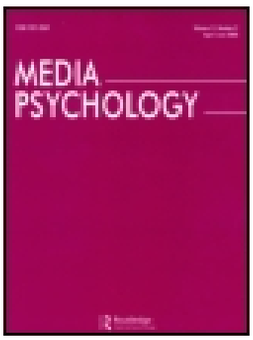

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Differential susceptibility to misleading flat earth arguments on youtube

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ABSTRACT

YouTube has been influential in propagating Flat Earth Ideology, but not everyone is equally susceptible to the effects of watching these videos. In an experiment with a participant pool restricted to regular YouTube users, we found that lower science intelligence and higher conspiracy mentality increase individuals' susceptibility to flat Earth arguments on YouTube. In fact, these two dispositional variables interact: whereas people with lower conspiracy mentality do not find the arguments compelling at any level of science intelligence, among those with higher conspiracy mentality, perception of argument strength decreases as science intelligence increases. Moreover, perceptions of argument strength varied on the thrust of the clip's argument (science-, conspiracy-, or religious-based), with the religious appeal being perceived as weaker and inspiring more counterarguing than the science clip. We discuss implications for both the knowledge deficit hypothesis and for the differential susceptibility to media effects model.

YouTube has been monumental in the flat Earth movement – at least according to the movement's leaders and evidence from in-depth interviews with the Flat Earth community. For example, the vast majority of the interviewees from the first International Flat Earth Conference[1] in Raleigh, North Carolina, said that they had only come to believe the Earth was flat after watching videos about it on YouTube (Landrum & Olshansky, 2019a; Olshansky, 2018). Importantly, interviewees explained their conversion process: While watching videos about other conspiracies, such as those about 9/11, YouTube recommended Flat Earth videos such as "Flat Earth Clues" by Mark Sargent and "200 Proofs the Earth is Not a Spinning Ball" by Eric Dubay. Interviewees described first ignoring the recommended videos and then deciding to watch and debunk them. After watching the videos and "doing their own research," they came to accept the premise that we do not live on a "spinning ball."[2] Though these videos are unlikely to sway the majority of individuals in the United States and abroad,

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there are clearly some who were convinced and some who still will be. The flat Earth phenomenon is symptomatic of a broad and growing distrust in institutions and authorities, but it also has contributed to the instigation of discussions about misinformation on YouTube and how to address it. Moreover, by understanding *what* can convince *whom* of this extreme view and *how*, we can better understand the acceptance of less extreme examples of misinformation about science propagated on social media, such as that related to vaccines and/or climate change. The purpose of this study is to examine *who* is susceptible to *which* types of appeals in flat Earth YouTube videos, guided by the Differential Susceptibility to Media Effects model (i.e., DSMM).

YouTube

YouTube is both a search engine and video-sharing website that allows users to upload their own videos and engage with videos shared by others (YouTube, 2019a). As of August 2018, YouTube ranks as the second-most popular website in the U.S. and the world, ahead of Facebook.com and behind Google.com (which owns the video-sharing platform; Alexa.com, 2019). A YouTube-commissioned study reports that adults 18 and older "spend more time watching YouTube than any television network"; and more adults under age 50 watch YouTube during peak television watching time (i.e., "prime time," between 8pm and 11pm Eastern in the U.S.) than the top ten prime-time shows combined (YouTube, 2016).

Though a large number of YouTube content creators upload content that is helpful, accurate, or at least not obviously problematic, there are also countless channels that present what YouTube calls "borderline" content. Borderline content is that which does not technically violate YouTube community guidelines (e.g., infringing on copyright, displaying explicit or pornographic images, or promoting violence against individuals or groups, YouTube, 2019b), but nonetheless could misinform users in potentially harmful ways (e.g., promoting phony miracle cures; YouTube, 2019c).

YouTube aids in selective exposure

Individuals are biased in how they search, attend to, evaluate, and incorporate new information into their existing knowledge, often privileging and prioritizing information that aligns with their pre-existing views and values (e.g., Akin & Landrum, 2017; Cappella, Kim, & Albarracin, 2015; Kunda, 1990; Stroud, 2008; Taber & Lodge, 2006). YouTube, like many other internet and social media platforms, aids in selective exposure. First, individuals who are searching for information, consciously or subconsciously, that aligns with their pre-existing views will find it on the vast platform. Second, YouTube employs an algorithm that determines what viewers see (Covington, Adams, & Sargin, 2016). This personalized recommendation system is composed of two neural networks, one

that first winnows down the massive body of YouTube content to a few hundred videos (i.e., "candidate generation") and then one that ranks those videos based on predicted user engagement from each audience member's history of activity (i.e., "ranking"; Covington et al., 2016; YouTube, 2019a).

Knowledge deficit hypothesis

Understanding biased information processing, like selective exposure, has contributed to understanding gaps between what scientists know and what publics believe, a key issue in science communication research (Akin & Landrum, 2017). Historically, members of the scientific community assumed that public reluctance to readily accept established science is due to low science knowledge (Bauer, Allum, & Miller, 2007). This "knowledge deficit hypothesis" is based on the public deficit model (or information deficit model), which posits that a unidirectional flow of more scientific information to the public will translate into a greater public understanding of science and then to increased public acceptance and support (see Suldovsky, 2016). Although there is an obvious role for knowledge in public understanding and acceptance of science, the knowledge deficit hypothesis is over-simplistic. Interpretation of scientific information, even when communicated clearly, is conditional on people's values, beliefs, and worldviews (e.g., Brossard, Scheufele, Kim, & Lewenstein, 2009; Landrum, Hallman, & Jamieson, 2019; Landrum, Hilgard, Lull, Akin, & Jamieson, 2018; Nisbet & Scheufele, 2009; Yeo, Xenos, Brossard, & Scheufele, 2015). After all, people often engage in motivated reasoning, dismissing otherwise credible scientific evidence that does not cohere with their preexisting views (Kunda, 1990). In certain cases, greater science knowledge – or "science intelligence" – can increase the probability of rejecting scientific results, suggesting people may use their science intelligence to more artfully motivate their own viewpoints instead of aligning with scientific consensus (e.g., Kahan et al., 2012).

Differential susceptibility to media effects

The DSMM, or Differential Susceptibility to Media Effects Model, compiles and extends key concepts of earlier media-effects theories to explain how and why certain individuals are susceptible to certain types of media under certain conditions (Valkenburg & Peter, 2013). Four components form the DSMM: media use, individual susceptibility variables, response states, and media effects; and four propositions describe the relationships between these components (see Table 1). These propositions guide the hypotheses for this study, for which we operationalized the media effect as the degree of openness to researching flat Earth views that results from watching flat Earth YouTube videos. We expand on each of these components and their relevance to the current study below.

Table 1. The four components and four propositions of the differential susceptibility to media effects model (Valkenburg & Peter, 2013).

Components			
Media Use	*Individual Susceptibility*	*Response States*	*Media Effects*
	• Dispositional • Developmental • Social	• Cognitive • Emotional • Excitative	
Propositions			
Proposition 1	Media effects are conditional on dispositional, developmental, and social susceptibility variables.		
Proposition 2	Media effects are indirect, and cognitive, emotional, and/or excitative response states mediate media use and its effects.		
Proposition 3	Dispositional, developmental, and social susceptibility variables affect individuals' response states by operating as both predictors of media use and as moderators of its effects.		
Proposition 4	Media effects are transactional and, in turn, influence the other components in the model.		

Media use

In the context of the DSMM, media use encompasses a variety of factors such as exposure to content, selection of media outlets, and frequency and duration of media use. Individual susceptibility variables predict media use. For example, political ideology and party affiliation influence which cable networks people choose to watch (e.g., Stroud, 2008). In the current study, however, we experimentally manipulated to which of four video clips participants were exposed, and we examine the interactions between the experimental manipulation (video clip) and the individual susceptibility variables on participants' response states and resulting media effects.

Individual susceptibility variables

Here, we focus on *dispositional* susceptibility variables, which can include a wide array of demographics (e.g., gender, race), personality traits, attitudes, moods, and/or cognitions. Valkenburg and Peter (2013) provide examples from the literature of the moderating effects of dispositional variables on response states. For example, Cacioppo and colleagues find that individuals' *need for cognition* moderates cognitive response states such as responsiveness to argument quality and number of thoughts generated (Cacioppo, Petty, Feinstein, & Jarvis, 1996). Several dispositional variables may predict susceptibility to flat Earth videos, including lower science intelligence, conspiracy mentality, and religiosity.

Science intelligence

We operationalize science intelligence as a combination of analytic thinking, quantitative reasoning, and knowledge of scientific facts (e.g., Kahan, 2017), and this measure positively correlates with other proxies for knowledge (e.g., education level) and thinking styles (e.g., actively openminded thinking, Kahan, 2017).

Moreover, science intelligence predicts acceptance of a variety of scientific issues – though, this acceptance is sometimes conditional on other dispositions, such as political ideology and religiosity (e.g., Kahan, 2017; Kahan, Landrum, Carpenter, Helft, & Jamieson, 2017). Additionally, this operationalization predicts acceptance of viral deception (or "fake news") as likely to be true (Landrum & Olshansky, 2019b).

Similar measures of analytic thinking and knowledge have also been linked to the rejection of science and acceptance of pseudoscience, fake news, and conspiracies. Pennycook and Rand (2019a), for example, found that lower scores on two versions of the cognitive reflection task (which is included in Kahan's 2017 measure of science intelligence) predicted less ability to discern between true and false news. Bronstein, Pennycook, Bear, Rand, and Cannon (2018) generalized this non-analytic or intuitive cognitive style to delusion-prone individuals based on research that associated this type of cognition with belief in conspiracies (e.g., Barron et al., 2018; Swami, Voracek, Stieger, Tran, & Furnham, 2014), paranormal activity (Pennycook, Cheyne, Seli, Koehler, & Fugelsang, 2012), and "pseudo-profound bullshit" (Pennycook, Cheyne, Barr, Koehler, & Fugelsang, 2015; Pennycook & Rand, 2019b). Similarly, the authors found that delusion-prone individuals, along with dogmatic individuals or religious fundamentalists, engaged in less analytic thinking and less open-mindedness (Campitelli & Labollita, 2010) and were more likely to assume that "fake news" headlines were true (Bronstein et al., 2018). Together, this work supports the proposition that individuals with reduced science intelligence are generally more vulnerable to other inaccurate and/or implausible information, such as conspiracies and rejection of science (Lewandowsky, Oberauer, & Gignac, 2013), which is consistent with the knowledge deficit hypothesis.

Thus, we hypothesize that lower science intelligence will predict susceptibility to flat Earth arguments on YouTube. Moreover, science intelligence may interact with the other dispositions (i.e., conspiracy mentality and religiosity) to influence susceptibility.

Conspiracy mentality

Conspiracies can be involved in the rejection of science in two, non-mutually exclusive ways: as a method of motivated reasoning (i.e., conspiracy theorizing) and as a disposition (i.e., conspiracy mentality, see Landrum & Olshansky, 2019b). This study focuses on the latter. Conspiracy mentality involves high levels of distrust in institutions, as well as feelings of political powerlessness and cynicism (Einstein & Glick, 2015; Hofstadter, 1965; Imhoff & Bruder, 2014; Jolley & Douglas, 2014). Prior research has shown associations between various measurements of conspiracy mentality and personality traits such as delusion (Dagnall, Drinkwater, Parker, Denovan, & Parton, 2015), paranoia (Bruder, Haffke, Neave, Nouripanah, & Imhoff, 2013; Grzesiak-Feldman & Ejsmont, 2008; Holm, 2009), and schizotypy (Darwin, Neave, & Holmes, 2011). Belief in the paranormal

(Darwin et al., 2011), a tendency for cognitive fallacies (Brotherton & French, 2014), and openness to experience have also been associated with holding conspiracy beliefs. Conspiracy mentality, which is sometimes referred to as conspiracy ideation, is often measured using questions about a range of common conspiracy theories (e.g., "The assassination of John F. Kennedy was not committed by the lone gunman, Lee Harvey Oswald, but was rather a detailed, organized conspiracy to kill the President"; Swami, Chamorrow-Premuzic, & Furnham, 2010; Swami et al., 2011) or general conspiracies (e.g., "Certain world leading political figures who died untimely deaths were in fact 'taken out' by government operatives", Brotherton, French, & Pickering, 2013; cf., Bruder et al., 2013; Stojanov & Halberstadt, 2019) in which participants are asked about agreement or to rate each item's likelihood of being true.

In addition to its associations with personality traits, conspiracy mentality has also been shown to predict rejection of well-established scientific facts, such as climate change (e.g., Lewandowsky, Gignac, & Oberauer, 2013; Lewandowsky et al., 2013; Uscinski & Olivella, 2017). And, recent work found that conspiracy mentality was the strongest predictor of believing viral deception about a variety of science-related topics over and above science literacy, political affiliation, and religiosity (Landrum & Olshansky, 2019b).

Thus, we hypothesize that greater conspiracy mentality will predict susceptibility to flat Earth arguments on YouTube.

Religiosity

Recent studies focused on the flat Earth community (Landrum & Olshansky, 2019a; Olshansky, 2018) and popular press articles (Dryer, 2018; Ross, 2018) have surmised that those who hold flat Earth views are often higher in religiosity – that is, the strength of one's religious conviction, regardless of specific denomination. Indeed, religiosity has a history of involvement in science denial, most famously with regard to human evolution (e.g., Weisberg, Landrum, Metz, & Weisberg, 2018). Religiosity also recently has been linked to vaccine refusal (e.g., McKee & Bohannon, 2016) as has spirituality (e.g., Browne, Thomson, Rockoff, & Pennycook, 2015).

Thus, we hypothesize that stronger religiosity will predict susceptibility to flat Earth arguments on YouTube.

Response states

Besides the individual susceptibility variables, another component to the DSMM is the response state elicited by media use (see Proposition 2 in Table 1). Interviewees from the Flat Earth conferences reported responding skeptically to initial exposure to flat Earth videos on YouTube, and only after spending time researching flat Earth perspectives on the web did they eventually decide that they, too, believe that the Earth is flat (Landrum & Olshansky, 2019a). This, albeit self-reported,

description of the conversion process, which was echoed by the majority of the individuals interviewed, suggests they may have taken a *System 2* (Kahneman, 2011) or *central route* approach to processing the persuasive messages.

The Elaboration Likelihood Model (i.e., the ELM) describes two distinct routes to persuasion: (1) a central route, in which attitude change is a result of a thoughtful systematic, or mindful, approach, or (2) a peripheral route, in which attitude change is a result of use of heuristics or mental shortcuts that save cognitive effort (Petty & Cacioppo, 1986). One factor that might lead a person to centrally process information is having the motivation to do so. The flat Earthers interviewed expressed this motivation when describing their initial desire to debunk the claims. A second key factor is an individual's *ability* to process a message, which can be influenced by an individual's knowledge and by external environmental distractions. Indeed, we can question whether a few, some, or most of the potential viewers have the requisite science knowledge to evaluate the claims made in the videos. For example, many of the flat Earthers we interviewed expressed *naïve theories* (see McCloskey, 1983; see also *intuitive theories*, Shtulman, 2017) of relevant physical scientific concepts (e.g., gravity, motion) that likely influenced their abilities to evaluate the claims made in the videos (Landrum & Olshansky, 2019a). They are not alone in this; even science teachers can hold misconceptions about physical principles (e.g., Burgoon, Heddle, & Duran, 2011; Kikas, 2004), so it is not merely a matter of holding naïve theories that leads to accepting a flat Earth. By considering cognitive (and other) response states as mediators of media effects, the DSMM incorporates essential components of the ELM.

To test potential central route processing in the context of DSMM, we focused on *cognitive* response states using two methods of assessment from prior literature: participants' evaluations of the video clips' argument strength (e.g., Landrum et al., 2019; Zhao, Strasser, Cappella, Lerman, & Fishbein, 2011) and the extent to which participants counterargued with the content in the videos (Boukes, Boomgaarden, Moorman, & De Vreese, 2015).

Hypotheses

Our hypotheses were guided by the DSMM model. Proposition 1 and 3 both address the influence of the differential susceptibility variables on the cognitive response states and media effects. From these propositions, we hypothesize the following.

> **Hypothesis $1_{a\text{-}c}$.** Openness to researching flat Earth views – the media effect – is conditional on individuals' dispositions, namely (H1a) science intelligence, (H1b) conspiracy mentality, and (H1c) religiosity.

Specifically, we anticipate that people with increased conspiracy mentality and/or increased religiosity will be more open to researching flat Earth views, whereas people with greater science intelligence will be less open to doing so.

Hypothesis $2_{a\text{-}c}$. (H2a) Science intelligence, (H2b) conspiracy mentality, and (H2c) religiosity will moderate the relationship between the video clip watched and the cognitive response state.

First, we anticipate that perceptions of argument strength will increase and counterarguing will decrease with increasing conspiracy mentality and/or religiosity, whereas perceptions of argument strength will decrease and counterarguing will increase with increasing science intelligence. Second, it is also possible that the dispositions will interact with the different appeals to predict perceived argument strength and counterargument. For instance, people who are more religious may counterargue less after watching the religious appeal than after watching the conspiracy or science appeal. Similarly, people with greater conspiracy mentality who saw the conspiracy appeal may report greater perceptions of argument strength than those who saw the religious or science appeals.

There are also reasons to expect that one or more of the dispositions will moderate the relationship between cognitive response state and openness to researching flat Earth views, although this role of dispositional variables is not specifically predicted by the DSMM. Thus, we hypothesize the following.

Hypothesis $3_{a\text{-}c}$. (H3a) Science intelligence, (H3b) conspiracy mentality, and/or (H3c) religiosity will moderate the relationship between cognitive response state and openness to researching flat Earth views.

For instance, even if people find the arguments to be somewhat strong (or if they cannot generate counterarguments), their lower conspiracy mentality or greater science intelligence may act as buffers against increased openness to researching flat Earth views that would otherwise arise from their cognitive response states.

Proposition 2 of the DSMM emphasizes that media effects may result from an indirect relationship of media use through cognitive response state. Therefore, we hypothesize the following.

Hypothesis 4. Cognitive response states (e.g., H4a. perceptions of argument strength and H4b. counterarguing) will mediate the relationship between video clip watched and the resulting degree of openness to researching flat Earth views.

Moreover, consistent with Proposition 3 and Hypotheses 2 and 3, this indirect effect may be moderated by the individual susceptibility variables.

Method

Participants

Participants were 402 regular YouTube users recruited using TurkPrime, a service associated with Amazon's Mechanical Turk. Of these participants, 57% were female, and the sample's race/ethnicity breakdown included 76% White, 11% Black/African American, 7% Hispanic/Latinx, 6% Asian, and 2%

Other. Moreover, participants ranged in age: 6% were at least 60 years of age, 12% were in their 50s, 20% were in their 40s, 34% were in their 30s, and 28% were under 30 (but at least 18). Highest level of education attained also varied: 11% of participants reported finishing only high school, 38% completed some college, 35% graduated college, and 16% reported attending graduate school. Most of the sample (73%) reported using YouTube daily, whereas 26% reported using it at least weekly, and 1% reported using it at least monthly. Participants were awarded 2 dollars after completing the survey.

Study design and procedures

Participants were told that the research study examines uncommon views shared via YouTube. The study contained four sections. In the first section, participants watched a short (25 to 30 seconds long) video clip and answered questions about that clip. Participants were randomly assigned to view one of four clips (i.e., the condition), which differed in which (misinformative) arguments were presented about the Earth's shape. In the second and third sections of the survey, participants answered questions about their views and what they know about science, respectively. Lastly, in the fourth section, participants answered standard demographic questions. Following the demographic questions, we provided a "fact check" that explained why the argument the participant saw in the video was misinformative[3]. For more information on the study design and procedures, please see the supplementary materials.

Stimulus materials

Participants were randomly assigned to one of three[4] experimental conditions that varied based on the type of flat Earth argument presented (scientific[5], conspiratorial, or religious) or a fourth condition that served as a control. The experimental clips (which each ranged from 25 to 30 seconds) were cut from a widely-shared YouTube video entitled "200 Proofs the Earth is Not a Spinning Ball" created by Eric Dubay, one of the leaders in the modern flat Earth movement. Dubay's name was not used in the experiment; he was referred to as "the narrator." Participants were introduced to the clip with the following: "In the video, '200 proofs the Earth is Flat' the narrator makes the following argument," and a transcription of the video and the watchable video clip followed. See Figure 1.

Participants in the "science" condition saw a clip that argued that an experiment conducted by Jean-Baptist Biot and Francois Arago proved the Earth was flat:

> *"In a 19th-century French experiment by M. M. Biot and Arago, a powerful lamp with good reflectors was placed on the summit of Desierto las Palmas in Spain and able to be seen all the way from Camprey on the Island of Ibiza. Since the elevation of the two points were identical and the distance between covered nearly 100 miles, if*

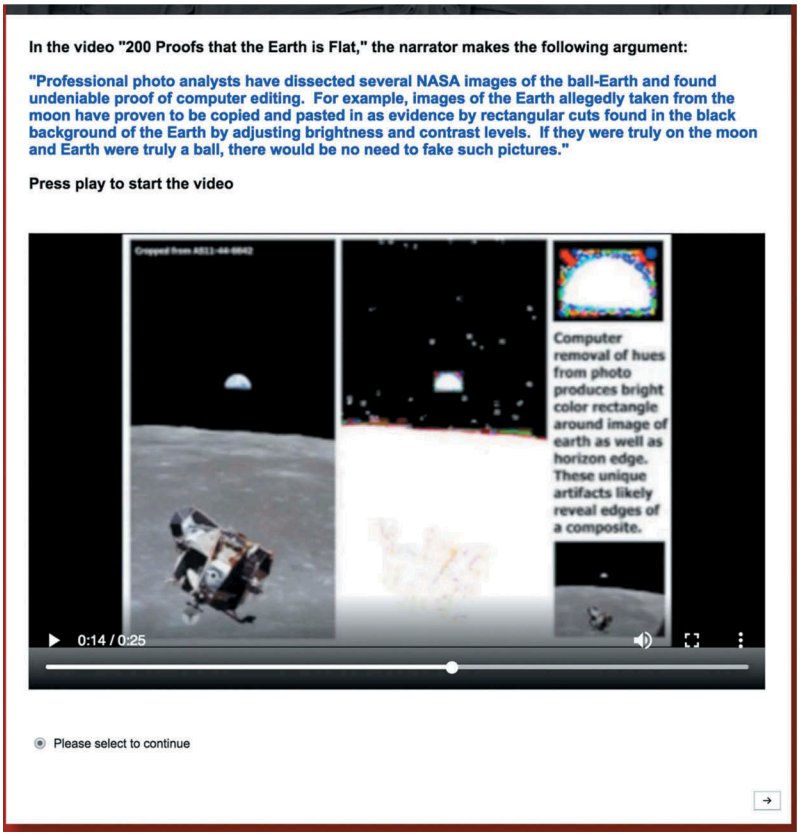

Figure 1. shows the conspiracy video item as the participants saw it in the survey. The transcription of the video was provided above the video clip in quotations. Participants had to press play to start the video.

> *Earth were a ball 25,000 miles in circumference, the light should have been more than 6600 feet, a mile and a quarter, below the line of sight."*

Participants in the "conspiracy" condition (depicted in Figure 1) saw a clip that argued that the images of the Earth provided by NASA are counterfeit:

> *"Professional photo analysts have dissected several NASA images of the ball-Earth and found undeniable proof of computer editing. For example, images of the Earth allegedly taken from the moon have proven to be copied and pasted in as evidence by rectangular cuts found in the black background of the Earth by adjusting brightness and contrast levels. If they were truly on the moon and Earth were truly a ball, there would be no need to fake such pictures."*

Participants in the "religious" condition saw a clip that argued that many religious texts support a flat Earth model:

> *"The Bible, Koran, Strimam Bablicam[sic], and many other holy books describe and purport the existence of a geocentric stationary flat Earth. For example, 1st Chronicles 16:30 and Psalm 96:10 both read he has fixed the Earth firm, immovable.*

> *And Psalm 93:1 says, " … the world also is stablished, that it cannot be moved." The Bible also repeatedly affirms that the Earth is outstretched as a plane with the outstretched heavens everywhere above, not all around, giving a scriptural proof the Earth is not a spinning ball."*

In the control video, participants saw a short clip of a man explaining what needs to be done to fix a bathtub faucet. The purpose of the control condition was to (a) ensure that watching the flat Earth clips did not influence the dispositional factors (i.e., that science intelligence, conspiracy mentality, and religiosity did not vary based on watching a flat Earth video clip compared to the control clip) and to (b) determine whether there were overall effects of watching flat Earth video clips on openness to researching flat Earth views compared to the control condition.

Measures

Media effects – openness to researching flat earth views

Presumably, the creators of flat Earth YouTube videos desire to increase viewers' openness to the viewpoint. Worth highlighting, the slogan of the conference was not "The Earth is Flat," but "*Research* Flat Earth," emphasizing the Do-It-Yourself culture of the movement. We thus conceptualized media effects for this study as the openness to researching flat Earth views resulting from watching the video clips. To this end, we asked participants to what extent they agree with six statements focused on self-reported planned behavior (e.g., I plan to watch more YouTube videos to learn more about flat Earth views; I plan to watch more YouTube videos to learn more about why scientists say the Earth is round; I plan to conduct my own experiments to determine the shape of the Earth) and one statement expressing doubt in the globe (i.e., I find myself questioning the shape of the Earth). We evaluated these items' fit as a scale using item response theory (a graded response model for ordinal polytomous data; Samejima, 1969); and we examined their internal consistency ($\alpha = 0.88$, 95% CI [0.80, 0.92]). For more information, see the supplementary materials.

Response state – argument strength and counterarguing

We used two measurements of cognitive response: perceptions of argument strength (e.g., Landrum et al., 2019; Zhao et al., 2011) and counterarguing (Boukes et al., 2015).

Argument strength

To measure argument strength, we reminded participants of the argument made in the video clip and asked how (1) believable, (2) convincing, and (3) strong

they found the argument to be. To answer these questions, participants used a slider scale that ranged from 0 to 100[6], with higher numbers reflecting greater argument strength. These three items formed a scale with strong internal consistency (α = 0.94, 95% CI [0.93, 0.95]). On average, participants rated the arguments as weak, or having low argument strength (M = 13.93 of 100, SD = 20.28, *Median* = 4.67).

Counterarguing

The second measurement of cognitive response was the extent to which participants counterargued with the claims. We mostly followed the method outlined by Boukes et al. (2015), in which participants were asked to write down their thoughts after watching the video clip, and the thoughts were coded as agreeing or disagreeing with the critical message from the video. In one block, we asked participants to provide any reasons (up to 5) why they think the argument made in the video is false and, in another block, any reasons (up to 5) why they think the argument made in the video might be true. The order of the presentation of the two blocks was randomized between subjects. Participants were given five text boxes for each question and asked to use one line per reason. Two coders read through the reasons provided to ensure that the reasons in the "False" boxes disagreed with the critical message made in the video and the reasons in the "True" boxes agreed with the messages. For instance, one participant wrote in the true boxes that "there is no reason for the argument to be true"; thus, this response was not counted as a reason it is true. Coders did not evaluate the responses based on whether the provided reasons were sound. We calculated intercoder reliability using Cohen's Kappa, ("False": agreement = 98.2%, κ = 0.96; "True": agreement = 99.2%, κ = 0.88). Disagreements between the coders were resolved by discussion with a third coder. Then, reasons-it-is-true were subtracted from reasons-it-is-false to create a counterarguing score (M = 1.89, *Median* = 2, SD = 1.52).

Dispositions

We hypothesized that science intelligence, conspiracy mentality, and religiosity would influence cognitive response states and media effects.

Science intelligence

To measure science intelligence, we used a shortened version of the Ordinary Science Intelligence scale (Kahan, 2017). Our shortened version of the scale consisted of 9 items that were selected based on the items' difficulty and discriminatory power from a previous item response theory analysis using a nationally-representative sample. The items were coded like a science quiz: correct answers were coded as 1, and incorrect items (including no response) were coded as 0. On average, participants in this sample answered about 5.5 questions out of 9 correctly (61% correct, *Median* = 5 questions, SD = 2.24

questions). As with prior work, the scale was evaluated and scored using item response theory (a 2PL model). Then, the scores were centered so that the mean was 0 (SD = .80; range = − 1.93 to 1.34). Scores did not vary based on condition, $F(5, 398) = 1.85$, $p = .137$, $\eta^2 = .014$.

Conspiracy mentality

To measure conspiracy mentality, we used the 5-item general conspiracy mentality questionnaire by Bruder et al. (2013). Items consisted of general conspiracy statements, such as "Events which superficially seem to lack a connection are often the result of secret activities." Participants were asked to rate each item on a 4-point scale, where response options were "definitely false" (1), "probably false" (2), "probably true" (3), and "definitely true" (4). On average, participants rated the items between probably true and probably false (M = 2.82, $Median$ = 2.8, SD = 0.51). As with the other scales, we analyzed this one using item response theory (this time, a graded response model) and examined the items internal consistency (α = 0.75, 95% CI [0.71, 0.78]). We found an unexpected significant difference between conditions in conspiracy mentality scores, $F(5, 493) = 2.87$, $p = .014$, $\eta^2 = .031$. Follow-up tests with Tukey correction show a statistically-significant difference exists only between the science clip condition and the control clip condition, with the control condition (M = 2.92, SD = 0.47) having a slightly *higher* average conspiracy mentality score than the science clip condition (M = 2.70, SD = 0.54, $p = .030$, d = 0.43). Though it is possible that seeing the science clip somehow decreased the group's average conspiracy mentality relative to the control condition, the lack of differences between any of the other clip pairs and lack of theoretical reason for the difference leads us to believe this is likely due to chance. Importantly, conspiracy mentality did not differ between the three experimental conditions which are compared in later analyses.

Religiosity

To measure religiosity, we asked three questions: (1) how much guidance does your faith, religion, or spirituality provide in your day-to-day life, (2) how often do you pray, and (3) whether the Bible should be interpreted literally (see Landrum & Olshansky, 2019b; Weisberg et al., 2018). The wording for the first two questions come from Pew Research Center. For the third question, we asked participants to what extent they agreed or disagreed with the following statement:

> "Religious scripture, such as the Bible, should be taken literally. For example, the tale in which Jonah is swallowed by a giant fish (or whale) and is spit back onto the shore three days later actually happened and is not simply a fictional moral tale."

We used item response theory (GRM model) to evaluate and score the measure. Then, the scores were centered and scaled so that the mean was 0 (SD = 1; range = − 1.13 to 1.91). There were no significant differences between conditions

in religiosity, $F(3, 398) = 1.21$, $p = .307$, $\eta^2 = .009$. More information about the properties of this scale is available in the supplementary materials.

Results

This study aimed to identify which dispositions predict susceptibility to the different flat Earth arguments. To do this, we begin by conducting a series of regression analyses before testing two moderated mediation models. For more detailed results, please see the supplementary materials. Additional information can be found on our osf.io page at: https://osf.io/j8rgv/

Cognitive response states and media effects are conditional on dispositions

Our first hypothesis was that participants' cognitive response states and their openness to researching flat Earth resulting from watching the clips are influenced by their science intelligence, conspiracy mentality, and religiosity. Our second hypothesis was that these dispositional factors would interact with the different appeals in the videos (our condition manipulation) to influence the cognitive states elicited and participants' resulting openness to researching flat Earth. Our third hypothesis was that the dispositional factors would interact with cognitive response states to influence openness to researching flat Earth.

To test these hypotheses, we used GLM analyses predicting cognitive response states (see Table 2) and openness to researching flat Earth (see Table 3). Note that we include the two cognitive response state variables as predictors for openness to researching flat Earth views and examine interactions between the dispositional variables and the cognitive response state variables (H3).

Cognitive response state 1: argument strength

Perceptions of argument strength increased with increases in conspiracy mentality ($b = 9.43$, $p < .001$) and *decreases* in science intelligence ($b = -6.26$, $p = .001$). Moreover, we found an interaction effect between science intelligence and conspiracy mentality: the effect of science intelligence on reducing perceptions of argument strength is stronger among those with higher conspiracy mentality than among those with lower conspiracy mentality ($b = -11.99$, $p < .001$; see Figure 2).

Though there was not a significant main effect of condition when accounting for other factors in the model ($F = 1.33$, $p = .267$, type III sums of squares), a one-way ANOVA finds differences between the clips, $F(2, 296) = 3.47$, $p = .033$, $\eta^2 = .023$. Follow-up tests with Tukey correction suggest that the science clip ($M = 17.66$, $SD = 20.79$) generally was perceived as providing a stronger

Table 2. Results from the GLM models for predicting perceptions of argument strength and predicting counterarguing. Statistical significance is based on Type III analyses (accounting for all model factors). Reported coefficients (b) are based on hierarchical regression, first accounting for the main effects, second accounting for the main effects and the two-way interactions, and third accounting for all effects including the three-way interaction.

	Argument Strength			Counterarguing		
	b	*F* values	η_p^2	b	*F* values	η_p^2
Video Clip (ref = Science)		1.33	.01		0.29	.00
Science vs. Conspiracy	*−6.98*			*0.47*		
Science vs. Religious	*−8.56*			*0.81*		
Conspiracy Mentality	9.43	19.16***	.06	−0.32	3.15 $^{\tau}$	.01
Religiosity	1.27	2.53	.01	−0.18	0.00	.00
Science Literacy	−6.26	11.48***	.04	0.10	0.45	.00
Clip X Conspiracy Mentality		1.75	.01		0.05	.00
Science vs. Conspiracy	*2.46*			*−0.04*		
Science vs. Religious	*−6.19*			*−0.22*		
Clip X Religiosity		0.90	.01		0.05	.00
Science vs. Conspiracy	*1.16*			*−0.03*		
Science vs. Religious	*3.29*			*0.06*		
Clip X Science Literacy		2.30	.02		2.58 $^{\tau}$	.02
Science vs. Conspiracy	*2.23*			*0.30*		
Science vs. Religious	*1.14*			*0.07*		
Conspiracy Mentality X Science Literacy	−11.99	18.03***	.06	0.19	0.65	.00
Conspiracy Mentality X Religiosity	−3.25	2.27	.01	−0.07	0.09	.00
Religiosity X Science Literacy	−0.59	0.23	.00	−0.04	0.05	.00
Clip X Conspiracy Mentality X Science Literacy		2.42$^{\tau}$	.02		2.37$^{\tau}$	.02
Science vs. Conspiracy	*1.86*			*−0.19*		
Science vs. Religious	*12.86*			*−1.09*		

$^{\tau}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table 3. Results from the GLM model predicting openness to researching flat Earth views. Statistical significance and effect size (η_p^2) are based on Type III analyses (accounting for all model factors). Reported coefficients (b) are based on hierarchical regression, first accounting for the main effects and then accounting for the main effects and the two-way interactions.

DV: Openness to Researching Flat Earth	b	Sum Sq	df	F values	Pr(>F)	η_p^2
Video Clip (ref = Science)		5.81	2	5.16**	.006	.04
science vs. conspiracy	*0.08*					
science vs. religious	*0.12*					
Conspiracy Mentality	0.16	1.64	1	2.92	.089	.01
Science Intelligence	−0.13	0.00	1	0.00	.957	.00
Argument Strength	0.03	2.54	1	4.51*	.034	.02
Counterargument	0.09	1.32	1	2.34	.127	.01
Religiosity	0.04	0.28	1	0.50	.478	.00
Clip X Conspiracy Mentality		6.34	2	5.64**	.004	.04
science vs. conspiracy	*0.76*					
science vs. religious	*0.44*					
Clip X Science Intelligence		0.33	2	0.29	.747	.00
science vs. conspiracy	*0.08*					
science vs. religious	*−0.02*					
Conspiracy Mentality X Science Intelligence	0.1	0.34	1	0.60	.438	.00
Argument Strength X Conspiracy Mentality	0	0.22	1	0.39	.535	.00
Argument Strength X Science Intelligence	−0.01	7.61	1	13.54***	<.001	.05
Counterargument X Science Intelligence	−0.14	4.71	1	8.37**	.004	.03
Counterargument X Conspiracy Mentality	−0.07	0.63	1	1.12	.292	.00

$^{\tau}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

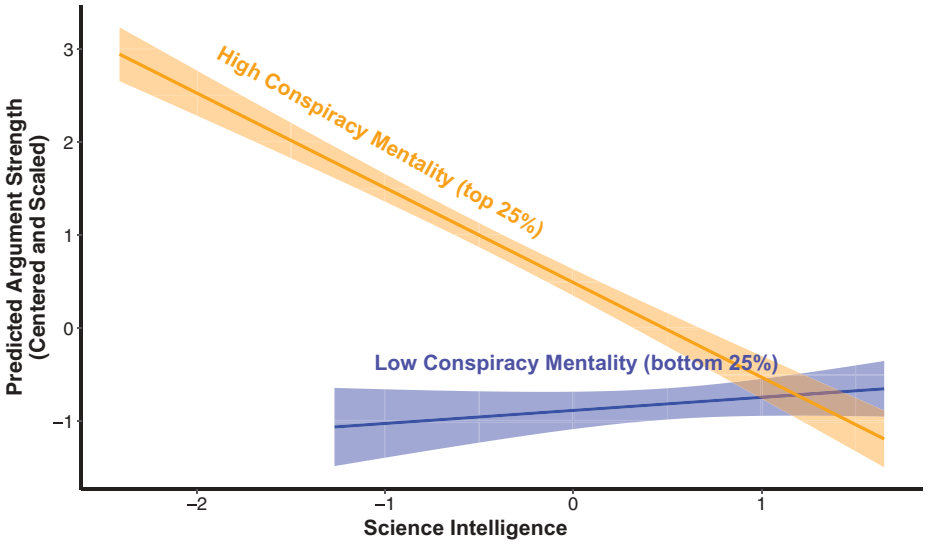

Figure 2. Interaction effect between science intelligence and conspiracy mentality on perceived argument strength. The effect of science intelligence on reducing perceptions of argument strength is strongest among those with higher conspiracy mentality. Although conspiracy mentality was a continuous variable in the analysis reported, we grouped the variable into quartiles and graphed the highest and lowest quartile for the purpose of the visualization.

argument than the religious clip (M = 10.09, SD = 18.67, p = .025, d = 0.38), but not compared to the conspiracy clip (M = 14.23, SD = 20.83, p = .453, d = 0.17). The religious and conspiracy clips also do not differ significantly from one another (p = .308, d = 0.21).

Cognitive response state 2: counterarguing

Participants were also asked to provide, if applicable, up to 5 reasons why the argument presented in the video clip was true and up to 5 reasons why the argument was false. Counterarguing was operationalized as the number of offered reasons why the argument would be false subtracting the number of offered reasons why it would be true.

When predicting counterarguing, we did not find any significant effects (though there were some marginal ones, see Table 2). Similar to argument strength, however, a one-way ANOVA (F(2, 297) = 7.30, p < .001, η^2= .047) with follow-up Tukey tests suggests that participants who watched the science clip provided fewer counterarguments (M = 1.52, SD = 1.4) than those who watched the religious clip (M = 2.28, SD = 1.43, p = .001, d = 0.58). There were no significant differences in counterarguing between participants who watched the religious clip and those who watched the conspiracy clip (M = 1.86, SD = 1.4, p = .106, d = 0.28), nor between those who watched the science clip and those who watched the conspiracy clip (p = .248, d = 0.26).

Media effect: openness to researching flat earth views

When predicting openness to researching flat Earth views, a one-way ANOVA (including the control condition) showed no main effect of video clip, $F(1, 400) = 0.76$, $p = .197$, $\eta^2 = .006$. However, we did find a significant effect of video clip after controlling for the other model variables (excluding the control condition[7], but including argument strength and counterarguing as well as the dispositional variables), $F(2, 283) = 5.16$, $p = .006$, $\eta_p^2 = .04$.

More importantly, however, we found conditional effects, including an interaction between video clip and conspiracy mentality. Specifically, those with *lower* conspiracy mentality were more open to researching flat Earth after watching the science clip, whereas those with *higher* conspiracy mentality were more open to researching flat Earth views after watching the conspiracy clip (see Figure 3).

Both of our cognitive response state variables also predicted openness to researching flat Earth views, and they both interacted with science intelligence (see Table 3). The relationship between the cognitive response states and openness to researching flat Earth views was stronger among those with lower science intelligence than those with higher science intelligence (see Table 3 and Figure 4).

Cognitive response states act as mediators

Our fourth hypothesis was that the cognitive response states, (H4a) argument strength and (H4b) counterarguing, mediate the relationship between the clip watched (condition) and openness to researching flat Earth views. We have

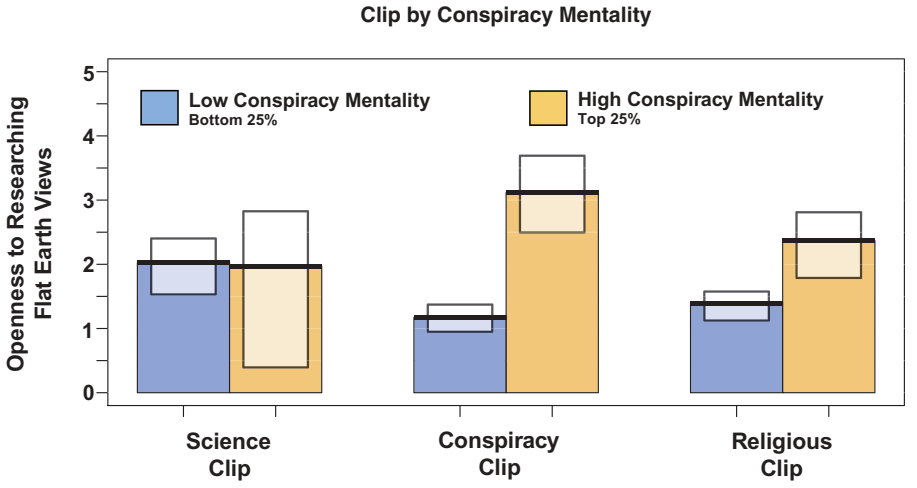

Figure 3. Conditional effect of video clip by conspiracy mentality on openness to researching flat Earth. Those with lower conspiracy mentality were more open to researching flat Earth after watching the science clip, whereas those with higher conspiracy mentality were more open to researching flat Earth after watching the conspiracy clip. Although conspiracy mentality was a continuous variable in the analysis reported, we grouped the variable into quartiles and graphed the highest and lowest quartile for the purpose of this visualization. The black bars represent the mean openness to researching flat Earth, and the white boxes represent Bayesian highest density intervals (confidence intervals).

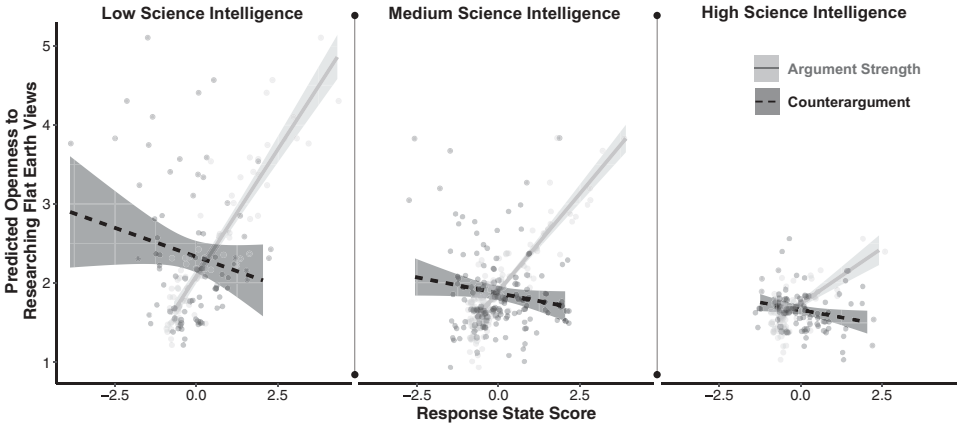

Figure 4. The relationship between the cognitive response states and openness to researching flat Earth was stronger among those with lower science literacy than those with higher science literacy. Although science literacy was a continuous variable in the analysis reported, we grouped the variable into bottom 25%, middle 50%, and top 25% and graphed these for the purpose of this visualization.

preliminary evidence for this effect from the regressions used to test the first three hypotheses. For hypothesis 4, then, we used path modeling to test for relative indirect effects and relative conditional indirect effects.

We also estimated whether science literacy and conspiracy mentality moderate the effects of the cognitive response states on openness to researching flat Earth. From our regression analyses, we found that science literacy, in particular, appears to moderate the effect of both argument strength and counterargument when predicting openness to researching flat Earth (see Table 3). As religiosity was not significant in the earlier regressions, we included it as a covariate instead of as an additional moderator in the path model. Furthermore, we ran separate models for each of the mediators instead of including them as parallel or serial mediators. The models used correspond to PROCESS model 76 (Hayes, 2018). We coded our experimental manipulation using indicator coding, with the conspiracy condition as the reference category. See Figures 5 and 6. The full results from the path analysis are available in the supplementary materials. Here, we provide a brief summary and a description of the overall and relative conditional direct and indirect effects (see Table 4).

Argument strength as the mediator

The first model included argument strength as a mediator with science intelligence and conspiracy mentality as moderators and religiosity as a covariate.

Direct effects

The results revealed a relative direct effect between the science clip (versus the conspiracy clip, X1) and openness to researching flat Earth ($b = 1.92$, $p = .003$), and

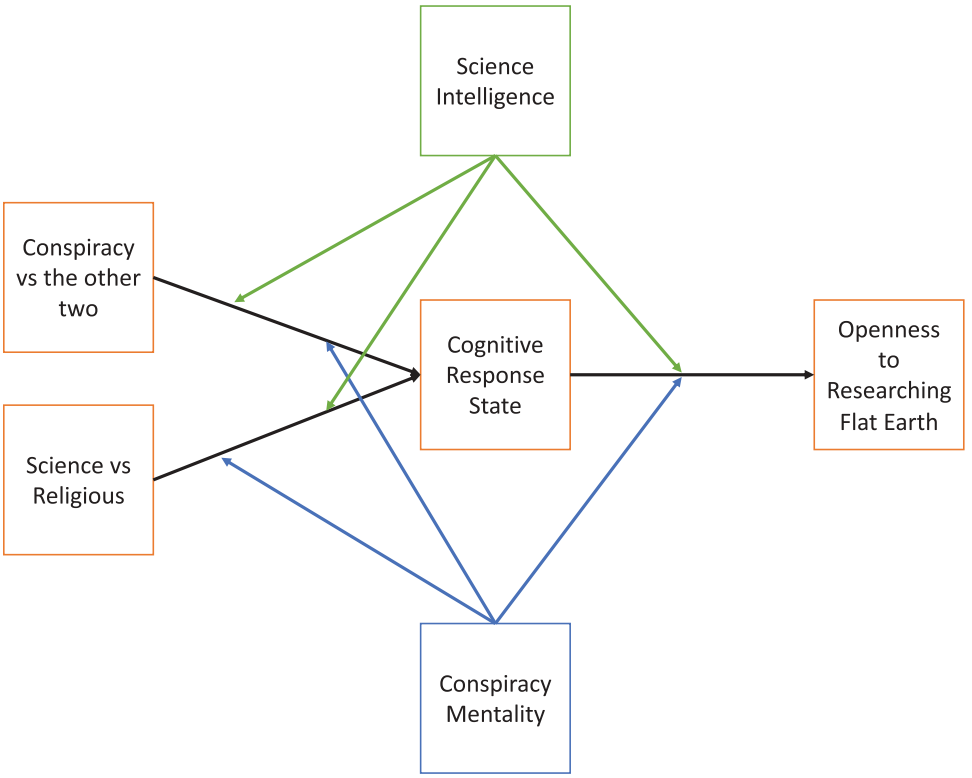

Figure 5. Paths tested for Hypothesis 2. Note that separate models were tested for each of the response state variables. In addition, the conditions were coded using Indicator coding.

this relationship was conditional on conspiracy mentality ($b = -0.72$, $p = .002$). There was not a significant relative direct effect between the religious clip (versus the conspiracy clip, X2) and openness to researching flat Earth ($b = 0.93$, $p = .160$). However, the test of highest order unconditional interaction between X (video clip) and conspiracy mentality on openness to researching flat Earth views was significant, $F(2, 286) = 5.13$, $p = .007$).

Conspiracy mentality ($b = 15.29$, $p < .001$) and science intelligence ($b = -5.97$, $p = .017$) both predicted argument strength, which, in turn, predicted openness to researching flat Earth ($b = 0.03$, $p = .023$). Moreover, the relationship between argument strength and openness to researching flat Earth was conditional on science intelligence ($b = -0.01$, $p = .007$). As expected, this is consistent with our GLM analysis.

Indirect effects

What this analysis adds to our earlier regression analyses is an estimation of relative conditional *indirect* effects (see Table 4). We found significant relative, conditional indirect effect of the science clip (vs. the conspiracy clip) through argument strength when conspiracy mentality is low (e.g., 16th percentile) and

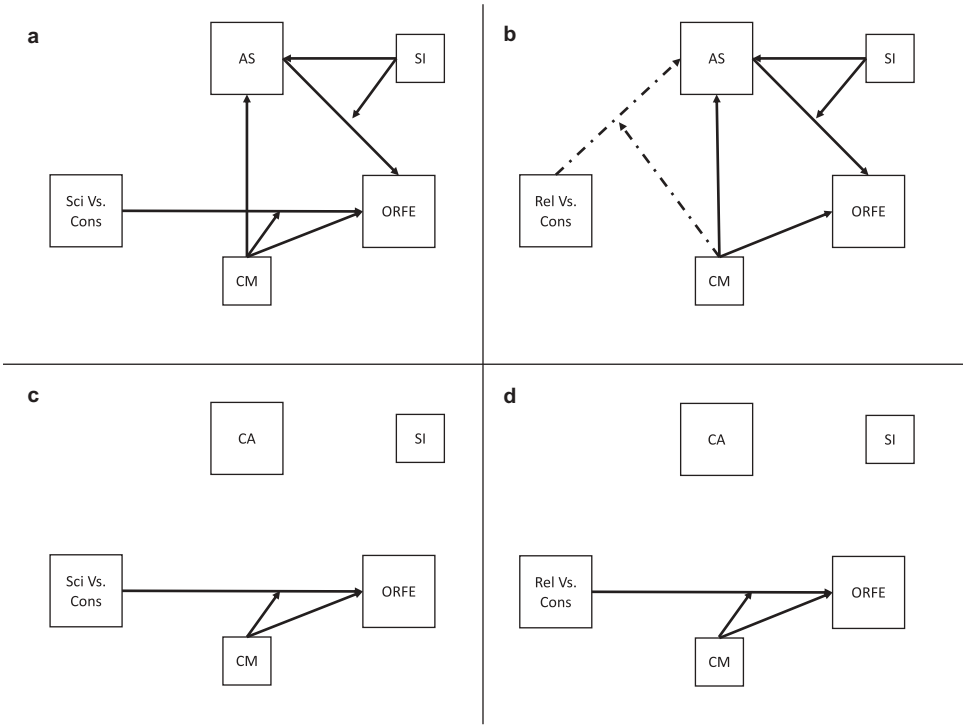

Figure 6. Significant direct effects from the path analysis in PROCESS. The top two squares (a and b) reflect the analysis where argument strength serves as the mediator and the bottom two squares (c and d) reflect the analysis where counterargument serves as the mediator. The two squares on the left (a and c) reflect the analyses comparing the science and conspiracy appeals. The two squares on the right (b and d) reflect the analyses comparing the religious and conspiracy appeals. Statistically significant paths are depicted with solid lines. Marginally-significant paths are depicted with dashed lines. Non-significant paths are not shown.

when science intelligence is low (b = 0.35, 95% CI[0.02, 0.75]), moderate (b = 0.26, 95% CI[0.06, 0.51]), and high (b = 0.19, 95% CI[0.02, 0.45]). We also found significant relative, conditional indirect effects of the science clip (vs. the conspiracy clip) through argument strength when conspiracy mentality is moderate (50th percentile) and when science intelligence is both moderate (b = 0.16, 95% CI[0.04, 0.29]) and high (b = 0.11, 95% CI[0.01, 0.24]). The indirect effects were not found for those higher in conspiracy mentality (e.g., 84th percentile). Moreover, the indirect effects were not found when comparing the religious clip to the conspiracy clip.

Counterargument as the mediator

The second model included counterarguing as the mediator with science intelligence and conspiracy mentality as moderators and religiosity as a covariate. As expected given the results of the previous model, we found a relative direct effect between the science clip (versus the conspiracy clip, X1)

Table 4. Relative conditional indirect effects of the experimental manipulation (video clip watched) on openness to researching flat earth views. Statistical significance was determined using 95% confidence intervals obtained from 5000 bootstrapped samples; asterisks indicate significant effects (where the confidence intervals do not cross 0). Values of the moderators (conspiracy mentality and science literacy) are at the 16th (low), 50th (med), and 84th (high) percentiles.

			Argument Strength			Counterarguing		
	Conspiracy Mentality	Science Intelligence	*Effect*	*LLCI*	*ULCI*	*Effect*	*LLCI*	*ULCI*
Science vs. Conspiracy	Low	Low	0.344*	0.005	0.754	−0.008	−0.172	0.166
	Low	Med	0.258*	0.064	0.511	−0.007	−0.072	0.063
	Low	High	0.194*	0.020	0.446	−0.006	−0.061	0.043
	Med	Low	0.215	−0.079	0.513	0.025	−0.070	0.157
	Med	Med	0.156*	0.040	0.285	0.014	−0.016	0.058
	Med	High	0.113*	0.011	0.244	0.007	−0.031	0.056
	High	Low	0.138	−0.174	0.496	0.052	−0.036	0.213
	High	Med	0.098	−0.059	0.291	0.030	−0.030	0.118
	High	High	0.068	−0.060	0.238	0.014	−0.076	0.111
Religion vs. Conspiracy	Low	Low	0.173	−0.171	0.636	0.001	−0.082	0.085
	Low	Med	0.115	−0.036	0.352	0.007	−0.055	0.071
	Low	High	0.078	−0.031	0.256	0.012	−0.069	0.105
	Med	Low	−0.023	−0.276	0.249	−0.004	−0.066	0.043
	Med	Med	−0.031	−0.134	0.075	−0.013	−0.057	0.015
	Med	High	−0.030	−0.142	0.069	−0.018	−0.097	0.052
	High	Low	−0.137	−0.408	0.123	−0.005	−0.106	0.072
	High	Med	−0.111	−0.278	0.025	−0.029	−0.131	0.026
	High	High	−0.085	−0.275	0.040	−0.045	−0.201	0.053

and openness to researching flat Earth ($b = 2.64$, $p < .001$), and this relationship was conditional on conspiracy mentality ($b = -0.94$, $p < .001$). There was also a relative direct effect between the religious clip (versus the conspiracy clip, X2) and openness to researching flat Earth ($b = 1.58$, $p = .042$), and the relationship was conditional on conspiracy mentality ($b = -0.54$, $p = .044$).

Unlike the previous model, however, conspiracy mentality ($b = -0.34$, $p = .304$) and science intelligence ($b = -0.10$, $p = .605$) did not significantly predict the cognitive response state (here counterarguing); and, counterarguing did not significantly predict openness to researching flat Earth ($b = 0.26$, $p = .209$). Unsurprising, then, there were no significant relative conditional indirect effects.

Discussion

Who is susceptible to which types of arguments presented in flat Earth videos? Perhaps unsurprising, our sample of regular YouTube users generally found the arguments presented in the flat Earth video clips to be weak. We asked participants to rate the arguments' strength on several dimensions using a scale from 1 to 100, and the ratings were strongly skewed positive (floor effect) with an average near 14 and a median rating of 4.67. Similarly, participants were not particularly open to researching flat Earth views. Like our argument strength index, our index of

openness to researching flat Earth views was positively skewed with an average near 1.98 (of 6) and a median score of 1.86. Given this, our findings may be more appropriately interpreted as who was *least resistant* rather than who was *most susceptible*.

Importantly, these were single exposures to Flat Earth videos. Many of the flat-Earthers we spoke to described dismissing the videos after their initial exposure to them. Therefore, our findings may not necessarily imply that these videos are broadly unconvincing. Rather, multiple exposures to a variety of different videos and/or a motivated attempt to "debunk" the videos may lessen one's defenses.

Effects of the different appeals

Although participants were not particularly swayed by the arguments, we did find differences between the different video clips, which used different appeals. The religious appeal, in particular, which described flat Earth as being consistent with multiple religious texts, was seen as weaker than the science argument and inspired more counterarguing than the science argument. This finding supports the views of individuals in the scientific community that see religious claims as being untestable and religion as being unable to "demonstrate the truth of its ideas in a straightforward way, whereas science can" (Haught, 1995, p. 10). This view would help to explain why study participants gave less weight to the religious appeal than the science one. Moreover, if religious claims are empirically untestable (Haught, 1995), then such appeals lend themselves to more criticism and refutation, as was seen by a myriad of comments survey respondents provided as counterarguments (i.e., "the bible was written by people before science could show cause of sphere").

This finding is also consistent with recent, related research examining people's views about evolution and climate change, which found that people tend to prefer scientific to religious explanations for phenomena, though their preferences are contingent on their religiosity (Metz, Weisberg, & Weisberg, 2018). Our finding was surprising in this context, however, given that one oft-cited reason for accepting the flat Earth model (from Flat Earthers, themselves) is that it fits with their literal interpretations of the Bible. It is possible that this is a result of the population from which we sampled. MTurk is known for having a large number of atheists and agnostics relative to the general population (e.g., Burnham, Le, & Piedmont, 2018, see also Lewis, Djupe, Mockabee, & Wu, 2015). Therefore, we may be seeing more push back to religious arguments than would be seen in the national population. Future research should examine the persuasiveness of this claim among more religious individuals, especially since members of the flat Earth community reportedly see this group as potential targets for conversion.

We also found interesting interaction effects between the appeal (science, conspiracy, religious) and individuals' conspiracy mentality on their openness

to researching flat Earth views (see Figure 3). It was expected and unsurprising that, compared with people who are lower in conspiracy mentality, people with higher conspiracy mentality would be more open to researching flat Earth after having seen the YouTube clips. It is also unsurprising that the greatest differences between those of low and high conspiracy mentality were found among those who saw the video that appealed to conspiracy views. What is surprising, and a bit unsettling, is how the difference between those with higher and lower conspiracy mentality seemed to disappear for those who saw the video that appealed to science (that is, it mentioned experimentation and measurement).

We should be careful not to draw strong conclusions about the effects of different categories of appeals, such as science, religion, and conspiracy, as we only tested one version of each. Future research that aims to specifically look at the influence of different appeals ought to consider using stimulus sampling and possibly fabricating flat Earth videos that vary only on the specific appeal (e.g., science, religion, conspiracy) to control for exogenous variables.

Effects of individual dispositions

As expected, conspiracy mentality strongly predicted perceiving the arguments made by the video clips as strong and being more open to researching flat Earth views. Interestingly, though, science intelligence interrupted the influence of conspiracy mentality on views of argument strength. Whereas those who are low in conspiracy mentality saw the arguments as weak regardless of their science intelligence, people who were high in conspiracy mentality saw the arguments as weak only when they scored higher in science intelligence.

This is counter to what was expected from previous literature investigating the influence of motivated reasoning and the knowledge deficit hypothesis. Traditionally, increased knowledge leads to increased acceptance of science *conditional* on views and values that are relevant to that topic, such as political ideology and religious beliefs. Take global warming as an example. For politically liberal individuals, whose worldviews are not at odds with proposed climate change mitigation policies, increased science knowledge leads to increased acceptance that global warming is a real phenomenon that is caused by humans (e.g., Kahan, 2017). For politically conservative individuals, whose political worldviews are in conflict with many of the proposed climate change mitigation policies, increased knowledge does *not* mean increased acceptance. In fact, increased knowledge means increased likelihood of rejection (e.g., Kahan, 2017; Kahan et al., 2012). Researchers have surmised that people use their knowledge and reasoning abilities, not to align with the position of the scientific community, but to more effectively counterargue and more strongly advocate for their preexisting views.

Implications for the knowledge deficit hypothesis

This study finds support for the knowledge deficit hypothesis in which likelihood of accepting the Earth is flat decreases as science intelligence increases. Whereas political ideology serves as the values filter through which information about global climate change is interpreted, conspiracy mentality serves in this role for the issue of flat Earth. If flat Earth was like climate change denial, we would expect that increased knowledge would lead to increased acceptance of the globe (or increased rejection of the flat Earth), but *only* for those with low conspiracy mentality. Indeed, for global climate change, researchers find that the likelihood of accepting that the phenomena is real and is human-caused increases with science intelligence, but only for political liberals whose views are not at odds with recommended climate change mitigation policies. In this case, science intelligence bolsters their belief. For flat Earth, however, we find that science intelligence protects against openness to researching flat Earth for those who are high in conspiracy mentality – that is, for those whose worldview is consistent with core features of the flat Earth message.

Most people acknowledge that the Earth is a globe (technically, an oblate spheroid; Choi, 2007); thus, those who are low in conspiracy mentality have no reason to question this model. For those with higher conspiracy mentality, science intelligence provides protection against accepting the conspiratorial narrative that the Earth is not as scientists (and astronauts) say. Again, this differs from the influence of knowledge in climate change beliefs because knowledge is influencing those who, because of their conspiracy views, are expected to be motivated to accept the flat Earth.

Finding support for the knowledge deficit is not completely misaligned with the literature. Recent work finds that knowledge predicts acceptance of human evolution for people with low, average, and high religiosity (Weisberg et al., 2018). Although the degree to which knowledge predicts acceptance is conditional on religiosity, the relationship between knowledge and acceptance remains a positive one.

Implications for the DSMM model

As stated earlier, we grounded our study in the DSMM model. One limitation to our current study is that we conceptualized media use as the type of argument participants witnessed, and we experimentally manipulated this variable. The missing relationship between media use and the cognitive response state does not insinuate that the path does not exist, but simply that there were not significant differences between the different video clips in how they related to these response states. In fact, there is necessarily a relationship – participants

cannot evaluate the strength of an argument of a video clip they do not know exists. Future studies should consider alternative ways to measure media use, such as "time watched," that can be collapsed across experimental conditions when differences between those conditions do not occur.

It is also a recognizable limitation of our current study that we had to restrict the number of differential susceptibility and response state variables we measured. We focused on factors relevant to cognitions (e.g., science intelligence, conspiracy mentality, argument strength, and counterarguing), but it is highly likely that other categories of variables also are relevant to understanding differential susceptibility to flat Earth videos. Indeed, future work ought to examine some of the emotional and excitative response states that can be elicited and how such states mediate the potential relationship between watching these videos and being open to researching flat Earth views.

Despite these limitations, we were able to test the DSMM model in a specific context that yielded interesting results. Based on these results, a small update could be considered for the DSMM. In the current version of the model, the role of the differential susceptibility variables as moderators is only explicitly hypothesized to influence the relationship between media use and response state. However, we propose that it is also possible that certain differential susceptibility variables could moderate the relationship between the response state and the media effect. In this study, for instance, we found that science intelligence interacted with both argument strength and counterarguing to influence openness to researching flat Earth.

Conclusion

Flat Earth is not entangled with politics the way disagreement surrounding climate change is, and its discussion allows for people to recognize the problems of misinformation dissemination on social media and consider workable solutions without polarizing stakeholders. This position was well articulated by Hannalore Gerling-Dunsmore, an astrophysicist who was interviewed for the documentary, "Behind the Curve." She says, "What flat Earthers can offer is a way to have 99% of people say, 'Well that's ridiculous. Imagine believing that!' And then to turn it around and say, 'How are *you* a flat Earther?'"

Although flat Earth YouTube videos may not convince the majority of the people who watch them, it is clear that some people are more open than others to these ideas. Importantly, this study shows that science intelligence can act to inoculate against at least some forms of pseudoscience and science-based misinformation. For individuals to find the relevant scientific knowledge, however, scientists and science communicators ought to engage these communities where they are and use platforms like YouTube to communicate science.

Notes

1. It is also noteworthy that all of the speakers at the conference have their own YouTube channels.
2. This same process of conversion was articulated to BBC reporters examining the flat Earth phenomenon (Silva, 2019).
3. This fact check was not displayed to participants in the control condition.
4. We had an additional experimental condition that we added as a pilot/exploratory condition. This condition had two possible videos displayed to participants and only 50 people saw each video. Because this condition was a pilot, it is excluded from this study. However, information about it is available in the online supplementary materials.
5. We use "scientific" to describe the clip that referred to experimentation and measurement, and we do not mean to suggest that the clip includes legitimate scientific evidence that the Earth is flat. Indeed, the narrator misrepresents the purpose and the findings of the experiments he describes in his video.
6. The slider scale allowed for participants to choose a number with up to two decimal points to approximate a continuous scale.
7. The control condition was excluded because participants in the control condition did not answer the argument strength or counterarguing questions as they did not see the flat Earth videos.

Disclosure statement

No potential conflict of interest was reported by the authors.

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