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Investigating the Generation and Spread of Numerical Misinformation: A Combined Eye Movement Monitoring and Social Transmission Approach

Jason C. Coronel, Shannon Poulsen, & Matthew D. Sweitzer

School of Communication, The Ohio State University, Columbus, OH 43210, USA

Numerical facts play a prominent role in public discourse, but individuals often provide incorrect estimates of policy-relevant numerical quantities (e.g., the number of immigrants in the country). Across two studies, we examined the role of schemas in the creation of numerical misinformation, and how misinformation can spread via person-to-person communication. In our first study, we combined eye movement monitoring and behavioral methods to examine how schemas distorted what people remembered about policy-relevant numerical information. Then, in a second study, we examined the consequences of these memory distortions via the social transmission of numerical information, using the serial reproduction paradigm. We found that individuals misremembered numerical information in a manner consistent with their schemas, and that person-to-person transmission can exacerbate these memory errors. Our studies highlight the mechanisms supporting the generation and spread of numerical misinformation and demonstrate the utility of a multi-method approach in the study of misinformation.

Keywords: Misinformation, Eye Movements, Social Transmission, Schemas, Serial Reproduction

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In a speech during his last year in office, President Barack Obama called for the establishment of stricter gun control laws in the United States by citing evidence that, “every single year, more than 30,000 Americans have their lives cut short by guns” (Luckerson, 2016). During his presidential address in 2019, Donald Trump argued for the construction of a wall at the U.S.-Mexico border by claiming that immigrants have been responsible for “100,000 assaults, 30,000 sex crimes, and 4,000 violent killings” (Rizzo, 2019).

Corresponding author: Jason C. Coronel; e-mail: coronel.4@osu.edu

As highlighted by these examples, numerical facts play a prominent role in public discourse (Prévost & Beaud, 2015), and there is growing recognition that it is important for voters to possess accurate knowledge of them (Lawrence & Sides, 2014). In the United States, for example, opponents of immigration have cited the number of immigrants entering the country to advance their cause (Bennet, 2018), politicians attempted to garner support for same-sex marriage by stating the percentage of Americans that supported it (Liptak, 2015), and news media have focused on U.S. casualty rates when covering wars (Aday, 2010).

However, a large body of work over the past two decades suggests that members of the American public are misinformed, confidently holding onto false beliefs across a variety of domains (Garrett, Weeks, & Neo, 2016; Kuklinski, Quirk, Jerit, Schwieder, & Rich, 2000; Pasek, Sood, & Krosnick, 2015; Thorson, 2016; Weeks, 2015). For example, people often provide incorrect estimates of numerical quantities, such as economic statistics and population demographics (Citrin & Sides, 2008; Nir, 2011). These inaccurate beliefs about numerical quantities are important, as they have been shown to influence people's attitudes and opinions (Citrin & Sides, 2008; Gilens, 2001; Kuklinski et al., 2000; although, see Lawrence & Sides, 2014).

The primary goal of our study was to examine how people become misinformed about policy-relevant numerical facts. In particular, we focused on instances in which individuals have been exposed to accurate numerical information, but their schemas—general mental representations about the world—lead them to misremember this information (Bartlett, 1932; Brewer & Treyens, 1981). For example, there were 12.8 million Mexican immigrants in the United States in 2007, but in 2014, the population decreased to 11.7 million (Gonzalez-Barrera, 2015). However, people may possess inaccurate schemas about the number of Mexican immigrants across time (e.g., incorrectly thinking that the number of Mexican immigrants increases every year). Thus, despite exposure and attention to accurate information, people may still misremember information in a way that is consistent with their schemas (e.g., misremembering that the number of Mexican immigrants in 2014 was larger than in 2007). Furthermore, misinformation created by memory distortions is not confined to a single individual, as it can spread via social transmission: people often retell information to friends, family members, and co-workers who, in turn, can retell it to others.

Our research advances the scholarly literature in three ways. First, many studies in the message-processing literature have assumed that enhanced attention to message content leads to better memory for that content (Jeong & Hwang, 2016; Kim & Southwell, 2017; Segijn, Voorveld, Vandeberg, & Smit, 2017; Young, Jamieson, Poulsen, & Goldring, 2018). Our studies identified an important domain (i.e., schema-based information) in which this assumption is not likely to be valid. Second, we examined the consequences of numerical misinformation by investigating the role of person-to-person transmission processes. Finally, we studied the creation and spread of numerical misinformation from an interdisciplinary approach, by combining different methods from cognitive science and studies of cultural evolution. The paradigm and analytical approaches we have developed here can be used to study the generation and spread of numerical misinformation in other domains, such as health, risk, and science communication.

Misremembering numerical information

Individuals in modern democratic societies can obtain policy-relevant numerical facts from a vast array of sources, including 24-hour news websites, social media, and person-to-person conversations. Some of this information is not always accurate: information sources have been shown to disseminate numerical misinformation (Barthel, Mitchell, & Holcomb, 2016). For example, Trump's claim that immigrants have been responsible for "100,000 assaults, 30,000 sex crimes, and 4,000 violent killings" has been judged by fact-checking and news organizations to be misleading (Greenberg, Sherman, Tobias, & Valverde, 2019; Rizzo, 2019).

We refer to these information sources from the environment, such as news websites and blogs that disseminate inaccurate facts, as external sources of misinformation. In the research reported here, however, we have focused on another important source of misinformation: instances in which individuals are exposed to accurate information from an external source (e.g., news websites), but biases inherent in memory cause them to misremember information. We refer to the processes in which memory biases cause individuals to form inaccurate memories as internal sources of misinformation (Davis & Loftus, 2007).

How, then, can individuals who are exposed to accurate numerical facts misremember them? One way this may come about is through schemas (Gallo, 2006; Gilboa & Marlatte, 2017). Schemas are mental constructs that represent people's abstract generalizations about groups, people, objects, and events in the world (Bartlett, 1932; Rojahn & Pettigrew, 1992). They are theorized to form via repeated exposure to systematic patterns in the information environment (Brewer, 2000; Gallo, 2006; Gilboa & Marlatte, 2017). Stereotypes about gender, race, and age are prominent examples of cultural schemas.

There are competing classes of theories regarding the extent to which schemas can enhance, or inhibit, people's ability to accurately remember numerical information.[1] According to one set of models, information that violates people's schemas tends to attract greater attention than information that is consistent with people's schemas (Loftus & Mackworth, 1978; Rojahn & Pettigrew, 1992). By "attention," we are referring to the processes by which information from the environment is given preferential access to cognitive processes (e.g., memory, decision making, etc.; Luck & Gold, 2008). A large body of work in cognitive psychology suggests that this increase in attention that is directed at information during encoding (the process of storing information in memory) leads to better memory for the information (Loftus, 1972; Neuschatz, Lampinen, Preston, Hawkins, & Toglia, 2002; Pertzov, Avidan, & Zohary, 2009). This proposed relationship, in which an increase in attention leads to an improvement in memory, is present in several message-processing accounts (Coronel & Sweitzer, 2018; Jeong & Hwang, 2016; Kim & Southwell, 2017; Segijn et al., 2017; Young et al., 2018). We refer to these theories as attention-memory models. These models predict that people will be more likely to remember numerical information that is inconsistent than consistent with their schemas, because inconsistent information will elicit greater attention at encoding.

In contrast, a different set of models suggest that greater attention to schema-inconsistent information will not necessarily lead to better memory for that information. We refer to these as misremembering models. Some of these models either explicitly or implicitly assume that schema-inconsistent information will still elicit greater attention than schema-consistent information at encoding (see Lew & Howe, 2017). However, information that is inconsistent with people's schemas will be misremembered in such a way that it becomes consistent with people's schemas. The processes by which this can occur vary by theory. From a motivated reasoning view, individuals engage in biased processing to maintain their prior beliefs over the course of remembering numerical facts (Hennes, Ruisch, Feygina, Monteiro, & Jost, 2016; Howe & Leiserowitz, 2013). When processing schema-inconsistent information, individuals may engage in various processes, such as counterarguing: the generation of arguments challenging the inconsistent information. The process of counter-arguing can lead to greater elaboration of and attention to schema-inconsistent information (Jain & Maheswaran, 2000; Taber & Lodge, 2006), but may not lead to improved memory for the information. Under views that specify that memories are forgotten over time, memories for schema-inconsistent information may gradually fade across time, leading people to doubt the accuracy of their memories (Kleider, Pezdek, Goldinger, & Kirk, 2007). As memories weaken, individuals are more likely to rely on their well-established schemas to guide what they remember (Kleider et al., 2007). Thus, despite increased attention, schema-inconsistent information fades and recollection relies on schemas. Indeed, a study found that individuals who denied the existence of climate change were more likely to misremember their previous summer as having normal, rather than above normal, temperatures (as indicated by objective measures of temperature; Howe & Leiserowitz, 2013).

In another account, work on processing fluency and the Continued Influence Effect suggest that individuals may misremember schema-inconsistent information as schema-consistent information. The Continued Influence Effect specifies that individuals desire to maintain coherent mental models (Ecker & Ang, 2019). Exposure to inconsistent information may prompt the retrieval of consistent information, and the activation of both consistent and inconsistent information is what leads to later inaccurate recall. Information that is coherent or logically consistent with mental models is processed more fluently than inconsistent information (Schwarz, Sanna, Skurnik, & Yoon, 2007). This fluency can serve as a cue for the accuracy of one's memories. Thus, despite exposure to schema-inconsistent information, the activated schema-consistent information conforms with mental models, is more fluent, and then is likely to be perceived as the accurate memory. Regardless of the exact mechanisms, misremembering models predict that people will be more likely to remember numerical information that is consistent than inconsistent with their schemas, because inconsistent information will be misremembered in a way that matches their schemas.

To summarize, attention-memory and misremembering models can converge on the same prediction at encoding. In particular, both models predict the following:

> H1: Individuals will direct greater attention to schema-inconsistent than schema-consistent numerical information.

The models differ in their predictions at memory retrieval. Specifically, the models make the following competing predictions during retrieval:

> H2: Individuals will possess greater accurate memory for schema-inconsistent than schema-consistent numerical information.
> H3: Individuals will possess greater accurate memory for schema-consistent than schema-inconsistent numerical information.

Our primary goal in this study was to examine the extent to which schemas can enhance or inhibit people's ability to accurately remember numerical information, by testing the predictions of these two models.

Eye movements as measures of attention

Eye-movement monitoring can provide communication scholars with the ability to assess people's attention to information at the moment of exposure. Studies in cognitive psychology have shown that eye movements can provide an assessment of where attention is deployed, because the direction of gaze is tightly linked to the orienting of attention (Loftus, 1972; Pertzov, Avidan, & Zohary, 2009). Thus, eye-movement monitoring technology can provide researchers with unique information on what features of a person's visual field are the focus of attention. Of particular interest here are studies in eye movements, as well as literature suggesting that eye movements can be used to determine whether individuals are more likely to direct greater attention to those specific types of information that violate their expectations or world knowledge (e.g., Cook & Myers, 2004; Coronel & Sweitzer, 2018). Indeed, these studies have shown that eye movements can be used to determine, with a high level of specificity, what parts of a text are eliciting enhanced attention (e.g., individual words or phrases).

For example, English readers do not continuously read from left to right while reading a passage of text (Rayner, 1998). They often move their eyes back to earlier parts of a text in order to re-read previous information. Instances in which readers move their gaze back to earlier parts of a text are called "regressions." Studies have found that regressions can occur if information contained at a later part of the text violates the reader's expectations, based on information that was generated by an earlier part of the text (Cook & Myers, 2004). This increase in regressions is likely because individuals were checking the accuracy of their memory for the earlier part of the text.

We took advantage of the phenomenon in which individuals re-read earlier parts of a text when their expectations are violated to determine whether individuals were more likely to direct greater attention to schema-inconsistent than schema-consistent information.

Study 1

Method

Participants

We recruited 120 participants from a Midwestern university in the United States and the surrounding community.[2] Participants were compensated with $15 for taking part in the study. Ten participants were excluded from the analysis, either because they were wearing glasses or contacts that interfered with the calibration of our eye-tracking instruments or because they did not follow task instructions while in the eye tracker (e.g., dismounted their heads in the middle of the eye-tracking task, etc.). We analyzed data from the remaining 110 participants (57% female; $M_{age} = 24.8$ years, $SD_{age} = 6.5$, age range = 18–56 years; see Supporting Information for additional demographic information).

Stimuli

Our critical stimuli consisted of eight paragraphs (see Table 1), representing four issues, that were 29 to 38 words in length.[3] We selected these stimuli based on pre-tests in which we recruited participants from Amazon's Mechanical Turk (see results of pre-tests in Table 1), hereafter referred to as MTurk. For two of the issue domains, the factually accurate numerical relationship coincided with people's schemas. For example, individuals expected more Americans to support than oppose same-sex marriage: an expectation that coincides with public opinion polls (Doherty, Kiley, & Weisel, 2015). Individuals also expected more Americans to prefer a male than a female boss: a belief supported by survey data (Newport, 2011; Riffkin, 2014).

For the other two issue domains, the factually accurate numerical relationship did not coincide with people's expectations. For example, individuals expected the number of Mexican immigrants to be higher in 2014 than in 2007, when the actual number had decreased (Gonzalez-Barrera, 2015). In addition, individuals expected more Black than White individuals to have been killed by police in 2016, although the opposite pattern was true (The Washington Post, 2016).[4] Thus, each paragraph contained two numerical values, associated with two "referents" (e.g., the year 2007 or 2014; people who prefer either male or female bosses) and the value associated with one referent was always larger than the other.

However, we created schema-consistent and inconsistent versions for each of the four critical issue domains, to ensure that differences in prior knowledge, attitudes, or other factors across issues were not confounded with the schema-consistency

Table 1 Critical Stimuli

Issue Domain	Schema-Consistent Version	Schema-Inconsistent Version	Estimated Numerical Values by Pre-Test Participants
Level of support/opposition to same-sex marriage	Same-sex marriage is a contested topic among Americans. In a poll conducted by the Pew Research Center, ***57%*** of respondents reported favoring same-sex marriage. ***39%*** reported opposing same-sex marriage.	Same-sex marriage is a contested topic among Americans. In a poll conducted by the Pew Research Center, ***39%*** of respondents reported favoring same-sex marriage. ***57%*** reported opposing same-sex marriage.	$n = 95$; 55% support, 39% oppose
Gender preference for bosses	According to a recent poll, ***33%*** of Americans say that they would prefer working under a male boss. ***22%*** of Americans would prefer to work under a female boss.	According to a recent poll, ***22%*** of Americans say that they would prefer working under a male boss. ***33%*** of Americans would prefer to work under a female boss.	$n = 96$; 61% prefer male boss, 33% prefer female boss
Number of immigrants from Mexico 2007/2014	In 2007, ***11.7*** million Mexican immigrants lived in the United States. In 2014, **12.8** million Mexican immigrants lived in the United States. Mexican immigrants have been at the center of one of the largest mass migrations in modern history.	In 2007, ***12.8*** million Mexican immigrants lived in the United States. In 2014, **11.7** million Mexican immigrants lived in the United States. Mexican immigrants have been at the center of one of the largest mass migrations in modern history.	$n = 91$; 10.8 million in 2007, 13.2 million in 2014
Number of White/Black individuals killed by police officers in 2016	According to a database compiled by The Washington Post, 963 individuals were shot and killed by police in 2016. Of those shot, ***233*** individuals were White and **465** individuals were Black.	According to a database compiled by The Washington Post, 963 individuals were shot and killed by police in 2016. Of those shot, ***465*** individuals were White and **233** individuals were Black.	$n = 96$; 324 Whites killed, 411 Blacks killed

Note: The shaded posts contain factually accurate information that is either consistent or inconsistent with people's schematic expectations about which referent group should be associated with a larger value. All text was presented in a standard typeface to participants. The fourth column presents estimated values from pre-test participants recruited from Amazon's Mechanical Turk. Pre-test participants were asked to estimate numerical quantities for our relevant groups (e.g., how many Mexican immigrants were in the U.S. in 2014?). We used this information from our pre-test participants to determine whether numerical information for a specific issue domain was consistent or inconsistent with people's schemas.

manipulation. For example, for the Mexican immigration issue, the schema-inconsistent version contained the factually accurate numerical relationship (e.g., 12.8 million for 2007 and 11.7 for 2014). In contrast, the schema-consistent version contained the factually inaccurate numerical relationship, but was consistent with people's expectations (e.g., 11.7 million for 2007 and 12.8 for 2014). We also used 16 stimuli that served as foils, meant to hide the true purpose of the study. These were similarly short paragraphs that contained actual news items about science, politics, and entertainment (see Supporting Information).

Procedures

Participants were tested individually in a quiet room, where they were seated 100 cm away from a 24-inch LCD monitor (resolution 1920 x 1080) with a refresh rate of 60Hz. Before the experiment began, the desktop-mounted SR Research EyeLink 1000 eye tracker was fitted and calibrated for each subject with a 9-point calibration system. A rigid mount was used to keep the chin and forehead from moving. Recordings were taken from the right eye, except for seven instances in which reflections off the participants' glasses necessitated left-eye recording.

The main experiment employed a study-memory test method (see Figure 1). Participants were instructed at the start of the study phase that they would be reading several blog posts. Each trial began with a drift-check target, in the form of a dot in the middle of the screen. Participants controlled the time spent on this screen by fixating on the target while pressing the advance button on the left side of the hand-held controller. Participants were then presented with a short paragraph in the center of the screen for 15 seconds.[5] The participants read each paragraph and rated it as "interesting" or "not interesting" before they advanced to the next trial/paragraph. We instructed participants that these options referred to whether the information conveyed in the paragraph captured their attention. During the study phase, participants were shown a total of 20 paragraphs (4 critical stimuli, 16 foils). Two of the critical stimuli were schema-consistent and the other two were schema-inconsistent across the four unique issues. The assignments of the schema-consistent or -inconsistent versions were counterbalanced across participants.

After reading all 20 paragraphs, the memory test followed next. There were no distractor tasks in between the study and test phases. Participants' memories were only tested for the four critical issues. Participants were not told that there would be a memory test until after reading through the 20 paragraphs. During the memory test phase, participants were asked to type the numerical value associated with one of the referents in the paragraphs (e.g., "according to one of the blog posts, how many millions of Mexican immigrants lived in the United States in 2007?"). These questions were grouped by issue domain (e.g., a question about the number of Mexican immigrants in 2007 would be followed by a question on the number of Mexican immigrants in 2014, or vice versa). The order of the issues was randomized between participants.

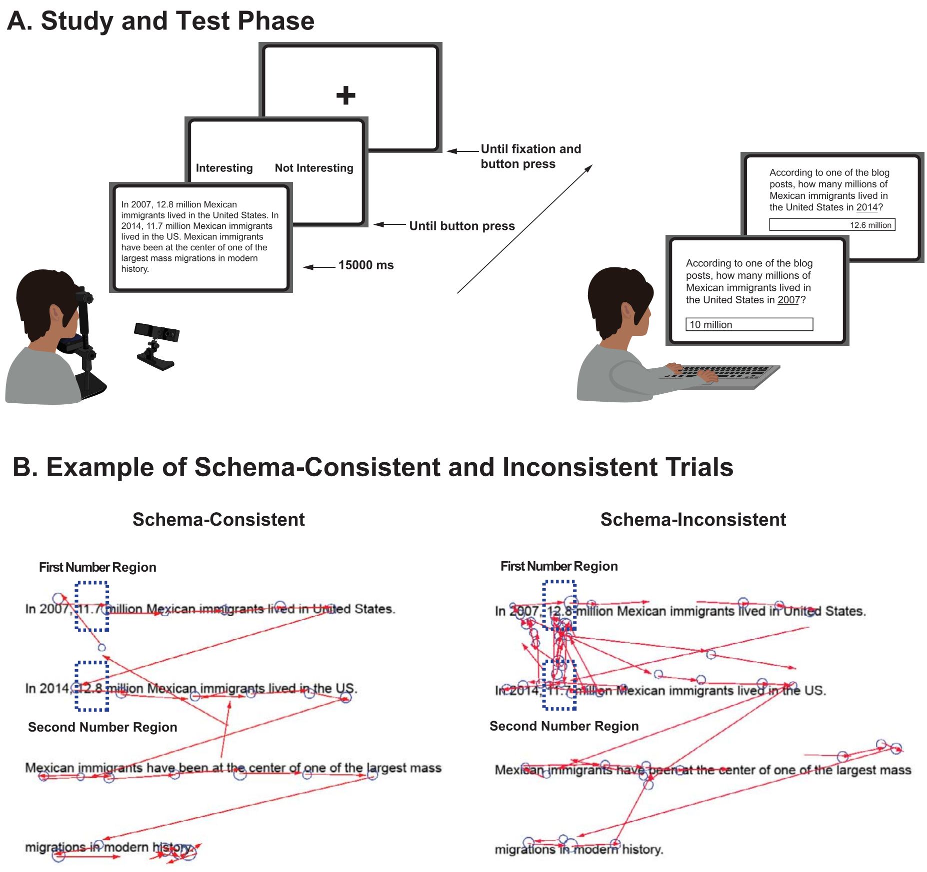

Figure 1 (A) The schematic design of the study and test phase for Study 1. (B) Examples of a single schema-consistent and -inconsistent trial for the Mexican immigration issue. The dashed squares show the first and second regions containing numerical information. Eye movements are superimposed on the text. Circles represent fixations. Lines represent saccades or movements of the eyes across the text. Larger circles represent longer fixation durations. The schema-inconsistent first number region elicited more regressions and fixations, along with longer fixation durations during these regressions, than the schema-consistent first number region.

Results

Eye movements

Attention-memory and some misremembering models converge on the prediction that schema-inconsistent numerical information will elicit greater levels of attention than schema-consistent numerical information, given that the information violates people's expectations. To test this prediction, we created two regions of interest. Our first area of interest was the first instance in which a relevant numerical value was mentioned in the paragraph (see bold and underlined numbers in Table 1). This interest area was our first number region.[6] Our second interest area encompassed the second instance a relevant numerical value was mentioned in the paragraph (see bold numbers in Table 1). This interest area was our second number region.[7] For example, 12.8 is the first number region and 11.7 is the second number region in, "in 2007, 12.8 million Mexican immigrants lived in the United States. In 2014, 11.7 million Mexican immigrants lived in the United States."

Individuals require both pieces of information in the first and second number regions to determine whether the relationship violates their schema. If violating one's schema elicits a greater level of attention, then we would expect the number of regressions to the first number region to be greater in the schema-inconsistent condition than in the schema-consistent condition. This would suggest that individuals were re-reading earlier parts of the text to check the accuracy of the information, given that it violated their world knowledge. We also operationalized gaze during these regressions as the number of fixations (discrete pauses of the eyes) and duration of fixations directed to a given region.[8] We expected the amount of fixations and duration of fixations during these regressions to the first number region to be greater in the schema-inconsistent than schema-consistent condition (see Figure 1 for an example).

To test these predictions, we used schema consistency (inconsistent = 1, consistent = 0) as our primary independent variable and used the total number of regressions to the first number region, total number of fixations during regressions to the first number region, and total duration of fixations during regressions to the first number region as our dependent variables. We estimated three mixed-effects regression models in which schema consistency was treated as a fixed effect and participants and the four issue domains were treated as random effects.[9] As can be seen in Table 2, a significant and positive effect of schematic consistency across the three models suggests that participants were more likely to make regressions to the first number region and direct greater and longer fixations during these regressions to the first number region when exposed to schema-inconsistent than schema-consistent information.[10] This outcome is consistent with the predictions of both the attention-memory and some misremembering models. We also estimated additional models that added the participant's sex, party affiliation, age, and general political knowledge as control variables. The addition of these variables did not change our substantive findings (see Supporting Information).[11]

We also conducted exploratory analyses to examine the extent to which results from eye movement measures of attention matched self-report measures. After reading each paragraph, participants were instructed to rate whether they found the information conveyed in the paragraphs to be "interesting" or "not interesting." We instructed participants that these options referred to whether the information conveyed in the blog post captured their attention. We used schema consistency (inconsistent = 1, consistent = 0) as our primary independent variable and their self-report ratings of interest as our dependent variable (interesting = 1, not interesting

Table 2 Attention and Memory Accuracy Analyses

	Encoding Analyses				Memory Retrieval Analysis
	Number of Fixations During Regressions to First Number Region	Duration of Fixations During Regressions to First Number Region	Total Number of Regressions to First Number Region	Self-report Measure of Attention/Interest in Article	Memory Accuracy
	Model 1	Model 2	Model 3	Model 4	Model 5
Schema Consistency, inconsistent = 1, consistent = 0	.60** (.19)	118.87* (52.79)	.33* (.14)	.17 (.22)	-1.16*** (.29)
n	392	392	392	433	423

Note. Mixed-effects regression coefficients are shown with standard errors in parentheses for Models 1, 2, and 3. Mixed-effects logistic regression coefficients are shown for Models 4 and 5. For the dependent variable in Model 5, accurate memory = 1 and inaccurate = 0 (pairwise gist). On average, participants did not report numerical values in 3.8% of trials and did not fixate on the two numbers in 10% of trials. See Supplementary Materials for model estimates with controls included. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

= 0). We estimated a logistic mixed-effects model. As can been seen in Table 2, Model 4, in contrast to the eye-movement results, a non-significant effect of schema consistency suggests that participants self-reported similar levels of interest for both the schema-consistent and schema-inconsistent conditions.

Memory measures

Similar to previous studies on memory for numbers, we distinguished between pairwise gist memory and item memory (Brainerd & Gordon, 1994; Reder, Wible, & Martin, 1986). Pairwise gist memories are memories for the general numerical relationships between our referents (e.g., "greater number of Mexican immigrants in 2007 than 2014," "greater support than opposition to same-sex marriage"). In contrast, item memory, in this context, refers to memories for the actual numbers, which are independent of their associations with the referents (e.g., 12.8 and 11.7 million Mexican immigrants). These memories are separable and it is possible for individuals to possess accurate item memory but incorrect pairwise gist memory (e.g., misremembering that 11.7 million is associated with 2007 and 12.8 million immigrants with 2014). Because we selected our issue domains based on people's general schemas on which of the two referents had a larger value, we used pairwise gist memory as our primary conception of memory for numerical information.

Pairwise gist memory

Attention-memory models predict that people will possess greater accurate memory for schema-inconsistent than schema-consistent numerical information, because they will pay greater attention to it. In contrast, misremembering models predict that people will be more likely to remember numerical information that is consistent than inconsistent with their schemas, because inconsistent information will be misremembered in a way that aligns with people's schemas.

To test these competing predictions, we operationalized memory accuracy as the extent to which participants were able to remember which value associated with a particular referent group was larger (pairwise gist memory). We coded a response as correct if a participant was able to correctly identify which value associated with a particular referent group was larger. For example, if participants were shown the values of 12.8 million Mexican immigrants for 2007 and 11.7 million for 2014, a response associating 20 million Mexican immigrants for 2007 and 10 million Mexican immigrants for 2014 would still be classified as "correct," given that the participant's responses would reflect that there had been a decrease in the number of Mexican immigrants from 2007 to 2014.

We estimated a logistic, mixed-effects model and used schema consistency (inconsistent = 1, consistent = 0) as our primary independent variable and memory accuracy—whether participants were able to correctly remember which value associated with a particular referent group was larger—as our dependent variable (accurate = 1, inaccurate = 0). A negative and significant coefficient for schema consistency (Table 2, Model 5) suggests that participants, despite directing greater attention to schema-inconsistent information, were more likely to correctly remember which value associated with a particular group was larger for schema-consistent ($M = 90\%$ of trials) than schema-inconsistent ($M = 75\%$ of trials) information. This outcome is consistent with the prediction of misremembering models. This decreased memory performance for the inconsistent trials is likely because participants misremembered numerical information that violated their schemas in a manner that was consistent with their schemas.

Item memory

Finally, we examined people's memory for the individual numerical values (e.g., if they were shown 33%, do they remember that they were shown a value around 30%), regardless of whether they assigned them to the correct referent (in this example, referents are the preference for either a male or female boss). This allowed us to examine whether individuals completely forgot the numerical content of the paragraphs presented to them during the study phase and relied exclusively on inferences, based on their schemas during the test phase.

We adopted an "accepted ranges" approach to evaluate item memory for numerical values (Prior & Lupia, 2008). This accepted range conception of accuracy captures the phenomenon that participants have memory for a given value (i.e., what they entered is close to what was presented), but the memory for that value may have been more general (e.g., participant might remember that the value is around 30%), as opposed to a memory of the precise value (e.g., value is exactly 33%).

For each value contained within a given paragraph, we specified an accepted range for the responses, which were as follows:

1. For gender preference for bosses, any values between and equal to 30 and 39 percent for one response and 20 and 29 percent for another response were coded as correct. For example, if participants indicated that 38% of Americans preferred a male boss and 10% preferred a female boss, their accuracy score for this issue would be 1 out of 2.
2. For level of support/opposition to same-sex marriage, any values between and equal to 50 and 59 for one response and 30 and 39 for another response were coded as correct.
3. For the number of immigrants from Mexico in 2007/2014, any values between and equal to 12 and 12.9 million for one response and 11 and 11.9 million for another response were coded as correct.
4. For the number of White/Black individuals killed by police officers in 2016, any values between and equal to 400 and 499 for one response 200 and 299 for another response were coded as correct.

Overall, participants demonstrated robust memory for the individual numerical values: there was no statistically significant difference in people's ability to remember schema-consistent ($M_{item\ memory} = 70\%$, $SD_{item\ memory} = 29\%$) and schema-inconsistent ($M_{item\ memory} = 70\%$, $SD_{item\ memory} = 31\%$) numerical values ($t[105] = -0.17$; $p = .86$). This suggests that most of the numbers that participants reported were based on numerical values they were exposed to during the study phase.

Further, across all trials, the average percentages of trials in which participants were able to accurately remember two, one, or zero of the numerical values were 28.6%, 11.5%, and 8.9%, respectively, among schema-consistent items (using a range conception of accuracy). Among schema-inconsistent items, the average percentages of trials in which participants were able to accurately remember two, one, or zero of the numerical values were 30.8%, 10.9%, and 9.2%, respectively. Breaking down the responses into these three categories further highlights the fact that there were no differences in item-memory accuracy between schema-consistent and schema-inconsistent trials. Interestingly, participants were equally likely to accurately remember two of the numerical values for schema-consistent (28.6%) and schema-inconsistent items (30.8%). However, the fact that pairwise gist memory was better for schema-consistent than schema-inconsistent items suggests that participants misremembered which referent those numbers were assigned to, such that they would flip the order of referents in the schema-inconsistent conditions to conform to their expectations.

Study 1 Discussion

In Study 1, we examined the extent to which people's general mental representations about the world (schemas) can enhance or inhibit their ability to remember numerical information. The attention-memory and some misremembering models converge on the prediction that schema-inconsistent numerical information will elicit greater levels of attention than schema-consistent information. As expected, our eye-movement results indicated that participants were more likely to re-read and direct their gaze at prior parts of a text for paragraphs that contained schema-inconsistent than schema-consistent numerical information. There were no differences in participants' interest ratings between schema-consistent and -inconsistent information. Although we explicitly instructed participants that these options referred to whether the information conveyed in the paragraph captured their attention, this measure may not adequately capture participants' responses to unexpected information. Future work should consider other, alternative, multi-item self-report measures, such as feelings of surprise (Schützwohl, 1998).

Critically, despite this greater amount of attention directed to schema-inconsistent information, participants were still more likely to accurately remember the general relationship between numbers if it was consistent with their schemas (pairwise gist memories): an outcome consistent with the prediction of some misremembering models. Furthermore, individuals had robust memories for the individual numerical values (item memories), suggesting that they did not completely forget the numerical information during the study phase.

Our study has two important implications. First, our results suggest that for schema-based numerical misinformation, an increase in people's attention to information does not necessarily lead to a better memory for it. Thus, attempts to correct numerical misinformation by increasing people's attention to factually accurate (but schema-inconsistent) information may not sufficiently correct it. Second, given that the mechanisms that lead people to misremember schema-inconsistent information are diverse, the strategies for increasing people's likelihood for remembering schema-inconsistent information may differ, depending on the mechanism at work.[12] For example, people may doubt the accuracy of their memories for schema-inconsistent information, because retrieving them can be associated with a more disfluent experience than retrieving schema-consistent information. Therefore, presenting information in a graphical format, rather than a textual format, may create a more fluent experience, which, in turn, will increase the ability to accurately remember schema-inconsistent information (Nyhan & Reifler, 2019). If individuals instead engage in counterarguing schema-inconsistent information at encoding, presenting information from a credible source may decrease counterarguing and, potentially, enhance accurate memory (Heesacker, Petty, & Cacioppo, 1983). Future work can explore the conditions under which specific mechanisms distort memories for schema-inconsistent information.

Study 2

Study 1 showed that schemas can distort memory for policy-relevant numerical facts. In Study 2, we examined one of the possible consequences of these memory distortions: they are not confined to a single individual, as they can be transmitted from person to person. We therefore examined the possibility that person-to-person transmission can exacerbate these memory errors.

Once created, numerical misinformation can spread from person to person via interpersonal communication. We often retell information, based on our memories of events, to other people who, in turn, can repeat the information to others (Hirst & Echterhoff, 2012). Importantly, retelling information to others can also increase the likelihood that numerical misinformation is created, especially under conditions in which an entire of group of individuals share the same schema (Kashima, 2000). That is, every time information is retold, it opens an opportunity for the receiver to produce schema-based distortions. Thus, this process, in which schema-inconsistent numerical information is retold from person to person, can increase the likelihood that the information is misremembered, such that it is consistent with people's schemas. In this study, we therefore postulated the following interaction hypothesis:

> H4: As the number of retellings increases from person to person, schema-inconsistent numerical information will be more likely to be transformed, such that it is consistent with people's schemas. For schema-consistent numerical information, numerical information will maintain schematic consistency.

We tested this interaction hypothesis in the context of our four critical issues from Study 1.

Serial reproduction paradigm

To test this hypothesis, we used the serial reproduction paradigm (Allport & Postman, 1947; Bartlett, 1932), which is an experimental paradigm often used in studies of cultural evolution (for a review, see Mesoudi & Whiten, 2008). In this paradigm, a series of individuals transmit information sequentially from one person to the next. Specifically, the first individual's recollection of an event is provided to the second individual, who, in turn, provides his or her own recollection, which is transmitted to a third individual, and so on (i.e., similar to the childhood game of "telephone"). This paradigm has been used to study the extent to which schemas/stereotypes can distort memories, and how this distortion is passed from person to person (Kashima, 2000).

For example, in a highly pertinent serial reproduction study by Allport and Postman (1947), they presented the first person in a chain of individuals with an image depicting a subway scene in which a Black man and a White man were standing and having a conversation. The White man was shown holding a switchblade in his hand. The first person's description of the scene was then passed down a communication chain. The researchers found that individuals misremembered the person holding the switchblade: the Black man was described as holding the switchblade in most of the communication chains. We used the paradigm here, and show how it can be useful in the study of numerical misinformation.

Method

General design

We conducted two studies that used the same stimuli and employed the same general design (Study 2a and 2b). Study 2a employed the same open-ended recall test, similar to Study 1. Study 2b used a less demanding, cued-recall test. For Study 2a, we recruited participants from MTurk. For Study 2b, we recruited participants from the U.S. National Institutes of Health *ResearchMatch* participant registry (Harris et al., 2012). This allowed us to examine the extent to which our results were robust across different samples and testing contexts.

Participants

Our design involved 100 three-person chains. For Study 2a, our 300 participants (38% female; $M_{age} = 33.08$ years, $SD_{age} = 8.5$) were recruited using Amazon's MTurk. Participants were compensated with \$5.00. Only participants with a U.S. IP address and an approval rate of at least 90% in the MTurk system were allowed take part in our study. For Study 2b, our 300 participants (70% female; $M_{age} = 43.9$ year, $SD_{age} = 15.5$) were recruited using the National Institutes of Health's *ResearchMatch* service. (For additional information about demographic characteristics, see the Supporting Information.)

Stimuli

Our critical stimuli consisted of the 4 paragraphs used in Study 1 and the 16 stimuli that served as foils. Unlike Study 1, however, we did not create schema-consistent and -inconsistent versions for each of the four issue domains. Instead, the issue domains relating to gender preferences for bosses and support/opposition to same-sex marriage were our schema-consistent conditions. The issue domains relating to the number of Mexican immigrants and number of individuals killed by police officers (by racial group) were our schema-inconsistent conditions. We did not create different versions of the stimuli, because one of our main goals in Study 2 was to examine how real-world schema-inconsistent information that was factually accurate (immigration, police shooting issues) could be changed over the course of person-to-person transmission to schema-consistent (but factually inaccurate) information.

Procedure

We used an online format with data collected using Qualtrics survey software for both Studies 2a and 2b. Similar to Study 1, we informed participants that they would be reading several blog posts. Study 2 employed a similar study-test method to Study 1. During the study phase, a trial consisted of a paragraph. Below the paragraph were buttons labeled "interesting" and "not interesting." A trial lasted for a maximum of 15 seconds and advanced to the next trial when participants either clicked on one of the buttons or after the 15 second time window has elapsed. The order of the 20 paragraphs was randomized between participants.

The memory test phase followed next. For Study 2a, participants were asked to type the numerical value associated with one of the referent groups in the paragraphs (open-ended recall test). For Study 2b, participants used sliders to indicate the numerical value associated with a particular referent group. The scale maximum and minimum values were shown to participants, but the slider used to indicate values was not shown with a default value, so as not to affect response values. Compared to the free-recall test, this was less demanding, in that for some of the issues, participants could not indicate a value above a certain number (e.g., 20 million for the immigration issue). Further, Study 2b was designed to prevent individuals from entering numerical values over 100% (same-sex marriage and boss issues) or 963 (police shooting issue), given that most of our participants in Study 2a were excluded based on these errors (see Supporting Information). See Figure 2 for a graphical representation of this procedure.

Both Studies 2a and 2b used the serial reproduction paradigm, using 100 three-person chains. We used a Wave terminology (Wave 1, Wave 2, and Wave 3) to indicate a participant's place in the chain (first, second, and third, respectively). Participants in Wave 1 were exposed to the original versions of our critical stimuli (see shaded cells in Table 1) during the study phase. Importantly, the responses of the Wave 1 participants during the memory test phase were used as the stimuli for participants in Wave 2. For example, suppose the first person in Chain 1 indicated "10 million" and "20 million" for the number of Mexican immigrants in 2007 and 2014, respectively.[13] The second person for Chain 1 (Wave 2), would see the values of 10 million and 20 million, instead of the original values (i.e., 12.8 million for 2007 and 11.7 for 2014), when shown the paragraph on Mexican immigration. Thus, 100 versions of each stimuli, based on responses from Wave 1 participants, were used in Wave 2. The responses

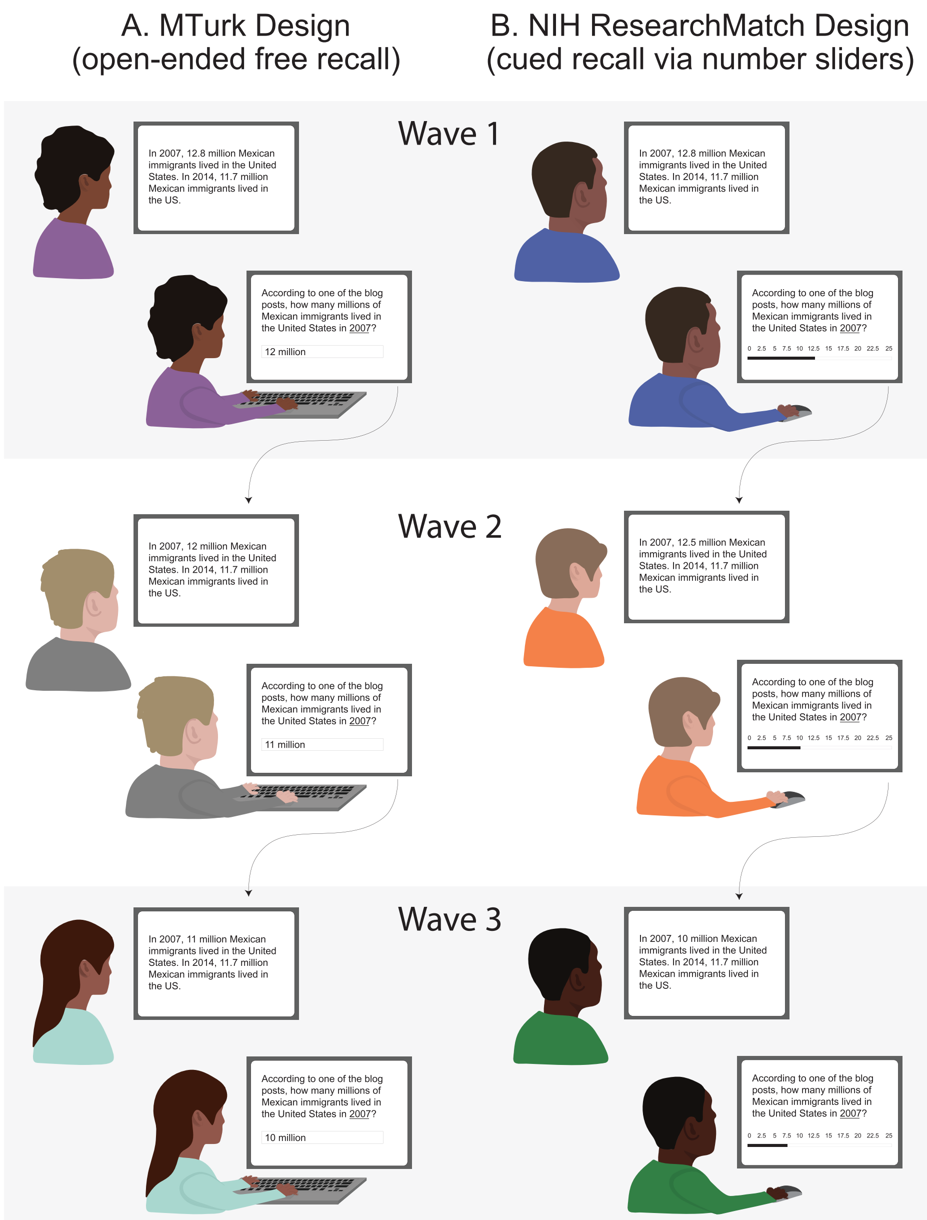

Figure 2 (A) The schematic design for the serial reproduction paradigm in the MTurk study. (B) The schematic design for the serial reproduction paradigm in the ResarchMatch study. MTurk = Amazon's Mechanical Turk; NIH = National Institutes of Health.

of participants for Wave 2 during the memory phase would then be used as stimuli for the Wave 3 participants. Participants were randomly assigned to the chains in all waves (i.e., we did not structure chains such that they were solely composed of females, Republicans, or other demographic groups).

Results

Our hypothesis for Study 2 was that as the number of retellings increased from person to person, schema-inconsistent numerical information would be more likely to be transformed, such that it was consistent with people's schemas. For schema-consistent numerical information, numerical information was expected to maintain schematic consistency. To test this interaction hypothesis, we analyzed the schema-consistent and -inconsistent issues. For schema-inconsistent issues (immigration and police shootings), the original values (i.e., more Mexican immigrants in 2007 than 2014, more White than Black individuals killed by police in 2016) were factually accurate but were inconsistent with people's schemas. If an increase in the number of retellings caused schema-inconsistent numerical information to be transformed into schema-consistent information, then we expected the proportion of schema-consistent responses to be greater in Wave 3 than Wave 1. For the schema-consistent issues (gender preference for bosses and support/opposition for same-sex marriage), we expected the numerical values to maintain schematic consistency across the waves.

To test these possibilities, we estimated a logistic regression model, with standard errors clustered on participants. We included wave (Wave 1 = 0, Wave 2 = 1, Wave 3 = 2), issue type (schema-inconsistent issue = 1, schema-consistent issue = 0), and the interaction between the two as our primary independent variables. For our dependent variable, we coded a participant's response as either reflecting a schema-inconsistent (e.g., more Mexican immigrants in 2007 than 2014, more White than Black individuals killed by police in 2016) or schema-consistent (e.g., more Mexican immigrants in 2014 than 2007, more Black than White individuals killed by police in 2016; consistent = 1, inconsistent = 0) response.

For both Studies 2a and 2b, we found a positive and significant wave by issue-type interaction (Study 2a: $B = 0.74$, $SE = .18$, $p < .001$; Study 2b: $B = 1.10$, $SE = .18$, $p < .001$). The interaction pattern can be seen in Figure 3. Across both studies, the average numerical estimates for the schema-inconsistent issues were transformed to be in line with people's schemas by Wave 3 (more Mexican immigrants in 2014 than 2007, more Black than White individuals killed by police). For schema-consistent issues, however, people's average numerical estimates were schematically consistent (more preference for male than female bosses, more support than opposition for same-sex marriage) across the waves. Finally, across Studies 2a and 2b, the accumulation of distortions through successive reproductions led to factually inaccurate numerical estimates that exceeded the initial bias present in Wave 1 among the schema-inconsistent issues.

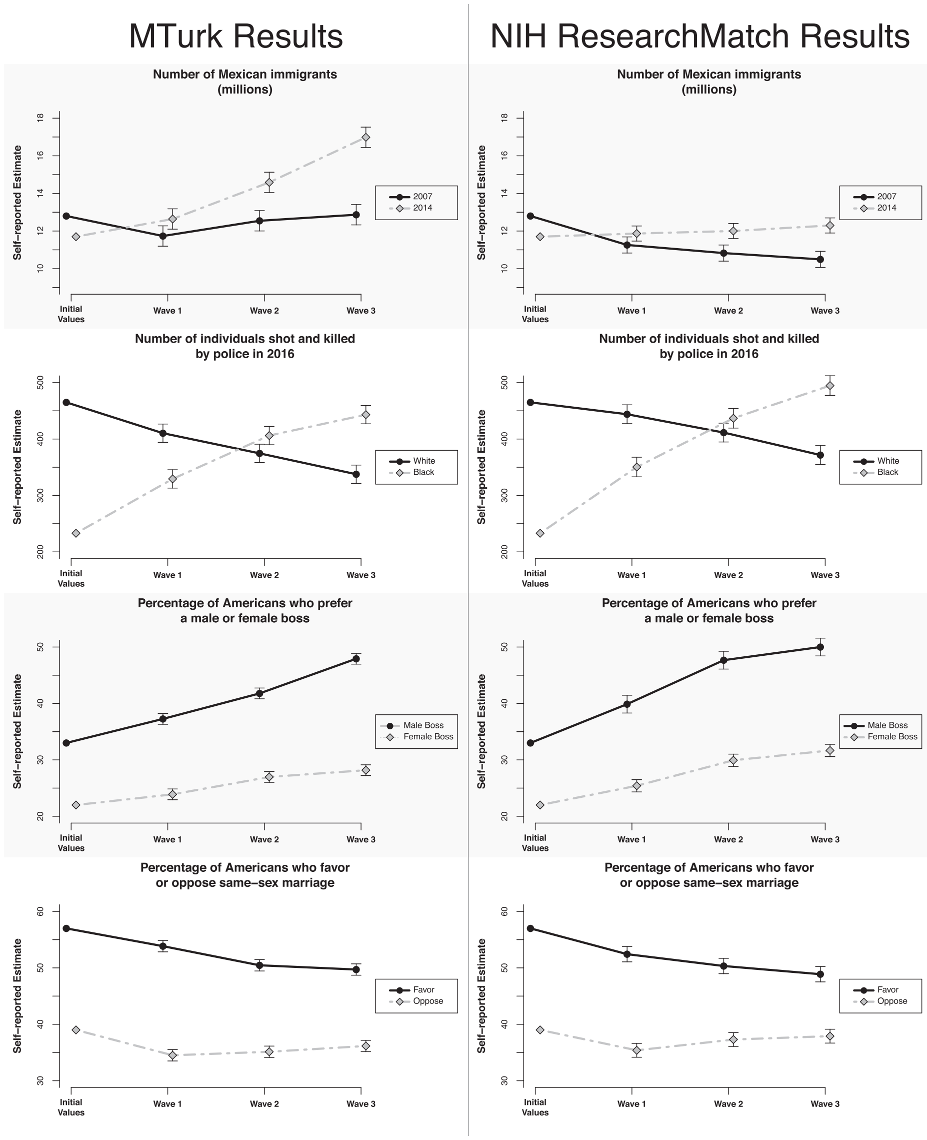

Figure 3 Average numerical estimates across the waves for MTurk and ResearchMatch samples. Error bars are standard errors, adjusted for the within-subjects design. In the x-axis, initial values were the original numerical information provided to participants in Wave 1. For the schema-inconsistent issues, the numerical estimates were transformed, such that they coincided with people's schemas (greater number of Mexican immigrants in 2014 than 2007; greater number of Black than White individuals killed by police in 2016). For the schema-consistent issues, numerical estimates maintain schematic consistency across the waves (greater preference for male than female bosses; greater support than opposition for same-sex marriage). Turk = Amazon's Mechanical Turk; NIH = National Institutes of Health.

For example, for the immigration issue in Study 2a, the average difference between participants' estimates of the number of Mexican immigrants between 2007 (11.7 million) and 2014 (12.6 million) was 900,000 in Wave 1. By Wave 3, that difference had increased to 4.1 million (12.8 million in 2007, 16.9 million in 2014). A similar pattern was observed for the issue of police shootings. In Wave 1, participants, on average, correctly estimated that more White than Black individuals had been killed by police (White = 410, Black = 329). However, in Wave 2, the relationship between the average estimates was no longer accurate (White = 374, Black = 406; a difference of 32). By Wave 3, the difference had increased to 106 (White = 337, Black = 443). Similar patterns can be observed for Study 2b (Figure 3b).

Study 2 Discussion

We found support for our hypothesis that as the number of retellings increased from person to person for schema-inconsistent numerical information, numerical information would be likely to be transformed, such that it was consistent with people' schemas. We obtained this result across two studies that used different samples and different memory tasks. Compared to Study 2a, the memory test was less demanding for Study 2b. In particular, the sliders provided helpful cues to participants in the form of reminders that the sum of numerical values could not exceed 100% for some issues and that the numerical values for the immigration issue were fewer than 20 million immigrants.

Despite these differences across studies, we found that as the number of retellings increased for the schema-inconsistent issues, the numerical estimates were transformed, such that they coincided with people's factually inaccurate schemas (more Mexican immigrants in 2014 than 2007, more Black than White individuals killed by police in 2016). This is likely because every time schema-inconsistent information is retold, there is an opportunity for memory distortions (in the direction of one's schema) to occur in the receiver of the information. These studies, to our knowledge, provide the first evidence that policy-relevant numerical information can be distorted by people's schemas as it is retold from person to person.

Our results further illustrate the evolution of numerical information through cumulative, schema-based memory biases. The accumulation of distortions led to factually inaccurate numerical estimates that emerged over time (Figure 3) and exceeded the initial bias present in Wave 1 through successive reproductions. These studies, then, move beyond the individual-level effects of schemas observed in Study 1 and show how numerical misinformation can spread and be subject to further distortions to an entire group of individuals.

General discussion

Across Studies 1 and 2, we examined instances in which individuals were exposed to accurate numerical information from an external source, but schemas led them to misremember information. Participants in Study 1 directed a greater amount of attention to numerical information when their referent order was schema inconsistent than when that order was schema consistent, likely because it violated their expectations (Loftus & Mackworth, 1978; Underwood & Foulsham, 2006). However, greater attention to the schema-inconsistent paragraphs did not translate into better memory accuracy, as participants' pairwise gist memories were less accurate for schema-inconsistent than -consistent information. According to misremembering models, this is because inconsistent information was misremembered in a way that aligned with people's schemas.

In Studies 2a and 2b, we showed that these memory distortions can have consequences beyond the individual that generated them, once person-to-person transmission processes are introduced. We examined instances in which factually accurate information was inconsistent with people's schematic expectations. Over the course of re-transmission in the serial reproduction paradigm, numerical information was transformed into factually inaccurate but schema-consistent information. These results were obtained across two different samples with two distinct memory tasks.

Given our findings, our study has several substantive and methodological contributions. First, our results support misremembering models. Notably, these models predict (and we found evidence here) that greater attention to information will not necessarily lead to better memory for that information. This prediction is in stark contrast to some views in the message-processing literature, which subscribe to the prediction of attention-memory models and specify a positive relationship between attention and memory (Jeong & Hwang, 2016; Kim & Southwell, 2017; Segijn et al., 2017; Young et al., 2018).

Second, our results point to the important conceptual distinction between internal and external sources of misinformation (Davis & Loftus, 2007). Importantly, this framework suggests that even if all external sources in the environment are disseminating factually accurate numerical information, individuals can still self-generate misinformation and, potentially, spread it from person to person. In addition, although we classified schema-based memory distortions as internal sources of information, the individual possessing inaccurate memories can turn into an external source when he or she passes the information to another person.

Third, our results highlight how person-to-person transmission processes can lead to cumulative distortions in numerical information that go beyond the biases of individuals who are positioned earlier in communication chains. This suggests that studies which do not take person-to-person communication processes into account may underestimate the strength of schemas in distorting numerical information. Furthermore, although our focus here was the manner in which person-to-person transmission can distort information, future work should examine the extent to which schemas can preserve the transmission of factually accurate, numerical relationships. Indeed, we observed such a pattern in Studies 2a and 2b for our schema-consistent issues.

Finally, our studies illustrate the value of a multi-method approach. We used eye-movement monitoring to gain unique leverage on the cognitive mechanisms supporting the creation of schema-based numerical misinformation (for other applications of eye-tracking technology in communication research, see King, Bol, Cummins, & John, 2019). Then, we used the serial reproduction paradigm to investigate the consequences of these cognitive biases by examining the creation and transmission of schema-based, numerical misinformation.

As with all studies, our studies have certain limitations and caution is warranted in terms of generalizing some of the study's findings. Study 1 used a chin-rest eye tracker that restricted participants' ability to move their heads. Although chin-rest eye trackers generally provide excellent spatial resolution, given that the eyes maintain a constant distance from the screen, individuals in their everyday lives often consume news information without restrictions on their head movements. In our studies, we used short paragraphs. Longer texts that discuss why certain numerical relationships exist (e.g., explanations as to why the number of Mexican immigrants has decreased) may increase the likelihood that people remember schema-inconsistent, numerical information, if individuals also encode explanations for the numerical relationships. We also did not manipulate issue importance. Given related work on the influence of motivated reasoning and issue importance on attitudes in other domains of politics (Slothuus & de Vreese, 2010), individuals may be more likely to misremember schema-inconsistent information for issues that are high in personal importance.

Importantly, we also did not measure each of our participant's specific schemas for what would be considered consistent or inconsistent information for each issue. We assumed, based on the findings from the pre-tests, that most individuals in our studies would possess our expected schemas. However, it is likely that there were individual differences in people's schematic representations or levels of motivation for maintaining desired, schema-consistent information (Tappin, van der Leer, & McKay, 2017). Future work should investigate the individual differences that can moderate the effects of schema consistency on memory for policy-relevant, numerical facts.[14]

In addition, our version of the serial reproduction paradigm does not reflect all the complexities involved in actual social transmission. Actual social transmission is influenced by many interpersonal and situational factors. We used the serial reproduction paradigm to look specifically at the critical role of memory for numerical information. Memory is arguably an important component of social transmission, given that individuals cannot transmit information to others if they do not possess memory of that information. However, the serial reproduction paradigm can be adapted to reflect elements of actual social transmission (e.g., two-way discussion, receiving information from multiple partners, evaluating information from a friend versus a stranger, etc.; for a review and examples, see Mesoudi & Whiten, 2008), which future work can explore. For example, source characteristics, such as knowledgeable individuals or in-group membership, have been shown to influence people's memory for, and attitudes towards, the socially transmitted information (Carlson, 2019; Lee, Gelfand, & Kashima, 2014).

In summary, our studies show the importance of memory biases and the role of re-transmission in the reinforcement and spread of numerical misinformation. Our results demonstrate how schemas, in conjunction with re-transmission, can generate inaccurate information, facilitate the spread of inaccurate information from person to person, and exacerbate these errors through cumulative distortion, resulting from serial reproduction. Our findings are relevant to important questions about whether individuals possess an accurate understanding of the political world. Policy-relevant numerical facts play a prominent role in public discourse, as politicians, journalists, and interest groups use them as evidence to advocate for, or fight against, certain political causes. The ability of individuals to possess accurate representations of numerical facts may help protect them from the various forms of deceptive persuasion they encounter in their everyday lives.

Supporting Information

Additional Supporting Information may be found in the online version of this article. Please note: Oxford University Press is not responsible for the content or functionality of any supplementary materials supplied by the authors. Any queries (other than missing material) should be directed to the corresponding author for the article.

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Notes

1 We use the terms "theory" and "models" interchangeably throughout our discussion.

2 Our target sample size was 100 participants. We recruited 120 participants, given that we expected to lose, on average, 10% to 20% of participants due to data quality issues (e.g., participants wearing certain glasses or contact lenses that would interfere with our ability to accurately track their eyes).

3 Note that the presence of information sources was balanced in our design, such that one of the schema-consistent issues was associated with the Pew Research Center (level of support/opposition to same-sex marriage) and one of the schema-inconsistent issues was associated with the Washington Post (number of White/Black individuals killed by police officers in 2016).

4 Note that this number is continuously updated. When Study 1 was conducted in 2017, the total number of fatal police shootings for 2016 was 963. By 2019, the number for 2016 had been adjusted to 962.

5 We chose a 15-second time limit, given that we wanted to ensure that participants had enough time to read the critical stimuli. Previous work on eye movements and reading has shown that individuals tend to spend an average of 200 milliseconds per word while engaged in silent reading (Rayner, 1998). Our longest critical stimulus contained 38 words, suggesting that it would take participants an average of 7.6 seconds to read it (38 x 200 milliseconds). We doubled this value to give participants sufficient time to read all our critical stimuli. Further, we imposed a time limit to avoid differences in reading times as a potential confound, given that differences in reading times could correlate with our schema-consistent/-inconsistent manipulation.

6 Note that on average, individuals fixated on the first number region before the second number region in 73% of the trials. In 27% of the trials, individuals fixated on the second number before the first number, because they initially skipped (i.e., did not fixate on) the first number. Because skipping can be due to scanning text (i.e., skipped words are not subjected to cognitive processing; Rayner & Fischer, 1996), we adjusted our analyses accordingly. Specifically, for trials in which participants fixated on the second number before the first number, the first number became the "second number region" and the second number became the "first number region."

7 We manually defined regions of interest around the numbers that encompassed our critical regions of interest prior to data collection. Further, the two numbers in each of our critical stimuli were spaced apart. Specifically, they were never presented in the same line and there were anywhere between 4 and 12 words in between the first and second numbers.

8 Similar to other eye movement studies of text processing (Stites & Federmeier, 2015), fixations which lasted under 80 ms or over 800 ms were discarded. Single fixations under 80 ms are unlikely to represent meaningful cognitive processing (Rayner, 1998), and fixations greater than 800 ms often do not represent a normal acquisition of information from text (Rayner, Sereno, Morris, Schmauder, & Clifton, 1989). On average, 5.8% of fixations were excluded from the analysis.

9 See Baayen, Davidson, and Bates (2008) for the advantages of using mixed-effects modeling.

10 If a participant did not regress their gaze back to the first number, such trials were assigned a value of zero for our three eye movement metrics (i.e., number of fixations during regressions to first number region, duration of fixations during regressions to first number region, total number of regressions to first number region). Our statistical analyses included trials containing these zero values.

11 We also conducted exploratory analyses examining the interactions between partisan identity and schema consistency and between factual accuracy and schema consistency. These analyses are reported in the Supporting Information.

12 Note that our design did not allow us to specifically isolate which mechanism was occurring; this is, therefore, important for future work to examine.

13 Furthermore, we standardized the numerical responses before they were transmitted to the next person in the chain for Study 2a. For example, if a participant in Wave 1 entered "twenty-five million" as a response, this response would be converted to "25 million" before it was transmitted to a participant in Wave 2. In Study 2b, responses between participants were already on the same scale, since they were using the same sliders.

14 Future work may be able to obtain individual-level information about participants' schematic representations by using a two-part, longitudinal design. At the first time point, researchers could use survey questions that inquire about people's world knowledge and embed these questions in a larger battery of questions.

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