Abstract

Individuals are often exposed to science information from both expert and non-expert sources. Previous work has yet to examine whether individuals are more likely to remember the information conveyed by the expert compared to the non-expert. In the research reported here, we examine (1) people's likelihood of remembering information conveyed by domain-specific expert and non-expert scientists and (2) whether information from experts is more likely to survive social transmission processes. We find that information from expert sources are more likely to be remembered than non-expert sources and that information from experts are more likely to remain intact over person-to-person transmission. These are important findings for the field of science communication as it illustrates that individuals are distinguishing expert and non-expert sources when encoding information into memory.

Can Expertise Survive? Examining the Effects of Social Transmission on Scientific Information

In the past, the responsibility of communicating science information to the public rested solely on journalists (Triese & Weigold, 2002). Today, scientists themselves are encouraged to communicate their research directly to the public through social media platforms (i.e., blogs, Twitter, Facebook; Wolf, 2017). Indeed, science-related content generated by scientists is popular amongst the public with millions of people following science-related pages on Facebook and Twitter (Hitlin & Olmstead, 2017). With this surge of science popularization, there comes the risk of scientists speaking on topics outside of their area of expertise. That is, topics where they are considered “non-experts” (i.e., a forensic anthropologist writing an opinion on the dangers of genetically modified organisms). Given the saturation of voices, it is important that individuals are distinguishing between experts and non-experts on a given scientific topic as domain-specific experts can offer a more accurate opinion on the scientific topic (Goldman, 2001; Ericsson & Lehman, 1996; Tetlock, 2005).

In the research reported here, then, we examine the extent to which individuals are able to distinguish between domain-specific expert and non-expert scientists by examining people’s memories of the information conveyed by the scientist. More specifically, we examine if, and to what extent, people are more likely to remember the opinions and arguments about a scientific technology if the information is conveyed by an expert than a non-expert. This question is important for two reasons. First, individuals are frequently faced with important science-related decisions in their everyday lives (i.e., whether to eat genetically modified foods, drink fluoridated water, vaccinate their children). Therefore, it is important that they are able to remember the expert's opinion in order to make an informed decision. For example, suppose an individual is trying to decide whether or not to vaccinate themselves against the seasonal flu. She reads one article by a vaccine researcher at the CDC who argues about the safety and health benefits of vaccinations. Then, she encounters a different article written by a climate scientist claiming that vaccination can cause Guillain-Barre-Syndrome. At a later point in time, it is important for her to remember that the arguments in favor of vaccination was made by the CDC researcher and not the climate scientist.

Second, individuals often talk about science information with their friends and family (Falk, Storksdiek, & Dierking, 2007). As a consequence, individuals are frequently exposed to secondhand science information. It is important that this secondhand information includes expertise information. Otherwise individuals might attribute disproportionate weight to an opinion made by a non-credible source. For example, while browsing the Internet an individual might come across an interesting article touting the dangers of genetically modified organisms (GMOs). However, the author of the article is an anthropologist who is unqualified to provide a professional opinion on the dangers of GMOs. During a subsequent conversation, the individual retells the information from the article to a friend while neglecting to mention the credentials of the author. This absence of expertise-information might lead the friend to give the opinion more weight than it merits. Since individuals frequently retell scientific information to others, it is important to understand if individuals are more frequently exposed to the opinions/arguments of experts than the opinions/arguments of non-experts.

This study advances the science communication literature in three ways. First, we examine whether individuals are more likely to remember the opinion and arguments of an expert than a non-expert. Past research has examined whether individuals are likely to select and trust information from credible sources (Metzger, 2007) but few have examined if, and to what extent, individuals remember information from experts and non-experts differently. Second, this is one of the first studies to examine how, and in what ways, multiple retellings can transform a scientific message. Indeed, the preponderance of studies within the realm of science communication examine the effects of science messages that have not been transformed by social transmission *(*e.g., a newspaper article). But, if we assume that individuals often retell information they acquire, then we need to understand how this retelling process can transform a message. These transformed messages are likely similar to the type of science information that individuals are exposed to in their every-day interactions Finally, we introduce the serial reproduction paradigm to the realm of science communication. Essentially, it employs the children's game of "telephone" to examine how messages are changed via multiple retellings. We are one of the first studies to apply the paradigm to study the role of memory in the transmission of scientific information in communication research, although the paradigm could also be applied to other communication domains such as health or political communication.

The paper will be organized as follows: first, we will provide an overview of the role of source credibility on memory. Then, we will move onto a discussion of the importance of memory on the transmission of accurate opinions and arguments of experts. This will be followed by a discussion of the serial reproduction paradigm and its unique affordances for the study of person-to-person communication, before explaining the current study's research methods. Finally, we will discuss our results and the broader implications this study has on the study of science communication.

Effects of Credibility on Memory for Science Information

A simple Google search using the term “vaccinations pros and cons” returns almost two-million sites for one to choose from. While a majority of the sites are of high-quality (provided by expert sources), about 47% of the sites are low quality (judged on information accuracy; Kitchens et al., 2014). This is just one example that illustrates the likelihood that individuals will be exposed to information from non-experts when they are conducting an information search. While vaccinations might be considered a more familiar topic (i.e., has received extensive media coverage), when individuals encounter science information, it is often about unfamiliar topics (e.g., phage therapy) where they possess very little background information. When determining what to believe about these topics, individuals will rely on heuristic cues, such as source credibility, rather than the arguments provided by the source (Goodwin, 2011; Sorial, 2017).

Source credibility is typically broken into two dimensions: competence and warmth (Hovland, Janis, & Kelly, 1953; Fiske, Cuddy, & Glick, 2008; Metzger, 2007). Warmth is determined by an assessment of whether the source has the receiver’s best interest in mind (Fiske, Cuddy, & Glick, 2008). Competence is determined by assessing whether the individual has the ability to inform the receiver on the matter at hand (Fiske, Cuddy, & Glick, 2008). Competence is typically assessed automatically while warmth is established over time (Fiske, Cuddy, & Glick, 2008; Fiske & Dupree, 2014). While we acknowledge that warmth is an important component of credibility, we will be focusing on competence as it is the dimension that is typically determined first in the credibility assessment.

Competence is often characterized by a person’s relevant experience (e.g., a person who has a Ph.D. in immunology who is providing advice on the efficacy of a vaccine; Fiske & Dupree, 2014; Metzger, 2007). An individual who is perceived as competent—or an expert—on a topic is one that is trained extensively in that particular subfield and can, therefore, offer the most accurate opinion on the topic (Goldman, 2001; Walton, 1996). There is evidence that while individuals will read information from both expert and non-expert sources, they are distinguishing information that is conveyed by expert and non-expert sources. For instance, Winter and Krämer (2014) found that when individuals are selecting articles to read, they will choose both credible and non-credible sources. However, these same individuals were still able to accurately determine the credibility of the source by examining the author's expertise.

Previous research has not considered the role memory might play in this process. While studies have looked at how individuals evaluate and select information, few studies have examined whether individuals encode information provided by both an expert and non-expert differently ("encoding" is the process of storing information in memory). Indeed, individuals may treat source information as a discounting when they realize that the source is a non-expert. Discounting cues are essentially a warning that the information provided should not be trusted (i.e., the source is not credible; Gruder et al., 1978). Therefore, when individuals are aware that the information provided is not from an expert source they might not encode the information into memory. On the other hand, if the individual is aware that the source of the information *is* an expert on the topic, they might expend more cognitive energy on the message than they would if it were provided by a non-expert source.

When individuals pay attention to information they are more likely to remember it (Chun, & Turk-Browne, 2007, Norman 1968). Indeed, research suggests that individuals are less likely to remember information that they did not pay attention to (Jian & Chun, 2001; Wagner, Shannon, Kahn, & Buckner, 2005). Therefore, when an indpvidual is presented with information from two sources—one that is perceived as competent (an expert) and another that I rceived as incompetent (a non-expert)—they will pay more attention to the opinion and arguments provided by the expert than the non-expert. Therefore, we pose the following hypotheses:

H1: Individuals will more accurately remember the opinion of an expert compared to the opinion of a non-expert.

H2: Individuals will more accurately remember the arguments provided by an expert compared to the argument provided by a non-expert.

Consequences of Memory on the Retelling of Science Information

About 30 percent of the U.S. population report they are likely to tell a friend or family member about science news they encounter (Mitchell, Gottfried, Shearer, & Lu, 2017). Green and Clémence (2008) suggest that individuals likely share science information with others in the hopes of collectively making sense of the information and to potentially alleviate ambivalent feelings induced by the scientific information. During this retelling process, information is likely to be shortened—essentially stripped of extraneous details (Bangerter, 2000; Bartlett, 1932; Edwards & Middleton, 1987). Despite the inventible shortening process, expertise information is likely to remain for the following two reasons.

First, when an individual is exposed to both the opinion/argument of an expert and a non-expert, they are more likely to remember the opinion/argument of the expert as they will have paid more attention to the information. Theoretically, they are more likely to remember the expert's opinion/argument as they spent more cognitive energy encoding it. Therefore, they are more likely to pass the information provided by the expert to another individual. If this pattern holds, then it is likely that the opinion and argument provided by the expert is more likely to remain than the opinion and argument of the non-expert over the course of social transmission. For instance, if a individual reads that an expert supports the use of phage therapy while a non-expert opposes it, they are more likely to retell another individual that an expert supports it while forgetting the non-expert's opinion.

Furthermore, during the retelling of information to others, the original message is likely to be conventionalized (Bangerter, 2000; Bartlett, 1932; Edwards & Middleton, 1987). Conventionalization is when an item (e.g., a message) undergoes change as it is retold from one person to another until it reaches a stable form that is no longer changed no matter the number of subsequent retellings (Bartlett, 1932; Yonelinas, 2002). During the conventionalization process, there is a great potential for important information to be lost. Indeed, within a science message, expertise information or details about the scientific technology might be lost (Bangerter, 2000; Courviosier, Clémence, & Green, 2008). This loss of the expertise information limits an individual's ability to ascertain the credibility of a message. But, if we assume that an individual is more likely to remember the expert's opinion/argument, then this shortened message is more likely to contain the expert's opinion/argument as the non-expert's opinion/argument will be stripped away during the conventionalization process. We therefore postulate the following hypotheses:

H3: As the number of retellings increase, the accurate opinion of the expert is more likely to persist than the accurate opinion of the non-expert.

H4: As the number of retellings increase, the accurate argument provided by the expert is more likely to persist than the accurate argument of the non-expert.

Serial Reproduction Paradigm

The serial reproduction paradigm is one of the most influential methods for testing the role of memory in social transmission within the field of cognitive psychology (Edwards & Middleton, 1987). In the simplest terms, the paradigm mimics the children's game of "telephone" or "Chinese whispers" (Bartlett, 1932). In the telephone game, children are lined up and the first child is told a simple phrase, which they are tasked to pass along to the next child in line, and so on, until eventually the last person in the line tells everyone what they heard. Often, the message is often a distorted version of the original phrase (Bartlett, 1932; Edwards & Middleton, 1987). The paradigm uses a similar method to explore memory.

In the paradigm, the line of individuals is called a "chain." Each chain is made up of "waves" which are the individuals through which the information is passing through. For instance, the first individual in "chain 1" is shown the original message and then asked to retell (in either written or oratory form) the information from memory. Then, in "Wave 2" the second individual in "chain 1" is shown the information that the individual in "Wave 1" provided, and again asked to retell the information from memory. This process is continued for as many waves as desired (for a visualization, refer to Figure 1). This paradigm has been used to examine the influence of memory on a variety of social phenomena including stereotypes (Kashima, 2003), science information (Bangerter, 2000; Courvoisier, Clémence, & Green, 2013; Green & Clémence, 2008), and rumors (Allport & Postman, 1945). For example, Green and Clémence (2008) examined the transmission of a new genetic discovery. They found that through the course of social transmission, technical, scientific terms were replaced with more colloquial terms, suggesting that individuals use their preexisting knowledge to reconstruct the scientific message (Green & Clémence, 2008).

Although the paradigm does not account for the dynamics of interpersonal communication, this paradigm allows us to isolate one of the most important mechanisms involved in the retelling of information: memory. For if an individual does not remember the original message, then they are unable to retell it. Therefore, we chose to focus on internal validity in order to test the role of memory on the retelling of information.

[INSERT FIGURE 1 HERE]

Methods

Participants

A total of 99 participants were recruited from a large public university in the United States and the surrounding area. Each participant was compensated with $15 in return for taking part in the study. Three participants were excluded as a technical error with the study software prevented the recording of their responses. Once they were excluded, we analyzed data from the remaining 96 participants. Fifty percent of our participants were female while the other fifty percent were male. The sample had a mean age of 23.70 (*M* = 23.70, *SD* = 5.91, range = 18 – 66).

Materials

The critical stimuli for the first wave of participants consisted of 6 social media posts about scientific topics (see Table 1). Three of the stories were about topics that are, generally, familiar to the public (genetically modified organisms [GMOs], stem cell research, and the MMR vaccine) and three of the stories were about topics that are, generally, unfamiliar to the public (bioremediation, phage therapy, and thorium fuels). We chose to include both familiar and unfamiliar topics to ensure that our findings were not dependent on a specific topic. Each social media post began with a one to two sentence description of the scientific technology (e.g., "Bioremediation is the process of using organisms to neutralize or remove contamination from waste. Bioremediation can clean up contaminated soil, groundwater, and surface water. It stimulates the growth of certain microbes that use contaminants as a source of food and energy."). The opinion and argument of an expert was described directly after the description of the scientific technology (e.g., "Dr. Harris, a microbiologist and an expert on bioremediation opposes the process saying it might harm the contaminant into another toxic by-product.”). This was then followed by a sentence stating the opinion and argument of the non-expert (e.g., “However, Dr. Anderson, a chemist who is not an expert on bioremediation, supports bioremediation since it relies on naturally occurring biological organisms to metabolize environmental pollutants and renders them harmless to humans.”).

For each of the six articles the description of the scientific technology was always the same; however, we manipulated whether the expert and the non-expert agreed or disagreed about the scientific technology. For the scenarios for which the expert and non-expert agreed, we included a scenario in which they were in support of the technology and one in which they were both in opposition of the technology. Each of the responses provided by the individuals were counterbalanced. All of the social media posts were between 88 and 104 words long.

Procedure

Participants were tested individually in a quiet room. Participants were instructed at the start of the study that they would be reading several social media posts. They were told that each post would be on the screen for 30 seconds and then the post would be replaced by an empty text-entry box in which they would be asked to reproduce, from memory, the post they just read. The participants could spend as much, or as little, time as they felt they needed to reproduce the post. The participants read 12 posts (6 were our critical stimuli and 6 were distractor posts) and were asked to reproduce each of them. The order of the posts was randomized.

The reproduction task was completed using either a laptop or a smartphone as social transmission can occur across various digital devices. Before beginning the experiment, participants were asked to fill out a brief device preference questionnaire asking which brand of laptop (Apple, Dell, HP, or Lenova) and smartphone (Apple or Samsung) they were most comfortable using. The Apple computer had a 13.3-inch LED screen (resolution 1280 x 800); all other laptops had 13.3-inch LCD screens (resolution 1366 x 768). During the experiment, participants completed half of the main task on their preferred brand of laptop and the other half on the preferred brand of smartphone. The order of device, as well as which posts were displayed on the device, were counterbalanced across participants. Additionally, the auto-corrected and auto-complete functions were disabled on the smartphones. As we utilized a web-based application, laptops did not provide a spell-checking function, either. To further prevent differences between participants, they were instructed to not change any settings on the devices and to use them as they were presented.

The study employed the serial reproduction paradigm. In particular, participants were randomly assigned to a position in one of the 32 3-person chains (see Figure 1). Sixteen of the 3-person chains were composed of all female participants and 16 of the 3-person chains were composed of all male participants. We utilize a "Wave" terminology to refer to each position in the chains: the first position is "Wave 1," the second position is "Wave 2," and the third position is "Wave 3." Participants in Wave 1 were exposed to the original versions of our critical stimuli (see Table 1). In Wave 2, individuals were exposed to what the person in Wave 1 of their chain produced. Then, Wave 3 participants were exposed to what individuals in Wave 2 wrote. Participants were informed that the stimuli were news stories posted on social media in order to reduce any suspicion caused by misspellings, poor grammar, or other peculiarities in the reproduction.

Content Analysis of the Reproduction

Two independent coders worked through coding the written responses. A codebook was created for the coding. The coders were trained together and then worked independently on a random sample (148) of the 576 responses. The SPSS version 19 macro for Krippendorff's alpha (K-alpha) was used to assess reliability of the two coders for each item coded (Hayes & Krippendorff, 2007). Reliability above 0.80 is conventionally considered a "high" intercoder reliability score (Neuendorf, 2002). The following is a description of each item coded.

Accurate Opinion. As shown in Table 1, each social media post contained the opinion of an expert and a non-expert (i.e., the expert supports/the non-expert opposes). A reproduction of the opinion would be considered accurate, if (1) a participant correctly reproduced the source's opinion of support or opposition and (2) a participant correctly identified the source of the opinion. For each replication, the coders identified if there was an accurate opinion for source 1 and then repeated the process for source 2 (K-alpha = .86).

Accurate Argument. As shown in Table 1, each social media post contained the argument (reason for support or opposition) of an expert and a non-expert (i.e., the expert supports *because…*). A reproduction of the argument would be considered accurate if, and only if, (1) a participant correctly reproduced the general "meaning" conveyed by argument and (2) a participant correctly identified the source of the argument. For each replication, the coders identified if there was an accurate argument for source 1 and then repeated the process for source 2 (K-alpha = .86).

Analytical Strategy

Our first two hypotheses are concerned with whether individuals are more likely to accurately remember the information provided by an expert compared to the information provided by a non-expert. Individuals who were in Wave 1 were exposed to the complete science message, a message that not only included a description of the scientific technology but also the opinion of the expert and non-expert. Since we were interested people's ability to remember the expert's opinion and argument compared to the non-experts, we limited our analysis to Wave 1, as in this wave individuals were guaranteed to be exposed to all of the information.

For our first hypothesis, the independent variable is expertise (coded as 0 = Non-expert, 1 = Expert) while our dependent variable is accurate opinions (coded as 0 = Incorrect, 1 = Correct). Within a reproduction, an opinion was considered as accurate if it included *both* the expertise information and the opinion of the individual (i.e., an expert supports). For each reproduction there would be a score for the correct opinion for the expert and one for the non-expert. For the second hypothesis—individuals would remember the argument presented by the expert more than the argument presented by the non-expert—our independent variable is also expertise (0 = Non-expert, 1 = Expert) and our dependent variable is accurate argument (0 = Incorrect, 1 = Correct). In order for an argument to be considered correct it needed to correctly identify the expertise information and the gist of the information presented by them. For each reproduction, there would be a correct argument score for the expert and another one for the non-expert.

The third and fourth hypotheses are interested in whether the number of retellings affects the likelihood that the information provided by the expert is more likely to remain (i.e., the reproduction in the third wave still includes the expert's opinion) than the non-experts. In order to test H3—as the number of reproductions increase, the accurate opinion of the expert is more likely to remain than the accurate opinion of the non-expert—wave (0 = Wave 1, 1 = Wave 2, 2 = Wave 3) and expertise (0 = Non-expert, 1 = Expert) were the independent variables and proportion of accurate opinions for each user was our dependent variable. Since we were interested in how the opinion of the expert and non-expert fared over multiple retellings, we created a variable that counted the number of correct opinions each user replicated (total possible is 6) for the expert and then divided this number by six, since that is how many expert opinions in the original message.

We then repeated the process for the non-expert. Therefore, each user would have a proportion of accurate opinions for the expert and a proportion for the non-expert.

In order to test H4—as the number of replications increase, the accurate argument provided by the expert is more likely to remain than the accurate argument provided by the non-expert—our independent variables are wave (0 = Wave 1, 1 = Wave 2, 2 = Wave 3) and expertise (0 = Non-expert, 1 = Expert) and our dependent variable is the proportion of correct arguments. For the dependent variable, we created a variable that counted the number of correct arguments each user replicated (total possible is 6) for the expert and divided it by six, since that is how many expert arguments were present in the original messages. We then repeated this process for the non-expert. Each user would, therefore, have a proportion of accurate arguments for the expert and a proportion of accurate arguments for the non-expert.

Results

Overall, as the number of waves increased the average number of words per replication decreased. In Wave 1, the average number of word was 50.20, in Wave 2 it was 35.08, and in Wave 3 the average number of words was 30.81 (the original science messages had a range of 88 to 104). This pattern replicates previous findings in the literature (Green & Clémence, 2008). Further, we examined how the quality of the description of the scientific technology fared over time. In the first wave around 79% of the replications included both the name of the scientific technology as well as an accurate description of it. In Wave 2 around 64% of the replications included both the name of the scientific technology as well as an accurate description of it. By Wave 3, 54% of the replications provided both the name of the scientific technology and an accurate description of it.

Our first hypothesis was that individuals would be more likely to accurately remember the opinion of an expert more than the accurate opinion of the non-expert. We tested this hypothesis by estimating a logistic mixed effects model using the “lme4” (Bates, Maechler, Bolker, & Walker, 2015) and ‘lmerTest’ (Kuznetsova, Brockhoff, & Christenson, 2016) packages in the R statistical program. We included expertise (coded as 0 = Non-expert, 1 = Expert) as our primary independent variable (modeled as a fixed effect) and participants as a random effect. Our primary dependent variable was whether the opinion in a given reproduction was correct or incorrect (coded as 0 = Incorrect, 1 = Correct). We only examined Wave 1 as individuals in Wave 1 were exposed to the original message that contained the opinion of both the expert and the non-expert. After Wave 1 individuals were not guaranteed to have seen both individuals’ opinions. A positive and significant coefficient ($\beta = 1.60, \mathrm{SE} = .44,\ p < .001$) suggests that individuals are more likely to accurately remember the opinion of the expert (*M* = 0.87, *SD* = 0.34) than the accurate opinion of the non-expert (*M* = 0.78, *SD* = 0.42). Therefore, H1 was supported.

Although we focused on only the first wave to examine whether individuals were able to more accurately remember the opinion of the expert over the opinion of the non-expert we were interested in whether the pattern held across all waves. We, therefore, created a variable that counted how many reproductions (for each user) accurately contained the opinion of the expert and the non-expert and divided this number by how many accurate opinions they were exposed to (for instance, if an individual was exposed to four reproductions that contained the accurate opinion of the expert and they only remembered one of them, they would have a value of 0.25 for the expert. Each user had a value for the expert and another for the non-expert. We then conducted a paired t-test to compare the number of accurate opinions for the expert compared to the non-expert across all waves. There was a significant difference in the scores for expert (*M* = 0.90, *SD* = 0.19) compared to non-expert (*M* = 0.79, *SD* = 0.28) accurate opinions; *t*(84) = 5.00, *p* < .001. This further supports H1, illustrating that individuals are more likely to remember the expert's opinion regardless of how many opinions they are exposed to.

Our second hypothesis posited that individuals would more accurately remember the argument presented by the expert than the argument presented by the non-expert. Similar to the first hypothesis, we estimated a logistic mixed effects model using the "lme4" (Bates, Maechler, Bolker, & Walker, 2015) and the "lmerTest" (Kuznetsova, Brockhoff, & Christenson, 2016) packages in the R statistical program. Expertise was our independent variable and modeled as a fixed effect (coded as 0 = Non-expert, 1 = Expert) and accurate argument (coded as 0 = Inaccurate, 1 = Accurate) was our dependent variable. We included participant and issues as random effects. We only examined Wave 1 as individuals in Wave 1 were exposed to the complete scientific message that included the arguments presented by both individuals. A positive and significant coefficient ($\beta = .50, \mathrm{SE} = .25, p < .05$) suggests that individuals more accurately remember the argument presented by the expert (*M* = 0.70, *SD* = 0.50) compared to argument presented by the non-expert (*M* = 0.61, *SD* = 0.50). H2 was supported.

We were also interested in testing whether this pattern held across all waves. In order to test this, we created a variable that counted how many reproductions (for each user) contained an accurate opinion for both the expert and the non-expert (each user had a value for the expert and another for the non-expert), we then divided this by how many accurate arguments the individual was exposed to for each of the values. For each user there was a proportion created for the expert and the non-expert. We then conducted a paired-t-test to compare the number of accurate arguments for the expert compared to the non-expert across all waves. There was not a significant difference between the number of accurate arguments present for the expert (*M* = 0.68, *SD* = 0.26) compared to the non-expert (*M* = 0.60, *SD* = 0.28); *t*(82) = 1.84, *p* = .07.

Our third hypothesis predicted that as the number of retellings increased, the accurate opinion of the expert was more likely to persist as compared to the accurate opinion of the non-expert's. To test this, we estimated a logistic mixed effects linear model using the "lme4" (Bates, Maechler, Bolker, & Walker, 2015) and "lmerTest" (Kuznetsova, Brokhoff, & Cristenson, 2016) packages in the R statistical program to predict the accurate opinion within replications based on expertise and wave (see Figure 2). Our first independent variable is wave (coded as Wave 1= 0, Wave 2 = 1, Wave 3 = 2) and our second independent variable is expertise (coded as 0 = Non-Expert, 1 = Expert), these were fixed effects. We included participant as a random effect. Our dependent variable is accurate opinion[1]. There was a significant main effect of wave ($\beta = -0.09, \mathrm{SE} = 0.03,\ p < .001$) which means that the number of accurate opinions (not differentiating for expertise) in Wave 3 (*M* = 0.64, *SD* = 0.32) was less than the number of accurate opinions (not differentiating for expertise) in Wave 1 (*M* = 0.82, *SD* = 0.27). There was also a significant main effect of expertise ($\beta = 0.15, \mathrm{SE} = 0.02,\ p < .001$), which means that, overall, more replications contained the accurate opinion of the expert (*M* = .79, *SD* = 0.26) than the accurate opinion of the non-expert (*M* = 0.63, *SD* = 0.33). Additionally, there was a significant interaction between expertise and wave ($\beta = .05, t(94) = 2.08, p < .05$) which means that as the number of retellings increased, individuals were more likely to accurately remember the opinion of the expert than accurately remember the opinion of the non-expert. H3 was supported.

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[1] We estimated two logistic mixed-effects linear models to examine the two main effects. We, then, estimated a third logistic mixed-effects linear model to examine the interaction.

In order to examine the nature of this interaction, we created an interaction plot in Figure 2. As can be seen in Figure 2, the x-axis represents waves and the y-axis represents average (out of the six scientific messages) proportion of accurate opinions. One line represents the average proportion of correct expert opinions and the other line represents the average proportion of correct non-expert opinions across the waves. Notably the difference in average proportion of correct opinions between experts and non-experts are getting larger as the waves increase. Whereby in Wave 1 there was around a ten percentage difference between the proportion of accurate expert (*M* = 0.87, *SD* = 0.23) and non-expert (*M* = 0.78, *SD* = 0.30) opinions and by Wave 3 there was around a 20 percentage difference between the proportion of accurate expert (*M* = 0.75, *SD* = 0.27) and non-expert (*M* = 0.54, *SD* = .33) opinions.

[INSERT FIGURE 2]

Our fourth hypothesis predicted that as the number of waves increased, individuals would more accurately remember the arguments presented by the expert compared to the non-expert. In order to test this, we first created a variable that added the number of accurate expert opinions replicated by an individual divided by six (the number of original expert opinions). We then repeated this for the non-expert. Each user had a value for the non-expert and one for the expert. After creating the variable, we estimated a logistic mixed-effects model with wave (coded as 0 = Wave 1, 1 = Wave 2, 2 = Wave3) and expertise (coded as 0 = Non-expert, 1 = Expert) as independent variables. Wave and expertise were fixed effects while participant was a random effect. The proportion of accurate arguments (coded as 0 = Correct, 1 = Incorrect) was the dependent variable (see Figure 4). There was a significant main effect of expertise ($\beta = .07, \mathrm{SE} = .03, p < .001$) on the proportion of accurate arguments within a replication[2].

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[2] We estimated two logistic mixed-effects linear models to examine the two main effects. We, then, estimated a third logistic mixed-effects linear model to examine the interaction.

Therefore, individuals were more likely to accurately remember the expert's argument (*M* = 0.40, *SD* = 0.26) than the non-expert's argument (*M* = 0.32, *SD* = 0.28). There was also a main effect of wave ($\beta = -0.15,\ \mathrm{SE} = .03, p < .001$) on the proportion of correct arguments (regardless of expertise) present in a replication. This suggests that replications in Wave 1 (*M* = 0.53, *SD* = 0.30) were more likely to contain accurate arguments than replications in Wave 3 (*M* = 0.23, *SD* = 0.20). There was not a significant interaction between wave and expertise for the proportion of correct arguments ($\beta = 0.02, t(94) = -5.19, p = 0.63$). Therefore, H4 was not supported.

In order to explore the relationship further we plotted an interaction plot. The x-axis represents wave and the y-axis the average (of the six scientific messages) proportion of correct arguments. One line represents the average proportion of correct expert arguments and the other line represents the average proportion of correct non-expert arguments across waves. As can be seen in the graph, there is a decrease in the proportion of correct arguments across all waves. Additionally, across all waves people more accurately remembered arguments presented by experts compared to non-experts. However, the difference between the average proportion of expert arguments and non-expert correct arguments remains small across waves. Indeed, in Wave 1 the difference between the average proportion of correct expert arguments (*M* = 0.56, *SD* = 0.28) and non-expert arguments (*M* = 0.51, *SD* = 0.30) is around five percentage points. In Wave 3 the difference between the average proportion of expert correct arguments (*M* = 0.28, *SD* = 0.19) and non-expert correct arguments (*M* = 0.20, *SD* = 0.21) is around eight percentage points.

Discussion

The goal of this study was to examine whether individuals were more likely to remember information provided by experts compared to non-experts. In addition, we examined the effects of social transmission on the integrity of a science message, specifically examining whether expertise information was more likely to remain after multiple retellings than non-expert information. Our results show that individuals are more likely to remember information presented by experts than non-experts.

Individuals are often faced with new science information that they need to make sense of. Frequently, individuals will turn to the Internet to find information about these scientific topics. Given the diversity of sources available on the Internet—traditional news sources, blogs, social media posts—scholars are concerned with whether individuals are distinguishing between expert and non-expert sources during their information searches. While the source credibility literature suggests that individuals will only pay attention to sources they deem as competent, scholars have also found that individuals may not pay attention to source expertise (Eysenbach & Kohler, 2002). However, our findings support the source credibility literature that suggests that individuals *are* paying attention to source information and are more likely to remember the opinion and arguments presented by an expert than that of a non-expert.

Furthermore, thirty-three percent of Americans report regularly getting their science news from their friends and family (Funk, Gottfried, & Mitchell, 2017). However, whenever individuals retell information there is a potential for important details to be lost. While this might not be as large of an issue if an individual is passing along the latest celebrity gossip, the details within a science message (e.g., expertise information) are vital for ascertaining the credibility of the information. Our study found that individuals are more likely to remember the opinion of the expert over the course of multiple retellings. Interestingly we found that through social transmission the difference between the average proportion of expert accurate opinions and non-expert accurate opinions drastically increases. On the other hand, we found that while the difference between the average proportion of expert arguments and non-experts stays stable throughout the social transmission process. This difference between the effects of social transmission on correct opinions and correct arguments could be a result of the opinion information being easier to remember than the argument information.

Limitations

Our findings should not be generalized to different forms of social transmission. Social transmission is inherently a complex process involving many dimensions of interpersonal communication. In order to fully understand social transmission, each of these layers would need to be examined in its entirety. For instance, one important component of interpersonal communication is the relationship between the two or more individuals exchanging information. If the individuals do not have a pre-existing relationship (e.g., strangers), then they may not trust one another. This lack of trust, in turn, may cause them to discount/disregard the information conveyed by the other party. While social transmission is complex, memory is arguably the most important mechanism, as information cannot be retold if the individual does not remember it. Therefore, we prioritized internal validity to isolate the role memory plays on social transmission.

Future Directions

Our study shows that individuals are monitoring source information and using source expertise-information as a determination of whether to pay attention and remember the information presented. However, our study used short social media posts to explore how individuals monitor source information. It is important, therefore, to examine whether individuals are able to monitor source information when the message is longer (i.e., a full-length article). Furthermore, our study limited the information to two sources—one expert and one non-expert—research should examine if individuals are able to monitor source information when they are exposed to more than two opinions, as this is more comparable to the current information environment. Future works should also build upon the foundation we laid for understanding the social transmission of science information. One promising area of exploration is looking at how two individuals communicate about science information to isolate the role dialogue plays on memory and social transmission.

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Table 1

Summary of presentation of scientific topics

Whether the individuals agree or disagree	Example of stimuli
Expert and Non-expert Disagree	Genetically modified organisms (GMOs) are organisms in which genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination. The foreign genes may come from bacteria, viruses, insects or animals. **Dr. Lewis, a crop ecologist and an expert on GMOs supports GM technology saying that it is the solution to the worlds' food shortage**. *Dr. Hall, a virologist who is not an expert on GMOs, agrees that GMs are bad for biodiversity saying removing one pest that harms your crop could be removing a food source for another animal.*
Expert and Non-expert Disagree	A stem cell is a generic cell that can make exact copies of itself indefinitely. A stem cell has the ability to make specialized cells for various tissues in the body, such as the heart muscle and brain tissue. **Dr. King, a geneticist and expert on stem cell research oppose the use of stem cells since they might cause tumors if the cell is transplanted straight from undistinguished culture preps. On the other hand,** *Dr. Harris, a chemist and non-expert on stem cell research advocates for the research since it can aid scientists in understanding why some cells develop abnormally and cause medical problems like cancer.*
Expert and Non-expert Agree	Bioremediation is the process of using organisms to neutralize contamination from waste. Bioremediation can clean up contaminated soil, groundwater and surface water. It stimulates the growth of certain microbes that use contaminants as a source of food and energy. **Dr. Moore, a molecular epidemiologist and an expert on phage therapy, advocates for phage therapy saying it has been effective in treating bacterial infections in Eastern Europe for many years.** *Dr. Wilson, a physicist who is not an expert on phage therapy, also supports phage therapy because phages are much less likely to create a resistant infection since there are so many combinations of phages that can be used.*
Expert and Non-expert Agree	Since some infections have become antibiotic resistant due to an overuse of antibiotics in society, scientists are looking into the use of phage therapy to attack bacterial infections. **Dr. Moore, a molecular epidemiologist who is not an expert on phage therapy disagrees with phage therapy saying phages have the potential to mutate to create bacterial toxins that are harmful to humans.** *Dr. Wilson, a physicist who is not an expert on phage therapy also opposes phage therapy saying they are so specific they are harder and more expensive to administer than antibiotics.*

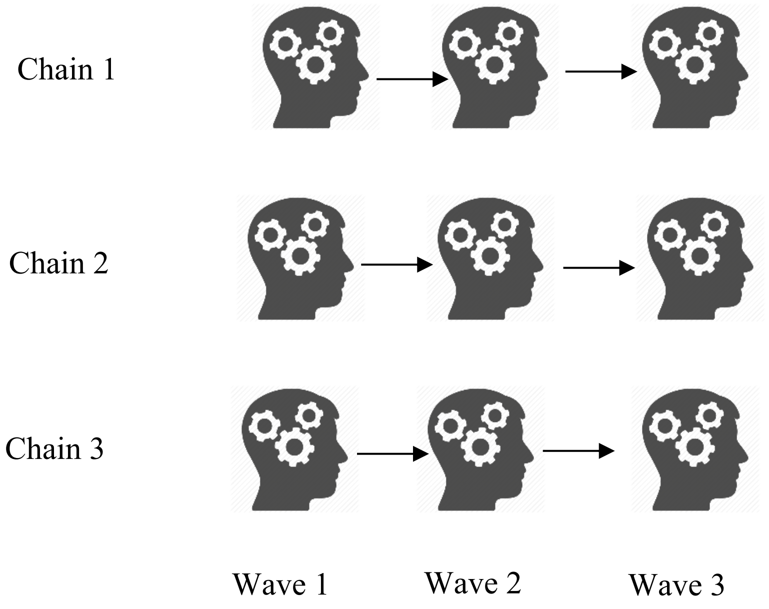

Figure 1. Schematic design of the serial reproduction paradigm

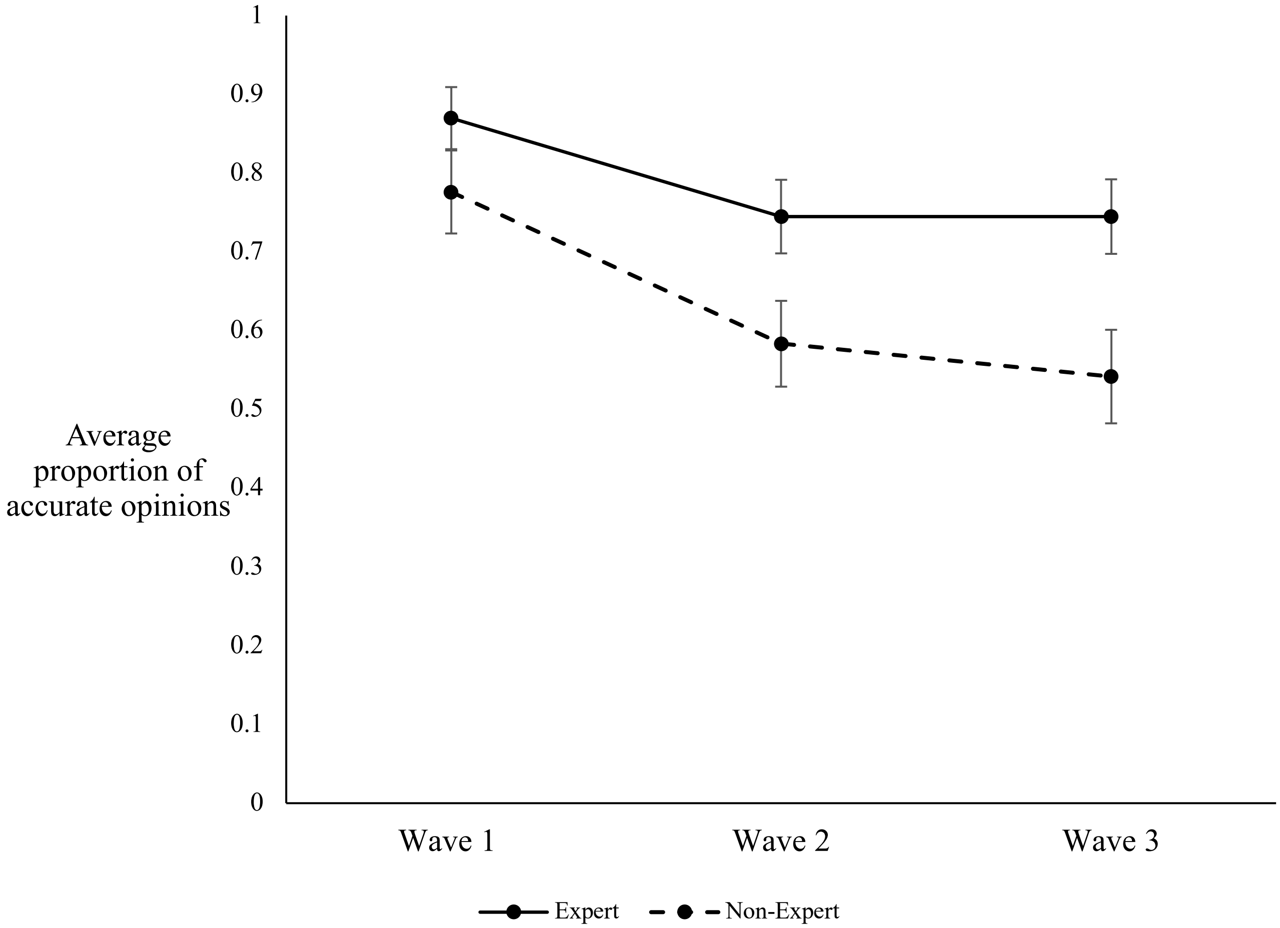

Figure 2. Proportion of reproductions with an accurate opinion across all three waves. Each participant had a proportion of accurate reproductions with the expert's opinion and non-expert' opinion. Each of the participant's accurate reproduction score was divided by six, as that is the number of expert (and non-expert) opinions in the original science message. The error bars represent standard errors of the mean (between-subject).

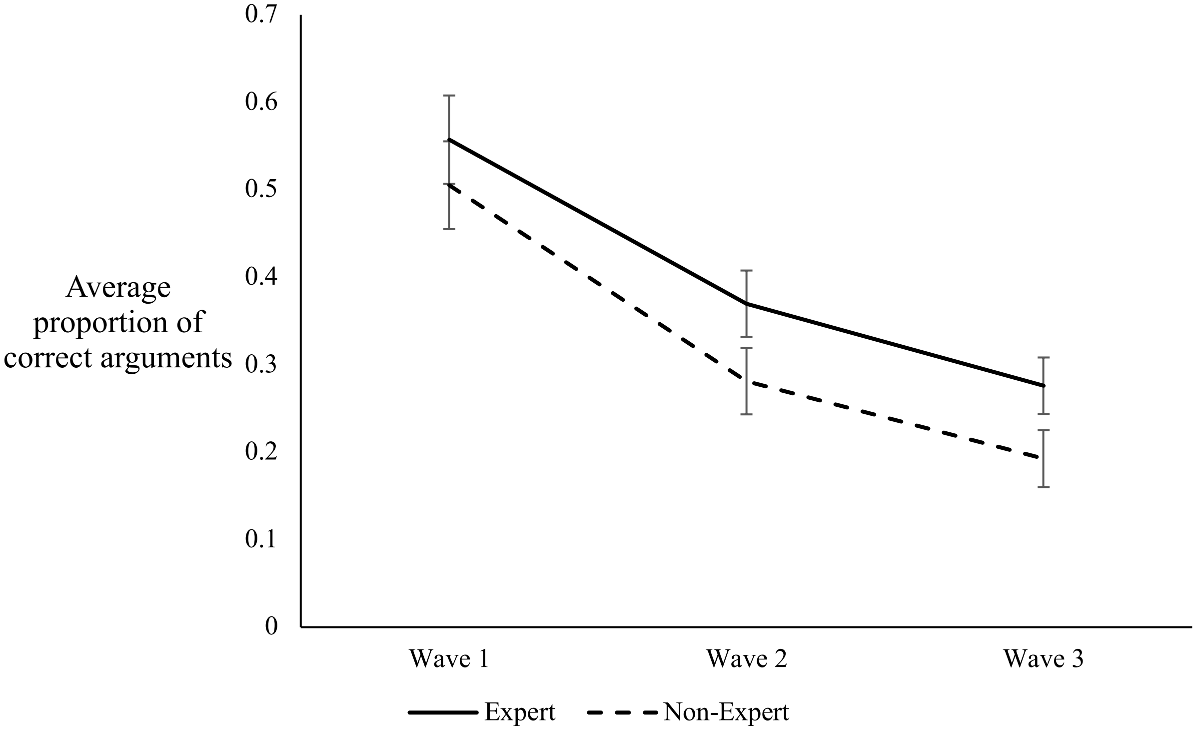

Figure 3. Proportion of reproductions with an accurate argument across all three waves. Each participant had a proportion of accurate reproductions with the expert's argument and non-expert argument. Each of the participant's accurate reproduction score was divided by six, as that is the number of expert (and non-expert) arguments in the original science message. The error bars represent standard errors of the mean (between-subject).