to two (McPherson, Smith-Lovin, & Brashears, 2009). In 2004, a quarter of Americans reported that they had no confidantes at all (Sander & Putnam, 2010), and nearly half of all respondents were only one confidant away from social isolation. Social isolation has been associated with increased all-cause mortality in both men and women, even when controlling for demographic variables (Steptoe, Shankar, Demakakos, & Wardle, 2013). The decline of social capital has been accompanied by a shift of the values and life goals of young Americans. For example, young Americans' agreement that they would like to help the environment has declined from 70% in 1975 to around 50% in 2008. Likewise, interest in philosophy of life has declined from 80% to 50% during the same time span. The importance of being well-off financially, by contrast, has doubled, from 40% agreement in 1966 to around 80% in 2008 (Twenge et al., 2012).

Growing Inequality

At the same time as money has become more important to young Americans, for most people (i.e., those at or below the median income) real income growth has largely stagnated since the 1960s, with most of the increase in disposable income limited to top income earners. To illustrate, the top 1% of income

earners captured 85% of the total income growth between 2009 and 2013. In consequence, by 2013 the top 1% made more than 25 times as much as the remaining 99% of the population (Sommeiller, Price, & Wazeter, 2016).

The consequences of inequality are manifold and have been thoroughly examined (e.g., Piketty & Saez, 2014; Wilkinson & Pickett, 2009). Here we therefore focus on the finding that inequality is associated with political polarization. For example, in an analysis of voting in the U.S. Senate, Garand (2010) found that U.S. senators from states with high levels of income inequality were more polarized than other senators. Similarly, in an analysis spanning 44 countries, Andersen and Curtis (2012) found that the association between household income and class identification—a proxy for economic polarization—is stronger in unequal countries than in countries with lesser inequality.

Increasing polarization. There is little doubt that political polarization in the U.S. has increased since the 1970s. The extent of polarization is such that when Americans are relocating, they now preferentially move into communities that are ideologically more congruent (Motyl, Iyer, Oishi, Trawalter, & Nosek, 2014). Similarly, political opinions are more strongly correlated between spouses than other social or biometric traits, and this interspousal homogeneity seems to arise during mate selection rather than being the result of persuasion (Alford, Hatemi, Hibbing, Martin, & Eaves, 2011). Iyengar and Westwood (2015) reported a series of studies showing that the extent of affective political polarization—that is, the tendency of Republican or Democratic partisans to view members of the opposing party negatively and members of the same party positively—is as strong or often greater than affective polarization based on race (see also Abramowitz & Webster, 2016).[3]

There is growing evidence that this polarization did not emerge from a symmetric "drifting apart" of the two main parties. Instead, the polarization appears to be largely the result of the Republican party moving further to the right during the last few decades. In a quantitative analysis of voting patterns in the U.S. Congress between 1879 and 2013, Hare and Poole (2014) found that today's Democrats have shifted little during the past 40 years. Republicans, by contrast, were found to have moved towards the right in a manner unprecedented since the 1880s.

The drivers for this asymmetrical polarization can be illustrated using climate change as a case study. There is a plethora of evidence that the current polarization of the climate debate is the result of a decade-long concerted effort by conservative political operatives and think tanks to cast doubt on the overwhelming scientific consensus that the Earth is warming from human greenhouse gas emissions (e.g., Dunlap, McCright, & Yarosh, 2016; McCright & Dunlap, 2011a, 2011b; Oreskes & Conway, 2010). To illustrate, in a quantitative textual analysis of more than 39 million words produced by 164 climate-contrarian organizations between 1993 and 2013, Farrell (2015a) found that corporate funding was associated with the language and thematic content of polarizing discourse on climate change. To illustrate, entities that received corporate funding were most likely to generate material between 2008 and 2013 that focused on temperature trends. During that time period, recent global warming fell below the long-term trend. This talking point became known as the "pause" or "hiatus" in global warming in public debate (Boykoff, 2014) and scientific discourse (Lewandowsky, Oreskes, Risbey, Newell, & Smithson, 2015), notwithstanding the fact that there is no discernible statistical evidence for a pause or slowing in warming (Cahill, Rahmstorf, & Parnell, 2015; Foster & Abraham, 2015; Lewandowsky, Risbey, & Oreskes, 2015, 2016; Rahmstorf, Foster, & Cahill, 2017). Thus, while climate change used to be a bipartisan issue in the 1980s, the Republican party has arguably moved from evidence-based concern to industry-funded denial (Dunlap & Jacques, 2013; Dunlap & McCright, 2011).

Declining Trust in Science

The politically-driven asymmetric polarization over climate change is not an isolated case. There has been a general decline of trust in science among conservatives during the last 40 years or so. By contrast, trust in science has remained unchanged (and high) among liberals (Gauchat, 2012).

When specific issues other than climate change are targeted in opinion surveys, there is widespread evidence for asymmetric rejection of well-established scientific findings by conservatives but not liberals (for a review, see Lewandowsky & Oberauer, 2016). This asymmetry extends to issues such as vaccinations (Hamilton, Hartter, & Saito, 2015; Kahan, Braman, Cohen, Gastil, & Slovic, 2010; Lewandowsky, Gignac, et al., 2013) that some media reports had identified as being the presumed domain of left-wing anti-science (Mooney, 2011). Trust in scientists is lower among conservatives than liberals even for issues such as nuclear power and genetically-modified foods (Hamilton, 2015)[4] on which one might expect a fair degree of political opposition on the political left.

Politically Asymmetric Credulity

Recent research has pointed to the possibility that people's susceptibility to misinformation may also be asymmetrically distributed across the political divide. There is a plethora of research into the cognitive and psychological differences between liberals and conservatives, and it is difficult to escape the conclusion that some of those differences are notable (for a recent review of those asymmetries based on a total sample of more than 450,000 participants, see Jost, 2017). It would therefore not be altogether unexpected if susceptibility to misinformation also differed with political orientation.

Sterling, Jost, and Pennycook (2016) examined whether economic conservatism might be associated with susceptibility to "bullshit"; that is, utterances designed to impress but generated

[3] Lelkes (2016) has argued that the polarization is the result of *partisans* becoming more polarized, and disliking each other increasingly, whereas the population overall has not drifted apart quite as far.

[4] The results of Hamilton (2015) are based on a poll of New Hampshire residents, rather than a nationally-representative survey.

without any concern for the truth (Pennycook, Cheyne, Barr, Koehler, & Fugelsang, 2015). Sterling et al. (2016) used sentences that were randomly generated from a set of buzzwords, yielding statements such as "we are in the midst of a self-aware blossoming of being that will align us with the nexus itself" or "consciousness is the growth of coherence, and of us." Because those statements are the product of a random generator that simply selects buzzwords and combines them in a syntactically plausible manner, they cannot contain adequate meaning although the presence of buzzwords may suffice to imply some profound deeper truth. When participants rated statements of this type on how profound they appeared, those ratings were found to be modestly but significantly associated with people's beliefs in free-market economics. That is, the more people endorsed neoliberal economics, the more they rated bullshit statements as profound.

Parallel results were reported by Pfattheicher and Schindler (2016), who found that endorsement of pseudo-profound bullshit statements was associated with general conservatism and support for the Republican candidates for president at the time. Importantly, no such association existed for mundane statements (e.g., "a wet person does not fear the rain"). The results therefore speak against there being a general tendency among conservatives to see profoundness in everything. Instead, it is pseudo-profoundness in bullshit statements that is mistaken for profundity by conservatives.

Fessler, Pisor, and Holbrook (2017) extended this line of research to statements about putative hazards (e.g., "kale contains thallium, a toxic heavy metal, that the plant absorbs from soil") that participants had to rate for their truth value. Unlike the bullshit sentences used by Pfattheicher and Schindler (2016) and Sterling et al. (2016), these statements had a clear discernible meaning, although 14 out of 16 statements presented to participants were actually false. Fessler et al. (2017) found that participants who were more conservative exhibited greater credulity for information about hazards. That is, conservatives were more likely to believe that kale contains thallium than liberals (there is no good evidence that it does). This correlation was absent for similar statements that underscored putative benefits (e.g., "eating carrots results in significantly improved vision"), which is consonant with a large body of research that has associated a negativity bias—a greater physiological response and allocation of more psychological resources to negative stimuli—with conservatism (Hibbing, Smith, & Alford, 2014). On balance, although the number of studies to date is limited, there is empirical reason to expect certain types of misinformation, namely pseudo-profound bullshit and claims about hazards, to be accepted more readily among conservatives than liberals.

Evolution of the Media Landscape

No contemporary analysis of societal trends can be complete without commenting on the rapid transformation of the media landscape. Whereas the public had access to a limited but relatively invariant set of offerings in the 1970s, today we are confronted with a plethora of competing, often chaotic, voices online. At the same time, the number of journalists working for daily papers in the U.S. dropped from around 55,000 in 2000 to 33,000 in 2015 (Painter, 2017).

This transformation has been analyzed in detail elsewhere (e.g., Curran, Fenton, & Freedman, 2012; Deuze & Witschge, 2017); here, we limit ourselves to the lines of evidence that reveal the links between this transformation of the media landscape on the one hand, and polarization and the emergence of a post-truth world on the other.

First, the flexibility and fractionation offered by social media has allowed people to choose their favored "echo chamber" in which most available information conforms to pre-existing attitudes and biases. One consequence of exposure to ideologically slanted media is the formation of inaccurate beliefs even when relevant evidence is understood correctly (Garrett, Weeks, & Neo, 2016). That is, when knowledge of the evidence is statistically controlled, the usage of partisan websites has a large effect on people's misperceptions. To illustrate, a Republican who knows the relevant evidence will respond incorrectly to questions about former president Obama's place of birth or Iraqi WMD only 3% of the time. A person with the same knowledge and political views would answer those questions incorrectly more than 30% of the time if they are a heavy user of conservative websites. A similar effect, albeit smaller in magnitude, was observed for Democrats with questions about Mitt Romney's record of outsourcing jobs (Garrett et al., 2016).

Although considerable choice of media content became available with the advent of cable TV in the 1980s, the proliferation of media online, combined with platforms such as Facebook that custom-deliver content consonant with a user's likes and behaviors, has rapidly accelerated the creation of alternative epistemic realities (Del Vicario et al., 2016; Jasny, Waggle, & Fisher, 2015). Often known as "filter bubbles" (Pariser, 2011), the creation of custom-designed information environments permeates much of our online existence, from helpful purchase suggestions on Amazon to the ads inserted into other websites by Google based on one's recent search history.

Second, the advent of greater consumer choice has also introduced greater heterogeneity among audiences in the extent to which they are misinformed about important issues. For example, it has repeatedly been shown that people who report that they source their news from public broadcasters (NPR or PBS) become *better* informed the more attention they report paying to the news, whereas the reverse is true for self-reported consumers of Fox News (Kull, Ramsay, & Lewis, 2003). Among the latter group, increasing frequency of news consumption is often associated with an *increased* likelihood that they are misinformed about various issues, such as the place of then-president Obama's birth or the existence of a strong scientific consensus on climate change (Ramsay, Kull, Lewis, & Subias, 2010).

Third, online political discourse has become characterized by extreme incivility. It has been suggested that Twitter, in particular, promotes public discourse that is "simple, impetuous, and frequently denigrating and dehumanizing," and that "fosters farce and fanaticism, and contributes to callousness and contempt" (Ott, 2017, p. 60). Even putting aside Twitter, there is much evidence of incivility. One aspect of

this incivility is outrage, characterized as "political discourse involving efforts to provoke visceral responses (e.g., anger, righteousness, fear, moral indignation) from the audience through the use of overgeneralizations, sensationalism, misleading or patently inaccurate information, ad hominem attacks, and partial truths about opponents" (Sobieraj & Berry, 2011, p. 20). In a quantitative content analysis of four media formats (TV, radio, online blogs, and mainstream newspaper columns), Sobieraj and Berry (2011) found that although both sides of politics resort to the same set of tools of outrage (e.g., insulting language, name calling, mockery, and sarcasm), the prevalence of outraged discourse on political blogs, talk radio, and cable news is 50% greater on the political right than the political left. Thus, if content was free of outraged discourse, the probability of the person being on the left was 60% (and 40% that they were on the right), whereas if content was suffused with outrage, the probability of the person being on the left was near zero, whereas it was above 80% that they would be on the political right.

Fourth, the psychological distance and associated deindividuation between online participants contributes to impoliteness, which in turn fosters group polarization (e.g., Lorenzo-Dus, Blitvich, & Bou-Franch, 2011). For example, exposure to uncivil blog comments can polarize risk perceptions of nanotechnology along the lines of religiosity and issue support (Anderson, Brossard, Scheufele, Xenos, & Ladwig, 2013). One particularly toxic form of online behavior, known as trolling, has repeatedly been associated with several or all of the dark tetrad of personality attributes: namely, narcissism, Machiavellianism, psychopathy, and sadism (Buckels, Trapnell, & Paulhus, 2014; Craker & March, 2016; Synnott, Coulias, & Ioannou, 2017). Trolling involves a combination of deception, aggression, and seemingly senseless disruption of civil online discourse. Trolls are thought to be driven by gaining negative power and influence over others by creating social chaos and negative interpersonal interactions (Craker & March, 2016).[5]

Finally, and perhaps most important, the fractionation of the media has created a reward structure for politicians to engage in strategic extremism (Glaeser, Ponzetto, & Shapiro, 2005). Although conventional wisdom holds that vote-maximizing politicians should cater to the middle, chasing the median voter (cf. Downs, 1957), extremism is rewarded when a politician gains more from energizing their own supporters than they lose by alienating median or opposing voters. This relative benefit of extremism can only occur when awareness of a politician's message is higher among his or her supporters than it is among the opponent's supporters. This differential targeting of political messages is facilitated by the existence of echo chambers that are primarily inhabited by partisans but have little effect on others.

A recent development that exploits and promulgates the existence of echo chambers involves the automatic recognition of people's personality attributes from their pattern of behavior on social media. Youyou, Kosinski, and Stillwell (2015) showed that a computer algorithm could infer people's personality on the basis of just 10 Facebook likes more accurately than human work colleagues. This success rate increased with the number of likes, and the program outperformed people's spouses—the best available human judges—when it had access to 300 likes. The more than one billion Facebook users worldwide (Synnott et al., 2017) reveal much about their personality, whether they like it or not.

This ability to predict important aspects of a person from a small set of electronic traces has arguably been exploited during the recent Brexit referendum in the U.K. and during the 2016 U.S. presidential election. A small marketing company, Cambridge Analytica, claims to have developed unique voter-targeting models that permitted campaign operatives to depress turnout among potential Clinton voters and to discover hidden Trump voters (Persily, 2017). The effects—and ethics—of such micro-targeting of advertising remain to be fully understood, but the current "disruption in democratic governance" has been squarely linked to social media (Persily, 2017, p. 75).

Characterizing Post-Truth Discourse and Politics

The trends just reviewed are tied to the emergence of the current post-truth malaise. We are now facing a situation in which a large share of the populace is living in an epistemic space that has abandoned conventional criteria of evidence, internal consistency, and fact-seeking. It follows that the current state of public discourse can no longer be examined through the lens of misinformation that can be debunked but as an alternative reality that is shared by millions.

The nature of this alternative epistemic space can be better understood by drawing on research into denial of climate science. Around 97% of climate scientists agree on the fundamental fact that the Earth is warming from greenhouse gas emissions (e.g., Anderegg et al., 2010; Cook et al., 2013, 2016). In the absence of notable scientific dissent, much of the opposition to mainstream climate science, like any other form of science denial, involves non-scientific outlets such as blogs (Diethelm & McKee, 2009; Lewandowsky, Oberauer, & Gignac, 2013; McKee & Diethelm, 2010). There is much evidence that this body of contrarian opinions should not be considered an equally valid alternative. For example, the small number of peer-reviewed publications that oppose the scientific consensus have been identified as being flawed (Abraham et al., 2014; Benestad et al., 2016). Likewise, in blind expert tests climate-contrarian talking points have been repeatedly identified as representing misleading interpretations of the data (Lewandowsky, Ballard, Oberauer, & Benestad, 2016; Lewandowsky, Risbey, et al., 2016). Other analyses of contrarian rhetoric have shown that climate science denial does not present a coherent alternative explanation of climate change. On the contrary, the arguments offered by climate denial are intrinsically incoherent (Lewandowsky, Cook, & Lloyd, 2016). Climate-science denial is therefore best understood not as an alternative knowledge claim but as a political operation aimed at generating uncertainty in the public's mind in order to preserve the status quo and

[5] In addition to fostering polarization (Lorenzo-Dus et al., 2011), online trolling and other forms of cyber-bullying have also been associated with increased risk of suicide in adolescents (Bauman, Toomey, & Walker, 2013).

to delay climate-change mitigation (e.g., Oreskes & Conway, 2010).

We propose that most other post-truth claims similarly do not seek to establish a coherent model of reality. Rather, they erode trust in facts and reality, to the point where facts no longer matter or are not even acknowledged to exist. We noted earlier that in behavioral experiments the presentation of misinformation can counter the effects of factual information (Cook et al., 2017; McCright et al., 2016; van der Linden et al., 2017). Here we extrapolate those empirical results to a tentative analysis of the possible political purpose and effect of post-truth claims. Because of the recency of these developments, at the time of this writing there was hardly any empirical research or data available. Our analysis thus draws mainly on media commentators and must necessarily remain sketchy. However, we believe that it identifies important issues for future research.

An obvious hallmark of a post-truth world is that it empowers people to choose their own reality, where facts and objective evidence are trumped by existing beliefs and prejudices. This can be amplified by leaders who model deception and delusion as adequate means to garner support. In this world, lying is not only accepted, it is rewarded. Falsifying reality is no longer about changing people's beliefs, it is about asserting power. As Gopnik (2017) described President Trump's claim about the 3 million illegally cast votes that he proffered to explain his loss of the popular vote, "The lie is not a claim about specific facts; the lunacy is a deliberate challenge to the whole larger idea of sanity. Once a lie that big is in circulation, trying to reel the conversation back into the territory of rational argument becomes impossible."

This theme—that the series of overt falsehoods emanating from the White House (according to the *Washington Post*, President Trump has made 469 false or misleading claims in the first 99 days of his presidency; https://www.washingtonpost.com/graphics/politics/trump-claims/) creates a sense of uncertainty about whether any facts are knowable at all—is echoed by the editorial board of the *Bangor Daily News*, who cite an anonymous memo circulating on the internet, arguing that in response to such overt lies "A third of the population will say 'clearly the White House is lying,' a third will say 'if Trump says it, it must be true,' and the remaining third will say 'gosh, I guess this is unknowable.' The idea isn't to convince these people of untrue things, it's to fatigue them, so that they will stay out of the political process entirely, regarding the truth as just too difficult to determine" (http://bangordailynews.com/2017/01/23/opinion/editorials/there-are-not-alternative-facts-just-truth-and-lies/). Those concerns are mirrored by analysts of Russian propaganda and disinformation campaigns (e.g., Pomerantsev & Weiss, 2014).[6]

Another discernible role of post-truth statements is that they serve to distract the public from unwanted information or potentially unpopular policy actions, which as a result of the distraction can go uncommented or unnoticed. For example, President Trump unleashed a Twitter tirade against a Broadway production of *Hamilton* after its cast read an open letter at the end of a show, pleading for respect of a "diverse America." This Twitter event coincided with the revelation that President Trump had agreed to a $25 million fraud settlement of three lawsuits targeting his (now defunct) Trump University. The Twitter controversy arguably served as a welcome distraction from the settlement, which included a $1 million penalty payment to the State of New York (Bulman, 2016). The success of this distraction can be illustrated by comparing the Google search trends for the two search terms *"Trump University" settlement* and *Trump Hamilton* (Figure 1). It is clear from the figure that the court settlement was of considerably less interest to the public than the Twitter event relating to a Broadway play.

A further aspect of the post-truth world appears to be an increasing fluidity of allegiances: not only do facts not matter (e.g., to voting intentions; Swire et al., 2017), but anyone can be turned into a friend or foe, even if this implies a departure from long-standing beliefs and principles. For example, recent survey data have revealed that among Republicans, approval for Vladimir Putin, the Russian leader widely considered to be at least autocratic if not despotic, has increased between 2015 and 2017 (Kiley, 2017). Although Putin is still viewed unfavorably by the majority of Republicans (61%), this represents a decline from 74% two years earlier. Conversely, approval ratings among Republicans have risen from 11% to 27% during the same period. The survey data suggest that decades of Cold War and anti-Russian sentiment among Republicans outlived their utility when a new party leader emerged who has expressed greater sympathy towards the Russian president than previous Republican leaders. In fact, only 20% of Republicans now see Russia as an adversary of the U.S., compared to 38% of Democrats. Those numbers are an almost precise mirror image of the situation in 2014, when Republicans were more likely to consider Russia to be an adversary than Democrats (Kiley, 2017).

A final notable aspect of post-truth discourse is that it invokes processes that render it self-perpetuating. One such process is that if it becomes permissible to believe whatever one wants, beliefs become harder to change because contrary evidence fails to find traction (or may ironically strengthen previously-held beliefs; Nyhan & Reifler, 2010). A second, potentially more pernicious process is that people tend to persist in beliefs that they *believe* to be widely shared—irrespective of whether or not they *are* actually widely shared. To illustrate, in two Australian surveys on people's attitudes about climate change, Leviston, Walker, and Morwinski (2013) found the proportion of people who denied that climate change was happening to be small (between 5% and 7%). However, those minority respondents thought that their opinion was shared by between 43% and 49% of the population. The massive discrepancy between actual and believed prevalence of an opinion (around 40% in this case) is known as the false consensus effect (e.g., Krueger & Zeiger, 1993). When people believe that their opinion is widely shared,

[6] At the time of this writing, the alleged connections between the Trump campaign and Russian state actors are avidly discussed in the media. We do not consider those claims in our analysis because their validity remains to be established.

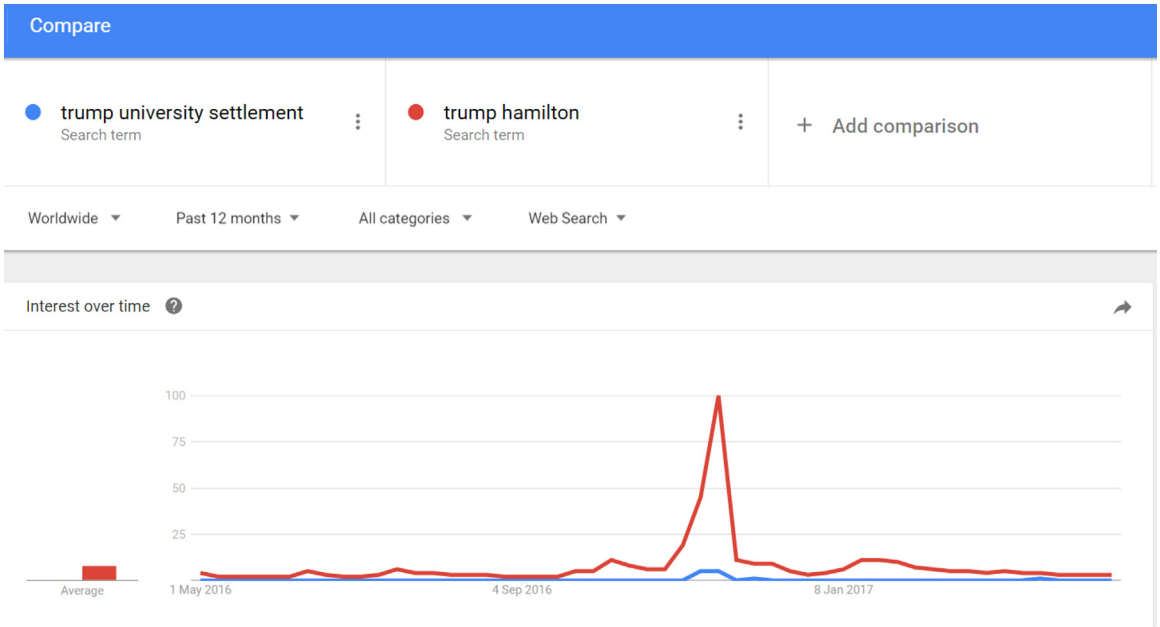

Figure 1. Google Trends results for the two search terms *"Trump University" settlement* and *Trump Hamilton*, conducted on 29 April 2017. Google trends provides time series of worldwide web search volumes for specified search terms. Google Trends is considered a good indicator of interest, attention, and public opinion over time (e.g., Ortiz et al., 2011). The search results are scaled such that the maximum interest recorded across search terms and across the temporal window is assigned the number 100, and all other data points are then scaled relative to that maximum.

they are particularly resistant to belief revision (Leviston et al., 2013), are less likely to compromise, and are more likely to insist that their own views prevail (Miller, 1993). In light of the fractionation of the media landscape into echo chambers (e.g., Jasny et al., 2015), we can expect that many people will believe that their opinions, however exotic or unsupported by evidence, are widely shared, thereby rendering them resistant to change or correction.

Where to? Possible Solutions to the Post-Truth Crisis

We have argued that a notable segment of the American public now subscribes to a non-standard epistemology that does not meet conventional criteria of evidentiary support. This non-standard epistemology is buttressed by statements from politicians and parts of the news media. We propose that the fallout from this post-truth demagoguery is not insignificant, in particular because this non-standard epistemology contains within it psychological mechanisms to self-perpetuate.

How can we move on from this state of affairs? Given how widespread the problem has become, further laboratory experimentation to derive better communication and debunking tools will, by itself, be insufficient. Techniques for correcting misinformation are bound to remain helpful and necessary, and effectively pointing out logical flaws in argumentation will continue to be valuable in inoculating people against potential disinformation campaigns (Cook et al., 2017; Ecker, Hogan, & Lewandowsky, 2017; Schwarz et al., 2016).

But we must look beyond those basic tools. The solution to the post-truth malaise ultimately must be informed by political constraints and must fit within those constraints. For the sake of the argument, we assume that those constraints are favorable, and that there is a sufficiently strong political recognition that the current information landscape is unsatisfactory. What might the solution involve?

Our preferred approach is perhaps best described as "technocognition": that is, an inter-disciplinary approach to the design of information architectures that incorporates principles borrowed from behavioral economics to "nudge" (Thaler & Sunstein, 2008) against the spread of misinformation, combined with a cognitively inspired program to educate the public and improve journalistic practices. In a nutshell, the idea of technocognition is to design better information architectures that can build bridges between the socially-defined epistemic islands that define the post-truth era. If technology can facilitate such epistemic fractionation in the first place (Persily, 2017), then it stands to reason that it might also contribute to the solution.

Cognition of Inoculation and Discernment

There is a sizeable literature in the global security arena that has confronted the problem of disinformation in various guises, most recently in the context of Russia's presumed disinformation campaigns against Western interests (e.g., Abrams, 2016; Bjola & Pamment, 2016; Kragh & Åsberg, 2017; Pomerantsev & Weiss, 2014).[7] That research has come to conclusions not dissimilar to ours. For example, Bjola and Pamment (2016) concluded that Russian propaganda can be "digitally contained" by "supporting media literacy and source criticism,

[7] We take no position here on the issue of whether or not Russia is seeking to unduly influence Western societies by digital propaganda. The conclusions of that literature are independent of what presumed (or indeed real) threat motivated it.

encouraging institutional resilience, and promoting a clear and coherent strategic narrative capable of containing the threat from inconsistent counter-messaging. Ultimately, the citizens of the EU and Eastern neighbourhood must be supported so that they can cease to be targets of propaganda, and instead act as nodes in its containment" (p. 9).

Pomerantsev and Weiss (2014) provided a set of recommendations that were crafted to counter Kremlin propaganda but that can be generalized to the general post-truth problem. The following list extends and augments Pomerantsev and Weiss (2014)'s recommendations:

1. An international NGO is required that could create a recognized rating system for disinformation and would provide tools with which it can be recognized. Pioneering developments along those lines exist already, for example in the form of the ClimateFeedback (http://www.climatefeedback.org/) organization which provides fact-checking of media articles in the climate arena.
2. A "Disinformation Charter" should be developed for media and bloggers that defines what is acceptable and unacceptable behavior and commits signing organizations to standards of accuracy.
3. Many newspapers already employ ombudsmen or editors who oversee the paper's operation and respond to public critique. The new position of a counter fake news editor would highlight disinformation that is circulating in the public sphere and would use the paper to debunk it.
4. At present, many representatives of think tanks and corporate front groups appear in the media without revealing their affiliations and conflicts of interest. This practice must be tightened and rigorous disclosure of all affiliations and interests must take center-stage in media reporting.
5. The public must be made aware of how "fake news" campaigns work and how they can be spotted. Inoculation strategies (e.g., Cook et al., 2017) can limit the damaging effects of disinformation, but this requires further research and broader application.
6. General training in information literacy is required so students learn which information to trust, particularly online. Recent efforts along those lines have yielded promising results (e.g., Walton & Hepworth, 2011).
7. People must be educated about (a) the realities of cyberbullying techniques, such as trolling and sock puppets, and how they can be countered, and (b) the mechanisms of automated filter bubbles as well as targeted disinformation and nudging campaigns based on their online profiles (Persily, 2017).
8. People should be encouraged to make their voices heard, not just to directly persuade, but also to influence people's perceptions of norms and the prevalence of opinions, so that false-consensus effects do not arise. Even a few dissenting voices can shift the perceived social norm (i.e., the perceived range of acceptable views), thus legitimizing opposition and encouraging evidence-based discourse. In this context, it is important for scientists to know that engagement in advocacy does not necessarily hurt their credibility (Kotcher et al., 2017).

The Technology of Overcoming the Post-Truth Malaise

On the technological side, there has been much promising recent work. At the time of this writing, the response of internet giants such as Facebook and Google to the post-truth crisis was ongoing and has been unfolding rapidly. We list a sample of developments that appear promising:

1. Algorithmic fact checkers, that is computer programs that automatically detect misinformation, are presently in their infancy. However, initial research has established their feasibility. For example, Ciampaglia et al. (2015) showed that using a knowledge representation that was extracted from Wikipedia, an algorithm consistently assigned greater truth value to statements that were independently known to be true than to false statements. Fact checkers of this type could be added to the information returned by search engines. Indeed, at the time of this writing, Google has been experimenting with fact-checking and disinformation alerts as parts of their routine search results (with, arguably, limited success thus far).
2. Provided that fact checking is available, this information can be used to alert users of social media that something they are about to share is likely false. At the time of this writing, Facebook appears to have commenced this practice. Likewise, Google provides additional information pointing to fact checks and debunking websites in response to certain search terms (e.g., "Obama birth certificate").
3. Google is also sponsoring development of a web-based app that combines machine learning and artificial-intelligence technologies to help journalists fact-check. The app will include the capability to search "big data" such as police and government records (Donnelly, 2017).
4. Reader comments on news articles and blog posts are known to affect other readers' impressions and behavioral intentions (e.g., Lee, 2012; Stavrositu & Kim, 2015; Winter & Krämer, 2016). The mere tone of blog comments—that is, whether they are civil or uncivil—has been shown to affect people's attitudes towards scientific issues they do not understand well. Anderson et al. (2013) have shown that when people read a neutral blog post about an issue such as nanotechnology, about which people typically know very little, exposure to uncivil comments, such as name calling and other expressions of incivility, polarized reader's views of the technology.

   The fact that a few commenters can sway readers' opinion and can set the tone of discourse is of growing concern to internet news services and media providers. In response, some sites have introduced strict moderation of comments, as for example *TheConversation.com* which employs a "community manager" and has entertained options such as a "community council" to provide moderation (https://theconversation.com/involving-a-community-council-in-moderation-25547). Another alternative that is being explored by at least one Norwegian site is the requirement that readers must pass a brief

comprehension quiz before being permitted to post comments (http://www.niemanlab.org/2017/03/this-site-is-taking-the-edge-off-rant-mode-by-making-readers-pass-a-quiz-before-commenting/). If it turns out to be successful, the latter idea appears particularly attractive because it can be automated and it is difficult to see how it could be construed as censorship.

5. At present, most online users are, knowingly or not, put into a filter bubble (Pariser, 2011) based on their known preferences. For example, Facebook is presenting personalized posts to users that are consistent with their likes and other algorithmically inferred preferences. While convenient, those recommendations and other customization tools facilitate further fractionation of the public. One solution is to increase the social distance of suggested content from the person's preferences, to escape or at least to broaden the filter bubble. The challenge is to find material that is sufficiently different to burst the filter bubble without being so different that it will be disregarded for being too offensive to the user.

Cognitive Research Towards Overcoming Post-Truth

The technocognitive approaches just outlined give rise to a number of basic research questions that require further applied cognitive research. We illustrate a few of those to provide pointers to future research:

1. To what extent do inoculation effects generalize across content domains? If people are taught to recognize a fake-expert strategy (e.g., Cook et al., 2017), would this also enable them to recognize other rhetorical tools by which they might be misled, as for example cherry picking (e.g., Lewandowsky, Ballard, et al., 2016)?
2. What are the long-term effects of information-discernment education programs in children and adolescents (e.g., Walton & Hepworth, 2011)? Are information-discernment skills resilient to the development of new rhetorical and political tools?
3. When people are nudged out of their filter bubbles, what is the optimal novelty of the information being offered as an alternative? How far can proposed material sit outside people's comfort zone?
4. What is the effect of indicators of trustworthiness (such as badges awarded by independent fact checkers) on perceived credibility of websites?
5. To what extent does the abundance of "alternative facts" undermine people's general epistemology? Do people consider things still knowable when everything and anything is contested? Can people be made more resilient to the undermining of their epistemology by post-truth rhetoric?

There are at least two important ethical considerations that must inform pursuit of these research questions. First, even though we have repeatedly noted the strong link between worldview on the one hand, and susceptibility to misinformation and resistance to its correction on the other (e.g., conservative worldviews are strongly associated with rejection of the consensual scientific position on climate change), it does not follow that worldviews must be (or should be) changed. Quite to the contrary, behavioral scientists must respect and protect people's choices of political opinion and personal ideologies. Instead, we argue that worldview ought to be decoupled from the propensity to accept misinformation and resist its correction, for example by seeking worldview-congruent messengers who can deliver information without emotional challenge to the recipients (e.g., Kahan et al., 2010). It is ethically permissible to seek optimal channels of communication for audiences across a broad range of personal views, but it would not be ethically permissible to develop tools to change people's worldview.

Second, in general our preferred solution to post-truth misinformation does not involve directives or censorship or other undemocratic means. Instead, we argue for the creation of better information architectures—by entirely transparent and democratic processes—that are more conducive to the circulation of valuable information rather than misinformation. By the same token, when we argue for the development of potential techniques to break filter bubbles or to educate people about information discernment, those techniques must aim to be politically neutral.

Our sketch is necessarily preliminary, but we are confident that cognitive science and applied research on memory and cognition, in conjunction with internet technology, have a crucial role to play in restoring a more evidence-based form of public discourse.

Concluding Remarks

In the 1990s, the internet was celebrated as an invention that would inaugurate a new era of cultural and political democracy, perhaps through new forms of "e-government" and through direct contributions from citizen-journalists. Curran et al. (2012) reviews some of those enthusiastic forecasts, which from today's perspective look as false and as amusing (or tragic) as the predictions from the 1950s that nuclear power would make electricity so plentiful that it would ultimately be given away for free.

The early enthusiasm has given rise to a less optimistic view of the post-truth information landscape that has been curated by the internet. Although we have approached the present article from this less optimistic vantage point, we do not consider the current situation intractable. We suggest that post-truth misinformation has arguably been designed and used as a smokescreen to divert attention from strategic political actions or challenges (see discussion in connection with Figure 1). On this assumption, post-truth politics—much like climate denial (Lewandowsky, Cook, et al., 2016)—can be identified as a rational strategy that is deployed in pursuit of political objectives. One implication of this view is that post-truth politics may cease when its effectiveness is curtailed. This may occur once the public recognizes the underlying political objectives, and when the discrepancies between political propaganda and actual policy outcomes become apparent. For example, in the case of climate change, it is difficult to see how the strong physical signals provided by reality (e.g., record-breaking annual temperatures, heatwaves, excessive precipitation and flooding)

would not ultimately prevail over the misleading talking points presented by contrarians (Lewandowsky, Ballard, et al., 2016; Lewandowsky, Risbey, et al., 2016).

The road towards educating the public about post-truth discourse is filled with rocks and pitfalls. One important potential pitfall is to believe that improved communication, or more or better information, will be sufficient to move forward. We are convinced that this by itself would be insufficient. The current malaise has arisen for political reasons and in pursuit of political and economic objectives. As Brulle, Carmichael, and Jenkins (2012) noted in the context of climate change, "introducing new messages or information into an otherwise unchanged socioeconomic system will accomplish little" (p. 185). Post-truth politics is a tool in a struggle for power and over the nature of Western democracies, and communication alone cannot resolve such deep-seated political conflicts. Instead, their resolution requires political mobilization and public activism (Brulle et al., 2012). Our proposed technocognition approach is thus not intended as a recipe for resolution of the post-truth crisis, but as a set of potential tools that could be deployed *if* there is political will to do so. But ultimately the post-truth malaise will be resolved only when there is sufficient motivation among politicians and the public alike to be well-informed, when there are political, social, and professional incentives to adequately inform, and when Senator Daniel Patrick Moynihan's insight, that "everyone is entitled to his own opinion, but not to his own facts," once more becomes consensually accepted across both sides of politics.

Conflict of Interest Statement

The authors declare no conflict of interest.

Author Contributions

Stephan Lewandowsky wrote a draft and the others commented on it before Stephan Lewandowsky finalized the paper.

References

Abraham, J. P., Cook, J., Fasullo, J. T., Jacobs, P. H., Mandia, S. A., & Nuccitelli, D. A. (2014). Review of the consensus and asymmetric quality of research on human-induced climate change. *Cosmopolis*, *1*, 3–18.

Abramowitz, A. I., & Webster, S. (2016). The rise of negative partisanship and the nationalization of U.S. elections in the 21st century. *Electoral Studies*, *41*, 12–22. http://dx.doi.org/10.1016/j.electstud.2015.11.001

Abrams, S. (2016). Beyond propaganda: Soviet active measures in Putin's Russia. *Connections: The Quarterly Journal*, *15*

Aldrich, D. P., & Meyer, M. A. (2015). Social capital and community resilience. *American Behavioral Scientist*, *59*, 254–269. http://dx.doi.org/10.1177/0002764214550299

Alford, J. R., Hatemi, P. K., Hibbing, J. R., Martin, N. G., & Eaves, L. J. (2011). The politics of mate choice. *The Journal of Politics*, *73*, 362–379. http://dx.doi.org/10.1017/S0022381611000016

Anderegg, W. R. L., Prall, J. W., Harold, J., & Schneider, S. H. (2010). Expert credibility in climate change. *Proceedings of the National Academy of Sciences of the United States of America*, *107*, 12107–12109. http://dx.doi.org/10.1073/pnas.1003187107

Andersen, R., & Curtis, J. (2012). The polarizing effect of economic inequality on class identification: Evidence from 44 countries. *Research in Social Stratification and Mobility*, *30*, 129–141. http://dx.doi.org/10.1016/j.rssm.2012.01.002

Anderson, A. A., Brossard, D., Scheufele, D. A., Xenos, M. A., & Ladwig, P. (2013). The "nasty effect:" Online incivility and risk perceptions of emerging technologies. *Journal of Computer-Mediated Communication*, *19*, 373–387. http://dx.doi.org/10.1111/jcc4.12009

Barr, A. (2015). *51% of GOP voters: Obama foreign.*. Retrieved from http://www.politico.com/story/2011/02/51-of-gop-voters-obama-foreign-049554

Basken, P. (2016, January). *On climate change, are university researchers making a difference?* Retrieved from http://chronicle.com/article/On-Climate-Change-Are/235035

Bauman, S., Toomey, R. B., & Walker, J. L. (2013). Associations among bullying cyberbullying and suicide in high school students. *Journal of Adolescence*, *36*, 341–350. http://dx.doi.org/10.1016/j.adolescence.2012.12.001

Benestad, R., Nuccitelli, D., Lewandowsky, S., Hayhoe, K., Hygen, H., van Dorland, R., & Cook, J. (2016). Learning from mistakes in climate research. *Theoretical and Applied Climatology*, *126*, 699–703. http://dx.doi.org/10.1007/s00704-015-1597-5

Berger, J., & Milkman, K. L. (2012). What makes online content viral? *Journal of Marketing Research*, *49*, 192–205.

Bjola, C., & Pamment, J. (2016). Digital containment: Revisiting containment strategy in the digital age. *Global Affairs*, *2*, 131–142.

Boussalis, C., & Coan, T. G. (2016). Text-mining the signals of climate change doubt. *Global Environmental Change*, *36*, 89–100. http://dx.doi.org/10.1016/j.gloenvcha.2015.12.001

Boykoff, M. T. (2014). Media discourse on the climate slowdown. *Nature Climate Change*, *4*, 156–158. http://dx.doi.org/10.1038/nclimate2156

Brulle, R. J., Carmichael, J., & Jenkins, J. C. (2012). Shifting public opinion on climate change: An empirical assessment of factors influencing concern over climate change in the U.S., 2002–2010. *Climatic Change*, *114*, 169–188. http://dx.doi.org/10.1007/s10584-012-0403-y

Bu, Z., Xia, Z., & Wang, J. (2013). A sock puppet detection algorithm on virtual spaces. *Knowledge-Based Systems*, *37*, 366–377. http://dx.doi.org/10.1016/j.knosys.2012.08.016

Buckels, E. E., Trapnell, P. D., & Paulhus, D. L. (2014). Trolls just want to have fun. *Personality and Individual Differences*, *67*, 97–102. http://dx.doi.org/10.1016/j.paid.2014.01.016

Bulman, M. (2016). *Donald Trump 'using Hamilton controversy to distract from $25m fraud settlement and other scandals'*.. Retrieved from http://www.independent.co.uk/news/world/americas/donald-trump-hamilton-settlement-university-fraud-mike-pence-scandals-a7429316.html

Cahill, N., Rahmstorf, S., & Parnell, A. C. (2015). Change points of global temperature. *Environmental Research Letters*, *10*, 084002.

Ciampaglia, G. L., Shiralkar, P., Rocha, L. M., Bollen, J., Menczer, F., & Flammini, A. (2015). Computational fact checking from knowledge networks. *PLOS ONE*, *10*, 1–13. http://dx.doi.org/10.1371/journal.pone.0128193

Cook, J., Ecker, U. K. H., & Lewandowsky, S. (2015). Misinformation and how to correct it. In R. A. Scott, & S. M. Kosslyn (Eds.), *Emerging trends in the social and behavioral sciences*. John Wiley & Sons. http://dx.doi.org/10.1002/9781118900772.etrds0222

Cook, J., Lewandowsky, S., & Ecker, U. K. H. (2017). Neutralizing misinformation through inoculation: Exposing misleading

argumentation techniques reduces their influence. *PLOS ONE*, *12*, e0175799. http://dx.doi.org/10.1371/journal.pone.0175799

Cook, J., Nuccitelli, D., Green, S. A., Richardson, M., Winkler, B., Painting, R., ... & Skuce, A. (2013). Quantifying the consensus on anthropogenic global warming in the scientific literature. *Environmental Research Letters*, *8*, 024024. http://dx.doi.org/10.1088/1748-9326/8/2/024024

Cook, J., Oreskes, N., Doran, P., Anderegg, W., Verheggen, B., Maibach, E., ... & Rice, K. (2016). Consensus on consensus: A synthesis of consensus estimates on human-caused global warming. *Environmental Research Letters*, *11*, 048002. http://dx.doi.org/10.1088/1748-9326/11/4/048002

Craker, N., & March, E. (2016). The dark side of Facebook: The Dark Tetrad, negative social potency, and trolling behaviours. *Personality and Individual Differences*, *102*, 79–84. http://dx.doi.org/10.1016/j.paid.2016.06.043

Curran, J., Fenton, N., & Freedman, D. (2012). *Misunderstanding the internet*. Routledge.

Del Vicario, M., Bessi, A., Zollo, F., Petroni, F., Scala, A., Caldarelli, G., ... & Quattrociocchi, W. (2016). The spreading of misinformation online. *Proceedings of the National Academy of Sciences of the United States of America*, *113*, 554–559. http://dx.doi.org/10.1073/pnas.1517441113

DeStefano, F., & Thompson, W. W. (2004). MMR vaccine and autism: An update of the scientific evidence. *Expert Review of Vaccines*, *3*, 19–22. http://dx.doi.org/10.1586/14760584.3.1.19

Deuze, M., & Witschge, T. (2017). Beyond journalism: Theorizing the transformation of journalism. *Journalism*, http://dx.doi.org/10.1177/1464884916688550

Diethelm, P., & McKee, M. (2009). Denialism: What is it and how should scientists respond? *European Journal of Public Health*, *19*, 2–4. http://dx.doi.org/10.1093/eurpub/ckn139

Donnelly, E. (2017). *Google backs Irish academic's fake-news fight*.. Retrieved from http://www.independent.ie/business/media/google-backs-irish-academics-fakenews-fight-35903839.html

Downs, A. (1957). An economic theory of political action in a democracy. *Journal of Political Economy*, *65*, 135–150.

Dunlap, R. E., & Jacques, P. J. (2013). Climate change denial books and conservative think tanks: Exploring the connection. *American Behavioral Scientist*, *57*, 1–33. http://dx.doi.org/10.1177/0002764213477096

Dunlap, R. E., & McCright, A. M. (2011). Organized climate change denial. In J. S. Dryzek, R. B. Norgaard, & D. Schlosberg (Eds.), *The Oxford handbook of climate change and society* (pp. 144–160). Oxford, UK: Oxford University Press.

Dunlap, R. E., McCright, A. M., & Yarosh, J. H. (2016). The political divide on climate change: Partisan polarization widens in the U.S. *Environment: Science and Policy for Sustainable Development*, *58*, 4–23. http://dx.doi.org/10.1080/00139157.2016.1208995

Ecker, U. K. H., Hogan, J. L., & Lewandowsky, S. (2017). Reminders and repetition of misinformation: Helping or hindering its retraction? *Journal of Applied Research in Memory and Cognition*, *6*, 185–192. http://dx.doi.org/10.1016/j.jarmac.2017.01.014

Ecker, U. K. H., Lewandowsky, S., & Tang, D. T. W. (2010). Explicit warnings reduce but do not eliminate the continued influence of misinformation. *Memory & Cognition*, *38*, 1087–1100.

Einstein, K. L., & Glick, D. M. (2015). Do I think BLS data are BS? The consequences of conspiracy theories. *Political Behavior*, *37*, 679–701. http://dx.doi.org/10.1007/s11109-014-9287-z

Farrell, J. (2015a]). Corporate funding and ideological polarization about climate change. *Proceedings of the National Academy of Sciences of the United States of America*, *113*, 92–97. http://dx.doi.org/10.1073/pnas.1509433112

Farrell, J. (2015b]). Network structure and influence of the climate change counter-movement. *Nature Climate Change*, *6*, 370–374. http://dx.doi.org/10.1038/nclimate2875

Fein, S., McCloskey, A. L., & Tomlinson, T. M. (1997). Can the jury disregard that information? The use of suspicion to reduce the prejudicial effects of pretrial publicity and inadmissible testimony. *Personality and Social Psychology Bulletin*, *23*, 1215–1226. http://dx.doi.org/10.1177/01461672972311008

Fessler, D. M. T., Pisor, A. C., & Holbrook, C. (2017). Political orientation predicts credulity regarding putative hazards. *Psychological Science*, *28*, 651–660.

Flood, A. (2016). *'Post-truth' named word of the year by Oxford Dictionaries*.. Retrieved from https://www.theguardian.com/books/2016/nov/15/post-truth-named-word-of-the-year-by-oxford-dictionaries

Foster, G., & Abraham, J. (2015). Lack of evidence for a slowdown in global temperature. *US CLIVAR*, *13*(3), 6–9.

Garand, J. C. (2010). Income inequality, party polarization, and roll-call voting in the U.S. Senate. *The Journal of Politics*, *72*, 1109–1128. http://dx.doi.org/10.1017/S0022381610000563

Garrett, R. K., Nisbet, E. C., & Lynch, E. K. (2013). Undermining the corrective effects of media-based political fact checking? The role of contextual cues and naïve theory. *Journal of Communication*, *63*, 617–637. http://dx.doi.org/10.1111/jcom.12038

Garrett, R. K., Weeks, B. E., & Neo, R. L. (2016). Driving a wedge between evidence and beliefs: How online ideological news exposure promotes political misperceptions. *Journal of Computer-Mediated Communication*, *21*, 331–348. http://dx.doi.org/10.1111/jcc4.12164

Gauchat, G. (2012). Politicization of science in the public sphere: A study of public trust in the United States, 1974 to 2010. *American Sociological Review*, *77*, 167–187.

Glaeser, E. L., Ponzetto, G. A. M., & Shapiro, J. M. (2005). Strategic extremism: Why Republicans and Democrats divide on religious values. *The Quarterly Journal of Economics*, *120*, 1283–1330.

Godlee, F., Smith, J., & Marcovitch, H. (2011). Wakefield's article linking MMR vaccine and autism was fraudulent: Clear evidence of falsification of data should now close the door on this damaging vaccine scare. *BMJ: British Medical Journal*, *342*, 64–66.

Gopnik, A. (2017). *Orwell's "1984" and Trump's America*.. Retrieved from http://www.newyorker.com/news/daily-comment/orwells-1984-and-trumps-america

Guagnano, G., Santarelli, E., & Santini, I. (2016). Can social capital affect subjective poverty in Europe? An empirical analysis based on a generalized ordered logit model. *Social Indicators Research*, *128*, 881–907. http://dx.doi.org/10.1007/s11205-015-1061-z

Guillory, J. J., & Geraci, L. (2013). Correcting erroneous inferences in memory: The role of source credibility. *Journal of Applied Research in Memory and Cognition*, http://dx.doi.org/10.1016/j.jarmac.2013.10.001

Hamilton, L. C. (2015). *Conservative and liberal views of science: Does trust depend on topic? (Regional issue brief No. 45)*. University of New Hampshire.

Hamilton, L. C., Hartter, J., & Saito, K. (2015). Trust in scientists on climate change and vaccines. *SAGE Open*, *5* http://dx.doi.org/10.1177/2158244015602752

Hare, C., & Poole, K. T. (2014). Polarization of contemporary American politics. *Polity*, *46*, 411–429. http://dx.doi.org/10.1057/pol.2014.10

Hart, P. S., & Nisbet, E. C. (2012). Boomerang effects in science communication: How motivated reasoning and identity cues amplify opinion polarization about climate mitigation policies. *Communication Research*, *39*, 701–723.

Heath, C., Bell, C., & Sternberg, E. (2001). Emotional selection in memes: The case of urban legends. *Journal of Personality and Social Psychology*, *81*, 1028–1041.

Hibbing, J. R., Smith, K. B., & Alford, J. R. (2014). Differences in negativity bias underlie variations in political ideology. *Behavioral and Brain Sciences*, *37*, 297–350.

Iyengar, S., & Westwood, S. J. (2015). Fear and loathing across party lines: New evidence on group polarization. *American Journal of Political Science*, *59*, 690–707. http://dx.doi.org/10.1111/ajps.12152

Jasny, L., Waggle, J., & Fisher, D. R. (2015). An empirical examination of echo chambers in US climate policy networks. *Nature Climate Change*, *5*, 782–786. http://dx.doi.org/10.1038/nclimate2666

Johnson, H. M., & Seifert, C. M. (1994). Sources of the continued influence effect: When misinformation in memory affects later inferences. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *20*, 1420–1436.

Jolley, D., & Douglas, K. M. (2013). The social consequences of conspiracism: Exposure to conspiracy theories decreases intentions to engage in politics and to reduce one's carbon footprint. *British Journal of Psychology*, *105*, 35–56. http://dx.doi.org/10.1111/bjop.12018

Jost, J. T. (2017). Ideological asymmetries and the essence of political psychology. *Political Psychology*, *38*, 167–208. http://dx.doi.org/10.1111/pops.12407

Kafka, P. (2016). *An astonishing number of people believe Pizzagate, the Facebook-fueled Clinton sex ring conspiracy story, could be true*.. Retrieved from https://www.recode.net/2016/12/9/13898328/pizzagate-poll-trump-voters-clinton-facebook-fake-news

Kahan, D. M., Braman, D., Cohen, G. L., Gastil, J., & Slovic, P. (2010). Who fears the HPV vaccine, who doesn't, and why? An experimental study of the mechanisms of cultural cognition. *Law and Human Behavior*, *34*, 501–516.

Kiley, J. (2017). *U.S. public sees Russian role in campaign hacking, but is divided over new sanctions*. Retrieved from http://www.pewresearch.org/fact-tank/2017/01/10/u-s-public-says-russia-hacked-campaign/

Kollanyi, B., Howard, P. N., & Woolley, S. C. (2016). *Bots and automation over Twitter during the first U.S. presidential debate*.. Retrieved from https://assets.documentcloud.org/documents/3144967/Trump-Clinton-Bots-Data.pdf

Kotcher, J. E., Myers, T. A., Vraga, E. K., Stenhouse, N., & Maibach, E. W. (2017). Does engagement in advocacy hurt the credibility of scientists? Results from a randomized national survey experiment. *Environmental Communication*, *11*, 415–429. http://dx.doi.org/10.1080/17524032.2016.1275736

Kragh, M., & Åsberg, S. (2017). Russia's strategy for influence through public diplomacy and active measures: The Swedish case. *Journal of Strategic Studies*, 1–44. http://dx.doi.org/10.1080/01402390.2016.1273830

Krieg, G. (2016). *14 of Trump's most outrageous 'birther' claims – half from after 2011*. Retrieved from http://edition.cnn.com/2016/09/09/politics/donald-trump-birther/

Krueger, J., & Zeiger, J. S. (1993). Social categorization and the truly false consensus effect. *Journal of Personality and Social Psychology*, *65*, 670–680. http://dx.doi.org/10.1037//0022-3514.65.4.670

Kuklinski, J. H., Quirk, P. J., Jerit, J., Schwieder, D., & Rich, R. F. (2000). Misinformation and the currency of democratic citizenship. *Journal of Politics*, *62*, 790–816.

Kull, S., Ramsay, C., & Lewis, E. (2003). Misperceptions, the media, and the Iraq war. *Political Science Quarterly*, *118*, 569–598.

Lakoff, G. (2010). Why it matters how we frame the environment. *Environmental Communication: A Journal of Nature and Culture*, *4*, 70–81. http://dx.doi.org/10.1080/17524030903529749

Larson, H. J., Cooper, L. Z., Eskola, J., Katz, S. L., & Ratzan, S. C. (2011). Addressing the vaccine confidence gap. *The Lancet*, *378*, 526–535.

Lee, E.-J. (2012). That's not the way it is: How user-generated comments on the news affect perceived media bias. *Journal of Computer-Mediated Communication*, *18*, 32–45. http://dx.doi.org/10.1111/j.1083-6101.2012.01597.x

Lelkes, Y. (2016). Mass polarization: Manifestations and measurements. *Public Opinion Quarterly*, *80*, 392–410. http://dx.doi.org/10.1093/poq/nfw005

Leviston, Z., Walker, I., & Morwinski, S. (2013). Your opinion on climate change might not be as common as you think. *Nature Climate Change*, *3*, 334–337. http://dx.doi.org/10.1038/NCLIMATE1743

Lewandowsky, S. (2011, March). *Bitten by a sock puppet, but the climate is still changing*.. Retrieved from http://www.abc.net.au/unleashed/45638.html Accessed 19.04.16

Lewandowsky, S., Ballard, T., Oberauer, K., & Benestad, R. (2016). A blind expert test of contrarian claims about climate data. *Global Environmental Change*, *39*, 91–97.

Lewandowsky, S., Cook, J., & Lloyd, E. (2016). The 'Alice in Wonderland' mechanics of the rejection of (climate) science: Simulating coherence by conspiracism. *Synthese*, http://dx.doi.org/10.1007/s11229-016-1198-6

Lewandowsky, S., Ecker, U. K. H., Seifert, C., Schwarz, N., & Cook, J. (2012). Misinformation and its correction: Continued influence and successful debiasing. *Psychological Science in the Public Interest*, *13*, 106–131. http://dx.doi.org/10.1177/1529100612451018

Lewandowsky, S., Gignac, G. E., & Oberauer, K. (2013). The role of conspiracist ideation and worldviews in predicting rejection of science. *PLOS ONE*, *8*, e75637. http://dx.doi.org/10.1371/journal.pone.0075637

Lewandowsky, S., & Oberauer, K. (2016). Motivated rejection of science. *Current Directions in Psychological Science*, *25*, 217–222.

Lewandowsky, S., Oberauer, K., & Gignac, G. E. (2013). NASA faked the moon landing–therefore (climate) science is a hoax: An anatomy of the motivated rejection of science. *Psychological Science*, *24*, 622–633. http://dx.doi.org/10.1177/0956797612457686

Lewandowsky, S., Oreskes, N., Risbey, J. S., Newell, B. R., & Smithson, M. (2015). Seepage: Climate change denial and its effect on the scientific community. *Global Environmental Change*, *33*, 1–13. http://dx.doi.org/10.1016/j.gloenvcha.2015.02.013

Lewandowsky, S., Risbey, J. S., & Oreskes, N. (2015). On the definition and identifiability of the alleged hiatus in global warming. *Scientific Reports*, *5*, 16784. http://dx.doi.org/10.1038/srep16784

Lewandowsky, S., Risbey, J. S., & Oreskes, N. (2016). The "pause" in global warming: Turning a routine fluctuation into a problem for science. *Bulletin of the American Meteorological Society*, *97*, 723–733. http://dx.doi.org/10.1175/BAMS-D-14-00106.1

Lewandowsky, S., Stritzke, W. G. K., Oberauer, K., & Morales, M. (2005). Memory for fact, fiction, and misinformation: The Iraq War 2003. *Psychological Science*, *16*, 190–195. http://dx.doi.org/10.1111/j.0956-7976.2005.00802.x

Lorenzo-Dus, N., Blitvich, G.-C., & Bou-Franch, P. (2011). On-line polylogues and impoliteness: The case of postings sent in response to the Obama Reggaeton YouTube video. *Journal of Pragmatics*, *43*, 2578–2593. http://dx.doi.org/10.1016/j.pragma.2011.03.005

Mathis-Lilley, B. (2017). *Trump-endorsed media outlet accuses NASA of operating child slave colony on Mars*. Retrieved from http://www.slate.com/blogs/the_slatest/2017/06/30/alex_jones_trump_endorsed_infowars_site_exposes_nasa_s_martian_slave_colony.html

McCright, A. M., Charters, M., Dentzman, K., & Dietz, T. (2016). Examining the effectiveness of climate change frames in the face of a climate change denial counter-frame. *Topics in Cognitive Science*, *8*, 76–97. http://dx.doi.org/10.1111/tops.12171

McCright, A. M., & Dunlap, R. E. (2011a]). Cool dudes: The denial of climate change among conservative white males in the United States. *Global Environmental Change*, *21*, 1163–1172. http://dx.doi.org/10.1016/j.gloenvcha.2011.06.003

McCright, A. M., & Dunlap, R. E. (2011b]). The politicization of climate change and polarization in the American public's views of global warming, 2001-2010. *The Sociological Quarterly*, *52*, 155–194. http://dx.doi.org/10.1111/j.1533-8525.2011.01198.x

McKee, M., & Diethelm, P. (2010). How the growth of denialism undermines public health. *British Medical Journal*, *341*, 1309–1311. http://dx.doi.org/10.1136/bmj.c6950

McPherson, M., Smith-Lovin, L., & Brashears, M. E. (2009). Models and marginals: Using survey evidence to study social networks. *American Sociological Review*, *74*, 670–681.

Miller, C. T. (1993). Majority and minority perceptions of consensus and recommendations for resolving conflicts about land use regulation. *Personality and Social Psychology Bulletin*, *19*, 389–398. http://dx.doi.org/10.1177/0146167293194004

Mooney, C. (2011, June). *The science of why we don't believe science*.. Retrieved from http://motherjones.com/politics/2011/03/denial-science-chris-mooney?page=1 Accessed 21.12.11

Motyl, M., Iyer, R., Oishi, S., Trawalter, S., & Nosek, B. A. (2014). How ideological migration geographically segregates and polarizes groups. *Journal of Experimental Social Psychology*, *51*, 1–14.

Nyhan, B., & Reifler, J. (2010). When corrections fail: The persistence of political misperceptions. *Political Behavior*, *32*, 303–330.

Nyhan, B., & Reifler, J. (2011). *Opening the political mind? The effects of self-affirmation and graphical information on factual misperceptions*. Unpublished manuscript.

Nyhan, B., Reifler, J., Richey, S., & Freed, G. L. (2014). Effective messages in vaccine promotion: A randomized trial. *Pediatrics*, *133*, e835–e842. http://dx.doi.org/10.1542/peds.2013-2365

Oreskes, N. (2004). The scientific consensus on climate change. *Science*, *306*, 1686. http://dx.doi.org/10.1126/science.1103618

Oreskes, N., & Conway, E. M. (2010). *Merchants of doubt*. London, UK: Bloomsbury Publishing.

Ortiz, J. R., Zhou, H., Shay, D. K., Neuzil, K. M., Fowlkes, A. L., & Goss, C. H. (2011). Monitoring influenza activity in the United States: A comparison of traditional surveillance systems with Google flu trends. *PLoS ONE*, *6*, e18687. http://dx.doi.org/10.1371/journal.pone.0018687

Ott, B. L. (2017). The age of Twitter: Donald J. Trump and the politics of debasement. *Critical Studies in Media Communication*, *34*, 59–68. http://dx.doi.org/10.1080/15295036.2016.1266686

Painter, J. (2017). New players and the search to be different. In J. Painter, J. Painter, et al. (Eds.), *Something old, something new: Digital media and the coverage of climate change* (pp. 8–23). Reuters Institute for the Study of Journalism.

Pariser, E. (2011). *The filter bubble: What the internet is hiding from you*. New York: Penguin Press.

Pennycook, G., Cheyne, J. A., Barr, N., Koehler, D. J., & Fugelsang, J. A. (2015). On the reception and detection of pseudo-profound bullshit. *Judgment and Decision Making*, *10*, 549–563.

Persily, N. (2017). Can democracy survive the internet? *Journal of Democracy*, *28*, 63–76.

Pew Research Center. (2009). *Public praises science; scientists fault public, media*.. Retrieved from http://www.people-press.org/2009/07/09/public-praises-science-scientists-fault-public-media/

Pfattheicher, S., & Schindler, S. (2016). Misperceiving bullshit as profound is associated with favorable views of Cruz, Rubio, Trump and conservatism. *PLOS ONE*, *11*, e0153419. http://dx.doi.org/10.1371/journal.pone.0153419

Piketty, T., & Saez, E. (2014). Inequality in the long run. *Science*, *344*, 838–843. http://dx.doi.org/10.1126/science.1251936

Poland, G. A., & Spier, R. (2010). Fear, misinformation, and innumerates: How the Wakefield paper, the press, and advocacy groups damaged the public health. *Vaccine*, *28*, 2361–2362.

Pomerantsev, P., & Weiss, M. (2014). *The menace of unreality: How the Kremlin weaponizes information, culture and money (Tech. Rep.)*.. Institute of Modern Russia. Retrieved from http://www.interpretermag.com/wp-content/uploads/2014/11/The_Menace_of_Unreality_Final.pdf

Qiu, X., Oliveira, D. F. M., Shirazi, A. S., Flammini, A., & Menczer, F. (2017). Limited individual attention and online virality of low-quality information. *Nature Human Behavior*, *1* http://dx.doi.org/10.1038/s41562-017-0132

Raab, M. H., Auer, N., Ortlieb, S. A., & Carbon, C.-C. (2013). The Sarrazin effect: The presence of absurd statements in conspiracy theories makes canonical information less plausible. *Frontiers in Psychology*, *4*, 453. http://dx.doi.org/10.3389/fpsyg.2013.00453

Rahmstorf, S., Foster, G., & Cahill, N. (2017). Global temperature evolution: Recent trends and some pitfalls. *Environmental Research Letters*, *12*, 054001. Retrieved from http://stacks.iop.org/1748-9326/12/i=5/a=054001

Ramsay, C., Kull, S., Lewis, E., & Subias, S. (2010). *Misinformation and the 2010 election: A study of the US Electorate (Tech. Rep.)*. Program on International Policy Attitudes, University of Maryland.

Ratzan, S. C. (2010). Editorial: Setting the record straight: Vaccines, autism, and The Lancet. *Journal of Health Communication*, *15*, 237–239.

Readfearn, G. (2016). *Revealed: Most popular climate story on social media told half a million people the science was a hoax*.. Retrieved from https://www.desmogblog.com/2016/11/29/revealed-most-popular-climate-story-social-media-told-half-million-people-science-was-hoax

Rodríguez-Pose, A., & von Berlepsch, V. (2014). Social capital and individual happiness in Europe. *Journal of Happiness Studies*, *15*, 357–386. http://dx.doi.org/10.1007/s10902-013-9426-y

Sander, T. H., & Putnam, R. D. (2010). Still bowling alone?: The post-9/11 split. *Journal of Democracy*, *21*, 9–16.

Scheufele, D. A. (2013). Communicating science in social settings. *Proceedings of the National Academy of Sciences of the United States of America*, *110*, 14040–14047. http://dx.doi.org/10.1073/pnas.1213275110

Schwarz, N., Newman, E., & Leach, W. (2016). Making the truth stick & the myths fade: Lessons from cognitive psychology. *Behavioral Science & Policy*, *2*, 85–95.

Seifert, C. M. (2002). The continued influence of misinformation in memory: What makes a correction effective? *The Psychology of Learning and Motivation*, *41*, 265–292.

Sobieraj, S., & Berry, J. M. (2011). From incivility to outrage: Political discourse in blogs, talk radio, and cable news. *Political Communication*, *28*, 19–41.

Sommeiller, E., Price, M., & Wazeter, E. (2016). *Income inequality in the US by state, metropolitan area, and county (Tech. Rep.).* Economic Policy Institute.

Spinney, L. (2017). How Facebook, fake news and friends are warping your memory. *Nature*, *543*, 168–170.

Stavrositu, C. D., & Kim, J. (2015). All blogs are not created equal: The role of narrative formats and user-generated comments in health prevention. *Health Communication*, *30*, 485–495. http://dx.doi.org/10.1080/10410236.2013.867296

Steptoe, A., Shankar, A., Demakakos, P., & Wardle, J. (2013). Social isolation, loneliness, and all-cause mortality in older men and women. *Proceedings of the National Academy of Sciences of the United States of America*, *110*, 5797–5801. http://dx.doi.org/10.1073/pnas.1219686110

Sterling, J., Jost, J. T., & Pennycook, G. (2016). Are neoliberals more susceptible to bullshit? *Judgment and Decision Making*, *11*, 352–360.

Swire, B., Berinsky, A. J., Lewandowsky, S., & Ecker, U. K. H. (2017). Processing political misinformation: Comprehending the Trump phenomenon. *Royal Society Open Science*, *4*, 160802. http://dx.doi.org/10.1098/rsos.160802

Synnott, J., Coulias, A., & Ioannou, M. (2017). Online trolling: The case of Madeleine McCann. *Computers in Human Behavior*, *71*, 70–78. http://dx.doi.org/10.1016/j.chb.2017.01.053

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness*. New Haven, CT: Yale University Press.

Twenge, J. M., Campbell, W. K., & Freeman, E. C. (2012). Generational differences in young adults' life goals, concern for others, and civic orientation, 1966-2009. *Journal of Personality and Social Psychology*, *102*, 1045–1062. http://dx.doi.org/10.1037/a0027408

van der Linden, S., Leiserowitz, A., Rosenthal, S., & Maibach, E. (2017). Inoculating the public against misinformation about climate change. *Global Challenges*, *1*, 1600008. http://dx.doi.org/10.1002/gch2.201600008

van Prooijen, J.-W., & Douglas, K. (2017). Conspiracy theories as part of history: The role of societal crisis situations. *Memory Studies*, *10*, 323–333.

Walton, G., & Hepworth, M. (2011). A longitudinal study of changes in learners' cognitive states during and following an information literacy teaching intervention. *Journal of Documentation*, *67*, 449–479.

WEF. (2013). *World economic forum: Outlook on the global agenda 2014*.. Retrieved from http://reports.weforum.org/outlook-14/

Weng, L., Flammini, A., Vespignani, A., & Menczer, F. (2012). Competition among memes in a world with limited attention. *Scientific Reports*, *2*, 335. http://dx.doi.org/10.1038/srep00335

Wilkinson, R., & Pickett, K. (2009). *The spirit level: Why more equal societies almost always do better*. London: Allen Lane.

Winter, S., & Krämer, N. C. (2016). Who's right: The author or the audience? Effects of user comments and ratings on the perception of online science articles. *Communications: The European Journal of Communication Research*, 339–360.

Youyou, W., Kosinski, M., & Stillwell, D. (2015). Computer-based personality judgments are more accurate than those made by humans. *Proceedings of the National Academy of Sciences of the United States of America*, *112*, 1036–1040. http://dx.doi.org/10.1073/pnas.1418680112

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